National Aeronautics and Space Administration

FISCAL YEAR 2009

Budget Estimates

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National Aeronautics and Space Administration
President's FY 2009 Budget Request Summary

Budget Authority, $ in millions

By Appropriation Account By Theme	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Science	**4,609.9**	**4,706.2**	**4,441.5**	**4,482.0**	**4,534.9**	**4,643.4**	**4,761.6**
Earth Science	1,198.5	1,280.3	1,367.5	1,350.7	1,250.9	1,264.4	1,290.3
Planetary Science	1,215.6	1,247.5	1,334.2	1,410.1	1,537.5	1,570.0	1,608.7
Astrophysics	1,365.0	1,337.5	1,162.5	1,122.4	1,057.1	1,067.7	1,116.0
Heliophysics	830.8	840.9	577.3*	598.9	689.4	741.2	746.6
Aeronautics	**593.8**	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**
Exploration	**2,869.8**	**3,143.1**	**3,500.5**	**3,737.7**	**7,048.2**	**7,116.8**	**7,666.8**
Constellation Systems	2,114.7	2,471.9	3,048.2	3,252.8	6,479.5	6,521.4	7,080.5
Advanced Capabilities	755.1	671.1	452.3	484.9	568.7	595.5	586.3
Space Operations	**5,113.5**	**5,526.2**	**5,774.7**	**5,872.8**	**2,900.1**	**3,089.9**	**2,788.5**
Space Shuttle	3,315.3	3,266.7	2,981.7	2,983.7	95.7	-	-
International Space Station	1,469.0	1,813.2	2,060.2	2,277.0	2,176.4	2,448.2	2,143.1
Space and Flight Support	329.2	446.3	732.8*	612.1	628.0	641.7	645.4
Education	**115.9**	**146.8**	**115.6**	**126.1**	**123.8**	**123.8**	**123.8**
Cross-Agency Support	**2,949.9**	**3,242.9**	**3,299.9**	**3,323.9**	**3,363.7**	**3,436.1**	**3,511.3**
Center Management and Operations	1,754.9	2,013.0	2,045.6	2,046.7	2,088.0	2,155.3	2,211.6
Agency Management and Operations	971.2	830.2	945.6	945.5	939.8	950.5	961.3
Institutional Investments	223.8	319.7	308.7	331.7	335.9	330.4	338.3
Congressionally Directed Items	-	80.0	-	-	-	-	-
Inspector General	**32.2**	**32.6**	**35.5**	**36.4**	**37.3**	**38.3**	**39.2**
FY 2008 Rescission**		(192.5)					
NASA FY 2009	**16,285.0**	**17,309.4**	**17,614.2**	**18,026.3**	**18,460.4**	**18,905.0**	**19,358.8**
Year to Year Change		6.3%	1.8%	2.3%	2.4%	2.4%	2.4%

Budgets include all direct costs required to execute the programs. Indirect costs are now budgeted within Cross-Agency Support.

* Deep Space and Near Earth Networks Transfer $256M to SFS in FY 2009.

** FY 2008 Appropriation rescinded $192.475M in prior-year unobligated balances, effectively reducing FY 2008 authority. Not included in totals.

FY 2008 budgets are the enacted levels per the FY 2008 Appropriation as shown in the Agency's FY 2009 Budget Estimates.

Totals may not add due to rounding.

National Aeronautics and Space Administration
President's FY 2009 Budget Request Detail

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Science	**4,609.9**	**4,706.2**	**4,441.5**	**4,482.0**	**4,534.9**	**4,643.4**	**4,761.6**
Earth Science	**1,198.5**	**1,280.3**	**1,367.5**	**1,350.7**	**1,250.9**	**1,264.4**	**1,290.3**
Earth Science Research	*349.5*	*375.8*	*380.6*	*388.2*	*390.6*	*400.7*	*409.3*
Research and Analysis	232.6	243.3	245.7	254.0	255.5	260.3	266.5
Computing and Management	91.3	103.1	104.9	104.7	107.3	110.1	111.8
Airborne Science	25.6	26.0	26.3	25.7	24.0	26.4	27.0
Near Earth Object Observations	-	3.4	3.7	3.8	3.8	3.9	4.0
Earth Systematic Missions	*420.9*	*530.1*	*677.9*	*661.5*	*583.2*	*563.6*	*569.6*
Global Precipitation Measurement (GPM)	23.8	74.4	125.8	161.7	129.8	140.0	113.3
Glory Mission	91.8	35.2	29.7	9.1	9.8	2.7	-
Landsat Data Continuity Mission	45.9	133.0	139.4	127.1	96.0	11.3	2.7
NPOESS Preparatory Project	47.3	70.0	94.4	46.3	8.6	8.9	9.2
Decadal Survey Missions	0.6	33.0	103.2	116.2	150.0	250.2	290.7
Ocean Surface Topography Mission	42.8	27.5	8.0	7.8	7.7	7.3	7.3
Other Missions and Data Analysis	168.7	157.0	177.4	193.4	181.2	143.1	146.3
Earth System Science Pathfinder	*167.9*	*113.8*	*88.6*	*58.8*	*37.4*	*50.0*	*54.9*
Orbiting Carbon Observatory (OCO)	84.8	35.6	25.4	9.0	1.4	-	-
Aquarius	62.4	48.6	33.8	27.9	5.1	4.0	2.9
Other Missions and Data Analysis	20.6	29.6	29.4	21.9	30.8	46.0	52.0
Earth Science Multi-Mission Operations	*168.0*	*167.8*	*140.5*	*159.1*	*157.9*	*166.5*	*170.9*
Earth Science Multi-Mission Operations	168.0	167.8	140.5	159.1	157.9	166.5	170.9
Earth Science Technology	*58.4*	*47.3*	*46.1*	*49.2*	*50.6*	*51.6*	*52.8*
Advanced Technology Initiatives	14.6	8.9	8.3	9.0	9.5	9.7	9.9
Instrument Incubator	32.1	26.6	25.9	28.2	28.4	28.8	29.5
Advanced Info Systems Technology	11.6	11.8	11.9	12.0	12.7	13.1	13.4
Applied Sciences	*33.9*	*45.4*	*33.8*	*33.8*	*31.3*	*32.1*	*32.8*
Pathways	33.9	45.4	33.8	33.8	31.3	32.1	32.8
Planetary Science	**1,215.6**	**1,247.5**	**1,334.2**	**1,410.1**	**1,537.5**	**1,570.0**	**1,608.7**
Planetary Science Research	*181.9*	*242.1*	*270.8*	*315.8*	*355.6*	*373.2*	*382.6*
Planetary Science Research and Analysis	111.7	127.8	142.4	145.1	150.4	155.2	159.0
Lunar Science Research	-	22.7	105.0	122.0	140.0	150.0	151.9
Operating Missions and Analysis	20.4	19.1	19.5	21.4	22.2	22.3	22.7

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Education and Directorate Management	49.8	72.4	3.9	27.4	43.1	45.7	49.0
Discovery	*128.3*	*153.0*	*247.0*	*258.3*	*256.0*	*326.1*	*140.5*
GRAIL	-	-	122.4	122.8	113.1	24.9	5.7
Moon Mineralogy Mapper	6.6	2.6	2.7	2.6	0.5	-	-
Discovery Future	13.1	103.9	50.4	49.1	65.4	239.8	90.7
Discovery Research	11.9	10.0	18.8	16.5	15.7	16.9	17.3
Operating Missions and Data Analysis	96.8	36.5	52.6	67.3	61.3	44.6	26.8
New Frontiers	*106.6*	*132.2*	*263.9*	*250.3*	*232.3*	*227.7*	*236.9*
Juno	87.8	108.3	245.0	225.2	168.0	14.4	17.8
Other Missions and Data Analysis	18.8	23.9	19.0	25.1	64.3	213.3	219.1
Mars Exploration	*634.9*	*553.5*	*386.5*	*299.6*	*344.5*	*341.1*	*413.8*
2009 Mars Science Lab	416.8	305.5	223.3	69.0	54.6	37.6	-
Mars Scout (2013)	5.3	57.7	6.7	68.5	152.5	170.7	121.8
Mars Research and Analysis	14.2	27.4	24.9	25.9	26.7	27.1	27.5
Operating Missions and Data Analysis	171.8	149.4	131.6	136.2	110.7	105.7	264.5
JPL Building	26.8	13.4	-	-	-	-	-
Outer Planets	*79.0*	*81.9*	*101.1*	*216.7*	*279.4*	*230.6*	*362.0*
Outer Planets	79.0	81.9	101.1	216.7	279.4	230.6	362.0
Technology	*84.8*	*84.8*	*64.9*	*69.3*	*69.6*	*71.3*	*73.0*
Technology	84.8	84.8	64.9	69.3	69.6	71.3	73.0
Astrophysics	**1,365.0**	**1,337.5**	**1,162.5**	**1,122.4**	**1,057.1**	**1,067.7**	**1,116.0**
Astrophysics Research	*98.9*	*102.2*	*152.3*	*170.4*	*181.0*	*203.0*	*198.9*
Astrophysics Research and Analysis	52.2	50.3	61.4	65.4	69.3	72.6	77.5
Balloon Project	22.2	22.8	24.6	26.7	28.8	32.4	33.2
Operating Missions and Data Analysis	24.5	29.1	66.3	78.4	82.9	97.9	88.2
Cosmic Origins	*790.9*	*807.3*	*674.4*	*571.1*	*515.4*	*485.6*	*458.5*
Hubble Space Telescope	279.5	228.5	154.9	125.6	114.7	94.8	93.9
James Webb Space Telescope	398.6	448.3	371.9	311.1	265.1	236.1	194.9
Stratospheric Observatory for Infrared Astronomy (SOFIA)	38.9	62.1	72.8	72.8	57.0	58.8	60.6
SIRTF/Spitzer	73.8	68.4	71.7	15.9	10.3	3.2	3.3
Astrophysics Future Missions	-	-	3.0	45.8	68.3	92.7	105.8
Physics of the Cosmos	*201.3*	*159.0*	*157.0*	*219.8*	*249.0*	*271.1*	*326.0*
Gamma-ray Large Space Telescope (GLAST)	88.9	33.3	23.2	23.3	24.1	24.9	24.9
Joint Dark Energy Mission (JDEM)	-	3.7	8.5	63.0	83.0	109.0	125.0

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Herschel	11.7	14.5	27.2	17.4	17.6	17.5	16.4
Planck	6.8	8.0	9.4	8.9	6.6	6.5	6.5
Other Missions and Data Analysis	93.9	99.5	88.8	107.2	117.7	113.2	153.2
Exoplanet Exploration	*184.7*	*162.6*	*48.1*	*67.7*	*68.4*	*96.4*	*126.2*
Space Interferometer (SIM)	30.4	54.1	-	-	-	-	-
Kepler	121.8	78.9	25.2	14.9	13.9	12.6	8.8
Other Missions and Data Analysis	32.5	29.6	22.9	52.9	54.5	83.7	117.4
Astrophysics Explorer	*89.2*	*106.4*	*130.6*	*93.3*	*43.3*	*11.7*	*6.4*
Wide - Field Infrared Survey Explorer	54.1	71.8	65.2	13.0	5.2	1.6	-
NuStar	-	-	41.5	57.8	31.0	6.8	6.4
Operating Missions and Data Analysis	35.1	34.6	23.9	22.5	7.1	3.2	-
Heliophysics	**830.8**	**840.9**	**577.3**	**598.9**	**689.4**	**741.2**	**746.6**
Heliophysics Research	*208.0*	*181.2*	*184.8*	*180.3*	*175.3*	*179.8*	*187.5*
Heliophysics Research and Analysis	32.5	30.9	33.9	35.9	38.9	39.6	40.5
Sounding Rockets	31.9	30.2	45.1	47.3	48.9	49.7	51.8
ACE	4.6	5.7	4.0	3.8	4.0	4.1	4.2
Operating Missions and Data Analysis	91.5	81.6	71.5	62.1	65.0	67.3	71.4
Research Range	17.5	12.8	18.3	19.2	18.6	19.2	19.6
GSFC Building Support	30.0	20.0	12.0	12.0	-	-	-
Living with a Star	*188.6*	*217.1*	*223.8*	*212.0*	*216.6*	*232.8*	*237.5*
Solar Dynamics Observatory	144.0	90.0	24.1	14.2	14.0	14.9	14.1
Radiation Belt Storm Probes	12.9	77.7	154.4	154.7	113.4	57.9	15.8
Solar Probe	-	13.9	-	3.4	40.1	74.2	106.3
Balloon Array for Radiation -Belt Relativ	-	-	0.9	3.9	2.4	2.0	2.1
Other Missions and Data Analysis	31.7	35.5	44.4	35.8	46.8	83.8	99.2
Solar Terrestrial Probes	*71.8*	*105.9*	*123.1*	*137.5*	*171.4*	*172.6*	*161.5*
Magnetospheric Multiscale	31.1	73.2	94.6	116.0	149.3	148.8	137.5
Other Missions and Data Analysis	40.7	32.7	28.5	21.5	22.0	23.9	24.1
Heliophysics Explorer Program	*74.4*	*61.0*	*41.3*	*66.8*	*125.1*	*156.0*	*160.1*
Interstellar Boundary Explorer	45.1	30.8	9.5	6.9	1.0	-	-
Other Missions and Data Analysis	29.3	30.2	31.8	60.0	124.1	156.0	160.1
New Millennium	*40.8*	*25.8*	*4.3*	*2.2*	*1.1*	*-*	*-*
New Millennium	40.8	25.8	4.3	2.2	1.1	-	-
Near Earth Networks	*43.8*	*39.5*	*-*	*-*	*-*	*-*	*-*

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Near Earth Networks	43.8	39.5	-	-	-	-	-
Deep Space Mission Systems (DSMS)	*203.3*	*210.5*	-	-	-	-	-
Deep Space Network	203.3	210.5	-	-	-	-	-
Aeronautics	**593.8**	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**
Aeronautics	**593.8**	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**
Aviation Safety	*87.3*	*66.5*	*62.6*	*65.9*	*65.0*	*64.5*	*66.5*
Integrated Vehicle Health Management	30.7	22.0	19.7	19.9	18.8	18.6	19.2
Aging Aircraft	14.9	10.0	10.6	11.3	11.2	12.0	12.4
Integrated Resilient Aircraft Control	22.2	15.3	17.1	18.5	19.0	18.2	18.8
Integrated Intelligent Flight Deck Technologies	19.5	19.3	15.2	16.3	16.0	15.7	16.1
Airspace Systems	*102.5*	*100.1*	*74.6*	*72.7*	*74.2*	*75.4*	*78.4*
NextGen - Airspace	85.1	83.3	61.3	56.0	57.3	58.5	60.8
NextGen - Airportal	17.4	16.8	13.3	16.7	16.9	16.9	17.5
Fundamental Aeronautics	*330.4*	*269.9*	*235.4*	*233.2*	*235.2*	*238.6*	*244.6*
Subsonic - Rotary Wing	36.1	30.8	25.8	26.6	26.7	26.9	28.0
Subsonic - Fixed Wing	133.9	119.9	108.4	105.3	107.6	109.1	111.5
Supersonics	67.7	53.0	44.0	44.9	44.3	45.2	46.6
Hypersonics	92.8	66.2	57.3	56.4	56.5	57.4	58.4
Aeronautics Test Program	*73.5*	*75.1*	*73.9*	*75.8*	*78.0*	*78.2*	*78.2*
Aero Ground Test Facilities	48.5	50.0	48.2	49.4	50.8	51.0	51.0
Flight Operations and Test Infrastructure	25.0	25.1	25.6	26.4	27.2	27.2	27.2
Exploration	**2,869.8**	**3,143.1**	**3,500.5**	**3,737.7**	**7,048.2**	**7,116.8**	**7,666.8**
Constellation Systems	**2,114.7**	**2,471.9**	**3,048.2**	**3,252.8**	**6,479.5**	**6,521.4**	**7,080.5**
Constellation Systems Program	*2,023.6*	*2,341.4*	*2,875.1*	*3,221.5*	*6,479.5*	*6,521.4*	*7,080.5*
Program Integration and Operations	661.8	530.8	748.2	815.8	2,337.0	2,332.8	3,070.0
Crew Exploration Vehicle	479.5	775.7	1,101.4	1,104.9	1,745.9	1,556.8	1,282.8
Crew Launch Vehicle	882.3	999.2	1,018.5	1,276.8	2,031.7	1,744.7	1,497.7
Cargo Launch Vehicle	-	35.7	7.0	24.0	365.0	887.0	1,230.0
Commercial Crew and Cargo	*91.1*	*130.5*	*173.0*	*31.3*	-	-	-
Commercial Orbital Transportation Services	91.1	130.5	173.0	31.3	-	-	-

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Advanced Capabilities	**755.1**	**671.1**	**452.3**	**484.9**	**568.7**	**595.5**	**586.3**
Human Research Program	*148.7*	*146.9*	*151.9*	*152.8*	*153.2*	*158.7*	*162.7*
ISS Medical Project	18.9	19.2	19.9	20.1	19.1	19.8	20.4
Research Infusion Projects	129.9	127.7	131.9	132.7	134.1	138.9	142.4
Exploration Technology Development	*359.1*	*326.0*	*244.1*	*296.6*	*398.8*	*420.2*	*407.1*
ISS Research	32.5	39.4	24.8	25.8	25.2	25.4	27.1
Technology Infusion Projects	326.5	286.6	219.3	270.7	373.6	394.9	380.0
Lunar Precursor Robotic Program	*247.3*	*198.2*	*56.3*	*35.5*	*16.7*	*16.5*	*16.5*
Lunar Precursor Robotic Program Management	44.0	16.3	16.4	16.4	16.5	16.5	16.5
Lunar Reconnaissance Orbiter	199.2	147.5	40.0	19.1	0.2	0.1	-
Lunar Robotics Lander	4.1	34.3	-	-	-	-	-
Space Operations	**5,113.5**	**5,526.2**	**5,774.7**	**5,872.8**	**2,900.1**	**3,089.9**	**2,788.5**
Space Shuttle	**3,315.3**	**3,266.7**	**2,981.7**	**2,983.7**	**95.7**	**-**	**-**
Space Shuttle Program	*3,315.3*	*3,266.7*	*2,981.7*	*2,983.7*	*95.7*	*-*	*-*
Program Integration	511.4	470.3	489.6	614.8	95.7	-	-
Flight and Ground Operations	1,066.7	1,121.8	1,031.2	955.9	-	-	-
Flight Hardware	1,717.2	1,674.6	1,460.9	1,413.0	-	-	-
Hurricane Recovery	20.0	-	-	-	-	-	-
International Space Station	**1,469.0**	**1,813.2**	**2,060.2**	**2,277.0**	**2,176.4**	**2,448.2**	**2,143.1**
International Space Station Program	*1,469.0*	*1,813.2*	*2,060.2*	*2,277.0*	*2,176.4*	*2,448.2*	*2,143.1*
ISS Operations	1,469.0	1,713.1	1,755.4	1,750.2	1,754.2	1,697.2	1,528.5
ISS Cargo Crew Services	-	100.1	304.8	526.8	422.2	751.0	614.6
Space and Flight Support (SFS)	**329.2**	**446.3**	**732.8**	**612.1**	**628.0**	**641.7**	**645.4**
Space Communications and Navigation	*191.3*	*303.9*	*582.9*	*475.2*	*491.3*	*504.8*	*508.5*
Space Communications Networks	59.9	90.7	363.5	385.5	409.8	420.2	423.7
Space Communications Support	66.4	63.9	65.4	63.7	62.5	62.0	71.4
TDRS Replenishment	65.0	149.3	154.0	26.0	19.0	22.6	13.4
Launch Services	*83.4*	*91.7*	*99.6*	*84.0*	*83.4*	*83.8*	*83.8*
Launch Services	83.4	91.7	99.6	84.0	83.4	83.8	83.8
Rocket Propulsion Testing	*46.4*	*41.9*	*41.8*	*44.3*	*44.7*	*44.6*	*44.6*
Rocket Propulsion Testing	46.4	41.9	41.8	44.3	44.7	44.6	44.6
Crew Health & Safety	*8.1*	*8.7*	*8.6*	*8.6*	*8.5*	*8.5*	*8.5*

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Crew Health and Safety	8.1	8.7	8.6	8.6	8.5	8.5	8.5
Education	**115.9**	**146.8**	**115.6**	**126.1**	**123.8**	**123.8**	**123.8**
Education	**115.9**	**146.8**	**115.6**	**126.1**	**123.8**	**123.8**	**123.8**
Education	*115.9*	*146.8*	*115.6*	*126.1*	*123.8*	*123.8*	*123.8*
Elementary and Secondary Education	35.1	23.8	32.1	38.1	35.8	35.8	35.7
Competitive Educational Grant Program	-	11.6	-	-	-	-	-
E-Education	3.6	5.8	6.8	6.7	6.7	6.7	6.8
MUREP	24.7	27.5	28.1	30.7	30.7	30.7	30.7
Higher Education	8.1	9.0	9.5	10.1	10.1	10.1	10.1
EPSCoR	12.8	12.8	8.3	10.0	10.0	10.0	10.0
NASA Space Grant	29.9	35.7	28.7	28.4	28.4	28.4	28.4
Global Climate Change Education	-	7.0	-	-	-	-	-
Informal Education	1.6	-	2.0	2.1	2.1	2.1	2.1
Science Museums and Planetarium Grants	-	7.8	-	-	-	-	-
NASA Visitor Centers	-	5.8	-	-	-	-	-
Cross-Agency Support	**2,949.9**	**3,242.9**	**3,299.9**	**3,323.9**	**3,363.7**	**3,436.1**	**3,511.3**
Center Management and Operations	**1,754.9**	**2,013.0**	**2,045.6**	**2,046.7**	**2,088.0**	**2,155.3**	**2,211.6**
Center Management and Operations	*1,754.9*	*2,013.0*	*2,045.6*	*2,046.7*	*2,088.0*	*2,155.3*	*2,211.6*
Facility Services	419.2	465.3	486.1	492.5	485.9	503.4	512.9
Environmental Management	20.1	27.9	28.3	28.8	29.7	30.5	31.3
Institutional Administration	611.6	573.0	591.0	595.3	606.4	624.7	641.2
Safety and Mission Assurance	28.1	41.9	43.5	44.8	46.5	47.8	49.5
SMA Technical Authority	13.9	25.5	25.4	26.0	26.7	27.5	28.4
Science & Engineering	-	200.4	206.4	207.1	214.6	221.4	228.4
Center Investments Account	164.9	92.5	81.3	72.3	81.2	87.3	93.1
Test Services	-	16.9	16.9	16.8	17.1	17.5	18.1
Information Services	226.6	258.2	255.7	252.6	257.2	262.9	267.2
Security Program	94.0	113.1	110.8	111.7	115.4	118.8	121.3
Fabrication	-	9.8	7.0	5.1	5.5	5.7	5.7
Other Personnel Costs	65.0	74.2	76.1	71.4	73.2	74.4	77.2

National Aeronautics and Space Administration
President's FY 2009 Budget Request Detail

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Technical Excellence	111.6	114.4	117.0	122.1	128.5	133.2	137.5
Agency Management and Operations	**971.2**	**830.2**	**945.6**	**945.5**	**939.8**	**950.5**	**961.3**
Agency Management	*363.2*	*361.5*	*414.6*	*422.5*	*430.6*	*438.8*	*447.3*
Agency Management	363.2	361.5	414.6	422.5	430.6	438.8	447.3
Safety and Mission Success	*174.1*	*161.6*	*163.4*	*165.4*	*167.3*	*169.3*	*171.3*
Safety and Mission Assurance	49.8	42.2	42.9	43.4	43.8	44.2	44.6
Chief Engineer	90.7	87.7	87.0	88.2	89.4	90.6	91.9
Chief Health and Medical Officer	4.7	2.8	4.1	4.1	4.2	4.2	4.2
Independent Verification and Validation	29.0	29.0	29.3	29.7	30.0	30.3	30.6
Agency IT Services (AITS)	*173.2*	*133.1*	*163.9*	*145.9*	*133.1*	*133.5*	*133.9*
IT Management	59.9	33.2	24.2	24.9	23.5	22.3	22.3
Applications	75.8	68.0	61.4	65.0	61.7	62.0	62.2
Infrastructure	37.5	31.9	78.4	56.0	48.0	49.1	49.5
Innovative Partnerships Program	*189.2*	*146.8*	*175.7*	*181.9*	*178.0*	*178.1*	*178.1*
Small Business Innovative Research	124.4	103.7	117.9	124.1	124.1	124.1	124.1
Small Business Technology Transfer Research	14.9	12.5	14.1	14.1	14.1	14.1	14.1
Partnership Development	41.0	21.2	24.1	25.4	22.3	22.2	22.0
SBIR-STTR- Program Support	8.6	8.5	9.1	7.8	7.0	7.2	7.4
Future Centennial Challenges	-	-	4.0	4.0	4.0	4.0	4.0
Independent Project Review Capability	-	0.8	-	-	-	-	-
FAST	-	-	2.0	2.0	2.0	2.0	2.0
Investment Seed Fund	-	-	4.0	4.0	4.0	4.0	4.0
Innovation Transfusion	-	-	0.5	0.5	0.5	0.5	0.5
Space Product Development	0.3	-	-	-	-	-	-
Strategic Capabilities Assets Program	*71.5*	*27.2*	*28.0*	*29.8*	*30.7*	*30.7*	*30.7*
Simulators	11.5	10.9	11.5	11.9	12.3	12.3	12.3
Thermal Vacuum Chambers	7.5	7.7	7.2	8.2	8.4	8.4	8.4
Arc Jets	9.9	8.6	9.3	9.7	10.0	10.0	10.0
Microgravity Flight Services	0.1	-	-	-	-	-	-
Space Power Facility Upgrades	42.0	-	-	-	-	-	-
SCAP Maintenance Projects	0.6	-	-	-	-	-	-
Institutional Investments	**223.8**	**319.7**	**308.7**	**331.7**	**335.9**	**330.4**	**338.3**
Institutional Construction of Facilities	*160.4*	*243.2*	*233.9*	*260.5*	*269.6*	*279.1*	*286.9*
Institutional Construction Of Facilities	160.4	243.2	233.9	260.5	269.6	279.1	286.9

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Environmental Compliance and Restoration	*63.4*	*76.5*	*74.8*	*71.2*	*66.3*	*51.3*	*51.4*
Environmental Compliance and Restoration	63.4	76.5	74.8	71.2	66.3	51.3	51.4
Congressionally Directed Items	-	*80.0*	-	-	-	-	-
Congressionally Directed Items	-	80.0	-	-	-	-	-
Inspector General	**32.2**	**32.6**	**35.5**	**36.4**	**37.3**	**38.3**	**39.2**
Inspector General	**32.2**	**32.6**	**35.5**	**36.4**	**37.3**	**38.3**	**39.2**
IG Program	*32.2*	*32.6*	*35.5*	*36.4*	*37.3*	*38.3*	*39.2*
Inspector General	32.2	32.6	35.5	36.4	37.3	38.3	39.2
NASA FY 2009	**16,285.0**	**17,309.4**	**17,614.2**	**18,026.3**	**18,460.4**	**18,905.0**	**19,358.8**

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FY 2009 Budget Request Summary

Message from the Administrator

NASA's Mission is to pioneer the future in space exploration, scientific discovery, and aeronautics research. NASA's FY 2009 budget request, a 1.8% increase over FY 2008, addresses a balanced set of priorities among these goals for our Nation's civil space and aeronautics programs as set forth by the NASA Authorization Act of 2005 (P.L. 109-155), the FY 2008 Omnibus Appropriations Act (P.L. 110-161), the Vision for Space Exploration, the National Aeronautics Research and Development Policy, and NASA's Strategic Plan.

NASA is making steady progress in the assembly of the International Space Station in accordance with our commitments to our fifteen international partners. Completing the Space Station, retiring the Space Shuttle in 2010 and managing the transition from the Space Shuttle to the Orion Crew Exploration Vehicle and Ares launch vehicles are, collectively, the greatest management challenges facing NASA since Apollo.

Within the Science portfolio in FY 2009, we are accelerating Earth science missions pursuant to the recent National Academies decadal survey, initiating development of an outer planets flagship mission, and increasing the funding for lunar science missions, among many other exciting initiatives.

In aeronautics, we address the fundamental research challenges facing the Next Generation Air Transportation System while also developing world-class aeronautics expertise and capabilities. NASA is also pursuing innovative partnerships with commercial companies that will better leverage private investment toward NASA's strategic goals.

We have a lot of hard work ahead of us, and are deploying our workforce to meet the challenges of that work. Last fall, we assigned new leadership roles and responsibilities for exploration and science missions to NASA's ten field Centers to carry out this work, and are reinforcing the core technical capabilities within our Centers.

In order to implement the direction in the FY 2008 Omnibus Appropriation to establish seven NASA appropriations accounts in the FY 2009 budget request, we must end the practice of requesting the budget for each program and project to be provided in "full cost". It simply requires too much effort in comparison for the marginal benefit which it provides. Thus, the budgets for NASA's programs and projects are requested only in terms of direct cost, and not the additional indirect costs associated with operating NASA's centers, safety and mission success, and Agency management and operations. The direct budgets will continue to reflect labor and travel costs associated with each program and project. The indirect costs are now budgeted solely within the Cross Agency Support account, and not in the NASA programs and projects. We will strive to ensure that these changes, the result of Congressional direction, are transparent to our stakeholders, and we will continue to track the full cost of our programs.

Finally, February 1st, we recognized the five year anniversary of the Space Shuttle Columbia tragedy, as a touchstone to measure our progress since those dark days. Our journey into space continues because we are dedicated to the missions before us and are resolute in conducting them in a credible, effective, and affordable manner. We must invest our time, resources, and energy wisely. The President's FY 2009 budget request for NASA represents such an investment.

Michael D. Griffin
Administrator

FY 2007 Highlights

Below are FY 2007 performance highlights for each NASA Strategic Goal and Sub-goal. Details appear in the Annual Performance Report in the Management and Performance section.

Strategic Goal (SG) 1: "Fly the Shuttle as safely as possible until its retirement, not later than 2010." In December 2006, STS-116 delivered to the International Space Station (ISS) the P5 truss, supplies, and Sunita Williams to relieve German astronaut Thomas Reiter. The crew reconfigured the ISS power system and retracted the P6 solar array. After repairing damage caused by a hailstorm, NASA launched STS-117, which delivered the S3/S4 truss, supplies, and Clayton Anderson, who relieved Williams. The crew deployed solar arrays and radiators on the new truss, configured the ISS for activation of the Oxygen Generation System (OGS), and repaired a loose thermal blanket on the Shuttle's right Orbital Maneuvering System pod. In August, STS-118 delivered supplies and the S5 truss, which the crew installed. The crew activated the Station-Shuttle Power Transfer System (SSPTS), which enables mission flexibility at ISS through extended orbiter stays. STS-118 also was the first flight of Educator Astronaut Barbara Morgan.

SG 2: "Complete the International Space Station in a manner consistent with NASA's International partner commitments and the needs of human exploration." In May and June 2007, ISS crew completed three extravehicular activities (EVAs) for maintenance, science, and assembly tasks. The new S3/S4 truss increased the Station's power capability. The OGS rack will allow the ISS to accommodate a six-member crew and enable NASA to further develop and validate life-support technology for long-duration human space missions. The S5 truss, when paired with the next truss (S6), will enable installation of additional solar arrays. In August, crew conducted three more EVAs for maintenance, science, and assembly tasks, including repair of the Carbon Dioxide Removal Assembly and activation of the SSPTS.

SG3: "Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration."
Strategic Sub-Goal (SSG) 3A: "Study Earth from space to advance scientific understanding and meet societal needs." Scientists at NASA's Goddard Space Flight Center and the University of Colorado developed an innovative technique to estimate, with unprecedented spatial detail, the growth and shrinkage of major drainage systems of the Greenland and Antarctic ice sheets. For Greenland, these results show significant ice loss in the southeastern section of the ice sheet, as well as modest losses elsewhere, while the interior has been growing. The estimated net change in mass (101 gigatonnes per year) is equivalent of 0.3 millimeters per year of sea level rise.

SSG 3B: "Understand the Sun and its effects on Earth and the solar system." NASA launched four satellites to explore and understand the dynamics of the Sun and its interactions with Earth. The missions revealed that: the occurrence of polar mesospheric clouds is increasing; the Sun's magnetic field is much more turbulent and dynamic than previously thought; and the processes that power the auroras progress at a rate faster than expected. The missions are a major step toward refreshing the aging Heliospheric Great Observatory constellation of satellites, noted as a potential risk to this Sub-goal in the FY 2006 Performance and Accountability Report.

SSG 3C: "Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space." Cassini used its powerful radar to see through the dense, hazy atmosphere of Saturn's moon, Titan, and obtain a clear image of lakes in the north polar region. The atmosphere is approximately two percent methane, similar to the percentage of water in Earth's atmosphere. At Titan's temperature, methane can exist as solid, liquid, or gas, just as water does on Earth, and the moon has methane clouds, rain, lakes, rivers, and erosion features. Titan also has a methanological cycle that acts like Earth's hydrological cycle.

SSG 3D: "Discover the origin, structure, evolution, and destiny of the universe, and search for Earthlike planets." Scientists used the Hubble Space Telescope (HST) to create a 3-D map showing the distribution of dark matter in the universe, providing the best evidence that normal matter, largely in the form of galaxies, accumulates along the densest concentrations of dark matter. The map reveals a loose network of filaments that grew over time and intersect in massive structures at the locations of clusters of galaxies. The map stretches halfway back to the beginning of the universe and shows how dark matter has grown increasingly "clumpy" as it collapses under gravity. Mapping dark matter's distribution in space and time is fundamental to understanding how galaxies grew and clustered over billions of years.

SSG 3E: "Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems." NASA, in partnership with the Air Force Research Lab and Boeing Phantom Works, completed flight experiments of the X-48B Blended Wing Body (BWB) advanced aircraft. The BWB is a hybrid configuration combining the best attributes of a conventional tube-and-wing aircraft with a flying wing. It has the potential to meet expected future Next Generation Air Transportation System requirements for low noise, low emissions, and high efficiency, with the added ability to land and take-off on shorter runways than current aircraft.

SSG 3F: "Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration." NASA completed the final on-orbit part of the Renal Stone study, which began in 2001. NASA is examining astronaut diet logs and urine collections from 20 subjects to test whether potassium citrate is an effective countermeasure against the formation of kidney stones while crews are in orbit. The risk of kidney stones is elevated in space due to the mobilization of calcium from bone loss and the effects of microgravity on fluid distribution in the body.

SG 4: "Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement." The design, development, and acquisition phases for the Constellation Systems Program and its associated projects (Orion, Ares I, Ground Operations, Mission Operations, and EVA) are on schedule. Cost, schedule, and performance trades will continue throughout the design cycle as the system design matures and gains fidelity. The Preliminary Design Review in fall 2008 will establish a formal baseline for the Program.

SG 5: "Encourage the pursuit of appropriate partnerships with the emerging commercial space sector." The Commercial Crew and Cargo Program broadened its encouragement of the emerging commercial launch industry by signing unfunded Space Act Agreements (SAA) with five new participants: Constellation Services International, PlanetSpace, SpaceDev, SpaceHab, and t/Space. Pursuant to the SAA with the funded participants, NASA provided funds as participants successfully met agreedupon milestones (obtaining commercial funding, holding design reviews, fabricating hardware, etc.) and terminated the SAA when a participant missed agreed-upon milestones.

SG 6: "Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations." NASA's Lunar Crater Observation and Sensing Satellite (LCROSS) and Lunar Reconnaissance Orbiter (LRO) will launch in late 2008. LCROSS's use of it's Atlas Centaur booster as impactor will detect water ice in the impact plume. LRO will create a comprehensive atlas of the Moon's topography for safe landing sites and lunar resources and study the radiation environment. NASA also demonstrated a prototype technology to form water from lunar regolith for potentially reducing the amount of consumables transported to a lunar or Martian outpost.

NASA's Budget Structure Adjustments

NASA implemented a full cost management system, to include budgeting and execution, in FY 2004 to improve the Agency's understanding of the true costs of projects and increase the efficient use of resources. After three years of full cost implementation, NASA conducted a review to determine the effects on Agency operations. The review revealed that indirect allocations were more complex than necessary, and that the indirect allocation approach created disadvantages for NASA's smaller research Centers.

The Agency addressed those Center impact issues last year in NASA's FY 2008 President's Budget Request by applying a single Agency-wide rate for Center Management and Operations for all nine Centers based on project direct budget. (The indirect costs for NASA's Jet Propulsion Laboratory are included in its contract rates as a Federally Funded Research and Development Center.)

The FY 2008 Omnibus Appropriations Act (P.L. 110-161) directed NASA to modify the Agency's FY 2009 appropriations account structure from three accounts (Science, Aeronautics, and Exploration; Exploration Capabilities; and Inspector General) to seven accounts (Space Operations, Exploration Systems, Science, Aeronautics, Education, Cross Agency Support, and Inspector General). The FY 2009 President's Budget Request is presented in the new seven-account structure.

To execute this new appropriations account structure across NASA's 10 Centers, the Agency must fund its indirect activities separately, instead of receiving allocations from each of the different appropriation accounts. Direct project funding continues to include the full cost of resources to execute projects including procurement, labor, travel, and test and fabrication services. Center Management and Operations, Corporate G&A, and Institutional Investments funding are budgeted in the Cross Agency Support (CAS) appropriations account. The FY 2009 CAS and Inspector General sections are presented in direct dollars for FY 2007 onward, and provide comparisons to the FY 2008 President's Budget Request in direct dollars. The other appropriation accounts based on Mission Directorates, Themes, programs and projects compare the FY 2009 President's Budget Request in direct dollars to the FY 2008 President's Budget Request in full cost. The Major Program Annual Report (MPAR) baseline cost estimates in the Management and Performance section were adjusted to reflect the use of direct cost budgeting for FY 2007 onward.

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President's FY 2009 Budget Request

Budget Authority, $ in millions							
By Appropriation Account By Theme	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Science	**4,609.9**	**4,706.2**	**4,441.5**	**4,482.0**	**4,534.9**	**4,643.4**	**4,761.6**
Earth Science	1,198.5	1,280.3	1,367.5	1,350.7	1,250.9	1,264.4	1,290.3
Planetary Science	1,215.6	1,247.5	1,334.2	1,410.1	1,537.5	1,570.0	1,608.7
Astrophysics	1,365.0	1,337.5	1,162.5	1,122.4	1,057.1	1,067.7	1,116.0
Heliophysics	830.8	840.9	577.3*	598.9	689.4	741.2	746.6
Aeronautics	**593.8**	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**
Exploration	**2,869.8**	**3,143.1**	**3,500.5**	**3,737.7**	**7,048.2**	**7,116.8**	**7,666.8**
Constellation Systems	2,114.7	2,471.9	3,048.2	3,252.8	6,479.5	6,521.4	7,080.5
Advanced Capabilities	755.1	671.1	452.3	484.9	568.7	595.5	586.3
Space Operations	**5,113.5**	**5,526.2**	**5,774.7**	**5,872.8**	**2,900.1**	**3,089.9**	**2,788.5**
Space Shuttle	3,315.3	3,266.7	2,981.7	2,983.7	95.7	-	-
International Space Station	1,469.0	1,813.2	2,060.2	2,277.0	2,176.4	2,448.2	2,143.1
Space and Flight Support	329.2	446.3	732.8*	612.1	628.0	641.7	645.4
Education	**115.9**	**146.8**	**115.6**	**126.1**	**123.8**	**123.8**	**123.8**
Cross-Agency Support	**2,949.9**	**3,242.9**	**3,299.9**	**3,323.9**	**3,363.7**	**3,436.1**	**3,511.3**
Center Management and Operations	1,754.9	2,013.0	2,045.6	2,046.7	2,088.0	2,155.3	2,211.6
Agency Management and Operations	971.2	830.2	945.6	945.5	939.8	950.5	961.3
Institutional Investments	223.8	319.7	308.7	331.7	335.9	330.4	338.3
Congressionally Directed Items	-	80.0	-	-	-	-	-
Inspector General	**32.2**	**32.6**	**35.5**	**36.4**	**37.3**	**38.3**	**39.2**
FY 2008 Rescission**		(192.5)					
NASA FY 2009	**16,285.0**	**17,309.4**	**17,614.2**	**18,026.3**	**18,460.4**	**18,905.0**	**19,358.8**
Year to Year Change		6.3%	1.8%	2.3%	2.4%	2.4%	2.4%

Budgets include all direct costs required to execute the programs. Indirect costs are now budgeted within Cross-Agency Support.

* Deep Space and Near Earth Networks transfers $256 million to Space and Flight Support in FY 2009.

** FY 2008 Appropriation rescinded $192.475M in prior-year unobligated balances, effectively reducing FY 2008 authority. Not included in totals.

FY 2008 Budgets are the enacted levels per the Agency's FY 2009 Budget Estimates. Totals may not add due to rounding.

Science

The Science Mission Directorate (SMD) conducts scientific exploration, enabled by access to space or near-space, to help NASA achieve Strategic Goal 3. SMD's four science Sub-goals under Strategic Goal 3 are focused through a "Theme" as follows:
- Earth Science Theme: "Study Earth from space to advance scientific understanding and meet societal needs.";
- Planetary Science Theme: "Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.";
- Heliophysics Theme: "Understand the Sun and its effects on Earth and the solar system."; and
- Astrophysics Theme: "Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.".

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**4,609.9**	**4,706.2**	**4,441.5**	**4,482.0**	**4,534.9**	**4,643.4**	**4,761.6**
Earth Science	1,198.5	1,280.3	1,367.5	1,350.7	1,250.9	1,264.4	1,290.3
Planetary Science	1,215.6	1,247.5	1,334.2	1,410.1	1,537.5	1,570.0	1,608.7
Astrophysics	1,365.0	1,337.5	1,162.5	1,122.4	1,057.1	1,067.7	1,116.0
Heliophysics	830.8	840.9	577.3	598.9	689.4	741.2	746.6
FY 2008 President's Budget Request	**5,466.8**	**5,516.1**	**5,555.3**	**5,600.6**	**5,656.9**	**5,802.7**	**--**
Earth Science	1,464.5	1,497.3	1,545.8	1,520.1	1,411.2	1,353.2	--
Planetary Science	1,411.2	1,395.8	1,676.9	1,720.3	1,738.3	1,748.2	--
Astrophysics	1,563.0	1,565.8	1,304.2	1,268.9	1,266.2	1,393.8	--
Heliophysics	1,028.1	1,057.2	1,028.4	1,091.3	1,241.2	1,307.5	--
Total Change from FY 2008 President's Budget Request	**-856.9**	**-809.9**	**-1,113.8**	**-1,118.6**	**-1,122.0**	**-1,159.3**	**4,761.6**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Aeronautics

NASA's Aeronautics Research Mission Directorate (ARMD) conducts high-quality, cutting-edge research that generates innovative concepts, tools, and technologies to enable revolutionary advances in our Nation's future aircraft as well as in the airspace in which they will fly. ARMD programs will facilitate a safer, more environmentally friendly, and more efficient national air transportation system. In addition, NASA's aeronautics research will continue to play a vital role in supporting NASA's human and robotic space exploration activities.

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**593.8**	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**
Aeronautics	593.8	511.7	446.5	447.5	452.4	456.7	467.7
FY 2008 President's Budget Request	**529.3**	**554.0**	**546.7**	**545.3**	**549.8**	**554.7**	**--**
Aeronautics	529.3	554.0	546.7	545.3	549.8	554.7	--
Total Change from FY 2008 President's Budget Request	**64.5**	**-42.3**	**-100.2**	**-97.8**	**-97.4**	**-98.0**	**467.7**

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Exploration

The Exploration Systems Mission Directorate (ESMD) develops capabilities and supporting research and technology that enable sustained and affordable human and robotic exploration. ESMD is also developing a robotic precursor mission, human transportation elements, and life support systems for the near-term goal of lunar exploration.

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**2,869.8**	**3,143.1**	**3,500.5**	**3,737.7**	**7,048.2**	**7,116.8**	**7,666.8**
Constellation Systems	2,114.7	2,471.9	3,048.2	3,252.8	6,479.5	6,521.4	7,080.5
Advanced Capabilities	755.1	671.1	452.3	484.9	568.7	595.5	586.3
FY 2008 President's Budget Request	**4,152.5**	**3,923.8**	**4,312.8**	**4,757.8**	**8,725.2**	**9,076.8**	**--**
Constellation Systems	3,232.5	3,117.6	3,664.2	4,131.5	8,038.4	8,368.4	--
Advanced Capabilities	920.0	806.2	648.6	626.3	686.8	708.4	--
Total Change from FY 2008 President's Budget Request	**-1,282.7**	**-780.7**	**-812.3**	**-1,020.1**	**-1,677.0**	**-1,960.0**	**7,666.8**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual Column, the 2008 Omnibus Appropriations Act (P.L. 110-161) and the 5-year Proposed Budget estimates for 2009 through 2013. FY 2008 Adjusted President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Space Operations

The Space Operations Mission Directorate (SOMD) is responsible for providing mission critical space exploration services to both NASA customers and to other partners within the United States and throughout the world: flying the Space Shuttle to assemble the International Space Station; ensuring safe and reliable access to space; maintaining secure and dependable communications between platforms across the solar system; and ensuring the health and safety of our Nation's astronauts.

At the heart of SOMD is nearly half a century of experience at safely and reliably building, flying, and maintaining some of the world's most advanced and complex aerospace systems. The Vision for Space Exploration and the NASA Strategic Plan recognize the role of the International Space Station as a unique orbital outpost for carrying out the scientific and engineering research needed for prolonged stays on the Moon and Mars. The lessons being learned during the construction and operation of the International Space Station are directly applicable to the challenges that may be faced by explorers on the lunar and Martian surfaces.

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**5,113.5**	**5,526.2**	**5,774.7**	**5,872.8**	**2,900.1**	**3,089.9**	**2,788.5**
Space Shuttle	3,315.3	3,266.7	2,981.7	2,983.7	95.7	--	--
International Space Station	1,469.0	1,813.2	2,060.2	2,277.0	2,176.4	2,448.2	2,143.1
Space and Flight Support (SFS)	329.2	446.3	732.8	612.1	628.0	641.7	645.4
FY 2008 President's Budget Request	**6,108.3**	**6,791.7**	**6,710.3**	**6,625.7**	**3,036.6**	**2,978.0**	**--**
Space Shuttle	4,017.6	4,007.5	3,650.9	3,634.4	116.2	--	--
International Space Station	1,762.6	2,238.6	2,515.1	2,609.2	2,547.5	2,600.8	--
Space and Flight Support (SFS)	328.1	545.7	544.3	382.0	372.9	377.2	--
Total Change from FY 2008 President's Budget Request	**-994.7**	**-1,265.6**	**-935.6**	**-752.9**	**-136.5**	**111.8**	**2,788.5**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Education

The Office of Education (referred to as Education) partners with academia, professional associations, industry, and other agencies to provide teachers and faculty with experiences that capitalize on the excitement of NASA's missions and provides meaningful, content-rich educational programs to inspire students at all levels to pursue careers in fields related to Science, Technology, Engineering, and Mathematics (STEM). Education's programs strive to reach and connect with youth, and to excite and inspire them into becoming the next generation of scientists, inventors, technicians, and explorers.

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**115.9**	**146.8**	**115.6**	**126.1**	**123.8**	**123.8**	**123.8**
Education	115.9	146.8	115.6	126.1	123.8	123.8	123.8
FY 2008 President's Budget Request	**167.4**	**153.7**	**152.8**	**152.7**	**149.8**	**149.6**	**--**
Education	167.4	153.7	152.8	152.7	149.8	149.6	--
Total Change from FY 2008 President's Budget Request	**-51.5**	**-7.0**	**-37.2**	**-26.6**	**-26.0**	**-25.8**	**123.8**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual column, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Cross Agency Support

Cross-Agency Support provides a focus for managing technical capability and agency mission support functions. This budget area consists of three themes: Center Management and Operations (CM&O), Agency Management and Operations, and Institutional Investments (II). Cross-Agency Support is not directly identified or aligned to a specific program or project requirement but is necessary to ensure the efficient and effective operation and administration of NASA.

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**2,949.9**	**3,242.9**	**3,299.9**	**3,323.9**	**3,363.7**	**3,436.1**	**3,511.3**
Center Management and Operations	1,754.9	2,013.0	2,045.6	2,046.7	2,088.0	2,155.3	2,211.6
Agency Management and Operations	971.2	830.2	945.6	945.5	939.8	950.5	961.3
Institutional Investments	223.8	319.7	308.7	331.7	335.9	330.4	338.3
Congressionally Directed Items	--	80.0	--	--	--	--	--
FY 2008 President's Budget Request	**2,962.8**	**3,285.5**	**3,263.6**	**3,290.5**	**3,345.8**	**3,419.2**	**--**
Center Management and Operations	1,733.0	2,013.0	2,014.7	2,031.5	2,078.2	2,141.4	--
Corporate General and Administrative	741.1	678.7	679.1	673.9	680.1	695.7	--
Advanced Business Systems (IEMP)	80.8	84.1	56.8	58.9	55.7	55.7	--
Innovative Partnerships Program	178.6	162.0	161.8	164.7	165.2	165.3	--
Strategic Capabilities Assets Program	18.3	28.0	28.0	29.8	30.7	30.7	--
Institutional Investments	211.0	319.7	323.2	331.7	335.9	330.4	--
Total Change from FY 2008 President's Budget Request	**-12.9**	**-42.6**	**36.3**	**33.4**	**17.9**	**16.9**	**3,511.3**

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. The FY 2008 President's Budget Request is shown in direct dollars.

Inspector General

The NASA Office of Inspector General (OIG) budget request for FY 2009 is $35.5 million. The NASA OIG consists of 203 auditors, analysts, specialists, investigators, and support staff at NASA Headquarters in Washington, DC, and NASA Centers throughout the United States. The FY 2009 request supports the OIG mission to prevent and detect crime, fraud, waste, abuse, and mismanagement while promoting economy, effectiveness, and efficiency within the Agency.

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**32.2**	**32.6**	**35.5**	**36.4**	**37.3**	**38.3**	**39.2**
Inspector General	32.2	32.6	35.5	36.4	37.3	38.3	39.2
FY 2008 President's Budget Request	**33.5**	**34.6**	**35.5**	**36.4**	**37.3**	**38.3**	**--**
Inspector General	33.5	34.6	35.5	36.4	37.3	38.3	--
Total Change from FY 2008 President's Budget Request	**-1.3**	**-2.0**	**0.0**	**0.0**	**0.0**	**0.0**	**39.2**

Management and Performance Overview

The Management and Performance section provides a comprehensive record of the past and planned performance for NASA's programs and projects. This section includes the key NASA FY 2009 Performance Plan; an update to the FY 2008 Performance Plan based on Congressional budget action; a summary of the cost and schedule performance of NASA's projects with estimated life cycle cost above $250 million; progress on the implementation of the initiatives for the President's Management Agenda (PMA); and the FY 2007 Annual Performance Report.

NASA's planning and performance management processes are an essential part of the Agency's governance and strategic management system. The Agency has an integrated system to plan strategy and implementation; monitor, assess, and evaluate performance toward commitments; identify issues; gauge programmatic and organizational health; and provide appropriate data and information to NASA decision-makers.

Through its strategic management system, NASA: identifies the Agency's long-term Strategic Goals, multi-year Outcomes, and other key performance measures; develops and implements plans to achieve these Goals; and continuously measures the Agency's progress toward these Goals. NASA managers use performance results as a basis for key investment decisions, and NASA performance data provides a foundation for both programmatic and institutional decision-making processes.

NASA's planning and performance management processes provide data to Agency management via: ongoing monthly and quarterly analysis and reviews; annual assessments in support of budget formulation (for budget guidance and issue identification, analysis, and disposition); annual reporting of performance, management issues, and financial position; periodic, in-depth program or special purpose assessments; and recurring or special assessment reports to internal and external organizations.

NASA's performance system is designed to align with the Agency's internally and externally imposed performance measurement and reporting requirements, tools, and practices, including the Government Performance and Results Act, the President's Management Agenda, and the Office of Management and Budget's Program Assessment Rating Tool (PART) evaluations.

Overview

The Science Mission Directorate (SMD) conducts scientific exploration, enabled by access to space or near-space, to help NASA achieve Strategic Goal 3. SMD's four science Sub-goals under Strategic Goal 3 are focused through a "Theme" as follows:
- Earth Science Theme: "Study Earth from space to advance scientific understanding and meet societal needs.";
- Planetary Science Theme: "Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.";
- Heliophysics Theme: "Understand the Sun and its effects on Earth and the solar system."; and
- Astrophysics Theme: "Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.".

These Sub-goals encompass questions as practical as next week's weather, as enticing as the prospect of life elsewhere in the solar system and beyond, and as profound as the origin of the universe. Together, they support the Agency's Mission: "To pioneer the future in space exploration, scientific discovery, and aeronautics research."

Fundamental research on profound science questions is the hallmark of NASA's Science portfolio. SMD pursues its science Sub-goals with: observatories in high-altitude aircraft, Earth orbit, and deep space; spacecraft visiting the Moon and other planetary bodies; and robotic landers, rovers, and sample return missions. Responsibility for defining, planning, and overseeing NASA's portfolio of space and Earth science programs is assigned by the NASA Administrator to SMD. Each Theme is responsible for its science area and associated performance measures.

The FY 2009 budget is the result of a planning process that starts with the NASA Strategic Plan and uses a defined process for creating a balanced portfolio of science investments. In planning its science portfolio, NASA begins with the broad consensus science priorities defined by the National Research Council (NRC) in its decadal surveys of science community priorities and other reports. Under the auspices of the NASA Advisory Council (NAC), NASA engages the science community in developing triennial roadmaps for implementing these priorities.

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**4,609.9**	**4,706.2**	**4,441.5**	**4,482.0**	**4,534.9**	**4,643.4**	**4,761.6**
Earth Science	1,198.5	1,280.3	1,367.5	1,350.7	1,250.9	1,264.4	1,290.3
Planetary Science	1,215.6	1,247.5	1,334.2	1,410.1	1,537.5	1,570.0	1,608.7
Astrophysics	1,365.0	1,337.5	1,162.5	1,122.4	1,057.1	1,067.7	1,116.0
Heliophysics	830.8	840.9	577.3	598.9	689.4	741.2	746.6
FY 2008 President's Budget Request	**5,466.8**	**5,516.1**	**5,555.3**	**5,600.6**	**5,656.9**	**5,802.7**	**--**
Earth Science	1,464.5	1,497.3	1,545.8	1,520.1	1,411.2	1,353.2	--
Planetary Science	1,411.2	1,395.8	1,676.9	1,720.3	1,738.3	1,748.2	--
Astrophysics	1,563.0	1,565.8	1,304.2	1,268.9	1,266.2	1,393.8	--
Heliophysics	1,028.1	1,057.2	1,028.4	1,091.3	1,241.2	1,307.5	--
Total Change from FY 2008 President's Budget Request	**-856.9**	**-809.9**	**-1,113.8**	**-1,118.6**	**-1,122.0**	**-1,159.3**	**4,761.6**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Mission Directorate: Science

Budget Changes

Budget Authority ($ millions)	Actual FY 2007	Enacted FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-856.9**	**-809.9**	**-1,113.8**	**-1,118.6**	**-1,122.0**	**-1,159.3**	**4,761.6**
Earth Science	**-266.0**	**-217.0**	**-178.3**	**-169.5**	**-160.3**	**-88.7**	**1,290.3**
Programmatic Content	--	41.9	85.1	86.9	77.3	138.0	1,290.3
Programmatic Transfers	--	-0.1	3.6	3.7	3.7	3.8	--
Institutional Adjustments	-266.0	-258.8	-267.0	-260.1	-241.3	-230.5	--
Planetary Science	**-195.6**	**-148.4**	**-342.6**	**-310.2**	**-200.9**	**-178.2**	**1,608.7**
Programmatic Content	--	-2.2	-124.0	-90.4	23.3	55.6	1,613.6
Programmatic Transfers	23.6	25.8	-8.3	-9.3	-9.6	-9.0	-4.9
Institutional Adjustments	-219.2	-172.0	-210.3	-210.5	-214.6	-224.8	--
Astrophysics	**-198.0**	**-228.2**	**-141.8**	**-146.5**	**-209.1**	**-326.1**	**1,116.0**
Programmatic Content	--	29.1	34.2	21.2	-42.0	-136.9	1,116.0
Programmatic Transfers	--	-0.3	33.3	37.0	37.4	37.5	--
Institutional Adjustments	-198.0	-257.0	-209.3	-204.7	-204.5	-226.7	--
Heliophysics	**-197.3**	**-216.3**	**-451.1**	**-492.4**	**-551.7**	**-566.3**	**746.6**
Programmatic Content	--	-18.9	15.3	28.5	-33.9	-56.3	746.6
Programmatic Transfers	--	-33.2	-307.5	-353.0	-326.0	-308.9	--
Institutional Adjustments	-197.3	-164.2	-158.9	-167.9	-191.8	-201.1	--

Explanation of Mission Directorate Changes

Science

Earth Science

Programmatic Content:

Establishes a funding wedge to initiate the development of focused missions that respond to the recommendations of the recent Earth Science Decadal Survey; continues to implement seven precursor missions (OSTM, OCO, Glory, Aquarius, NPP, LDCM, GPM) for launch between 2008 and 2013; funds operations and routine data production for 13 on-orbit missions in prime and extended phases.

Programmatic Transfers:

Transfers funding for studies of Near-Earth Objects from the Exploration Systems Mission Directorate, now contained within Earth Science Research Program. Education and Outreach Program transferred into Earth Science Research Program. Transfers remaining Technical Authority to Center Management & Operations.

Institutional Adjustments:

Institutional Adjustments reflect the Agency reallocation of overhead which includes Corporate G&A, CM&O, and Institutional Investments.

Planetary Science

Programmatic Content:

Initiates an Outer Planets Flagship Mission with a planned launch date in the 2016-2017 timeframe; funds a second mission extension for Cassini; focuses the Mars Program after Scout 2013 to a sample return mission with a planned launch date no later than 2020; funds two NASA ExoMars 2013 instruments and sample caching for expanded US participation.

Programmatic Transfers:

Transfers funding to Advanced Multi-Mission Operations System (AMMOS) from Heliophysics. Transfers IT Services, Grants Processing and Quality Assurance audit funds to Corporate G&A.

Institutional Adjustments:

Institutional Adjustments reflect the Agency reallocation of overhead which includes Corporate G&A, CM&O, and Institutional Investments.

Astrophysics

Programmatic Content:

Funds a revitalized balloon and suborbital rocket program; sounding rocket vehicles are also augmented via Heliophysics; accelerates Stratospheric Observatory for Infrared Astronomy (SOFIA) research capability to 2009; initiates Joint Dark Energy Mission (JDEM) in FY09; continues Laser Interferometer Space Antenna (LISA), Constellation-X, and Einstein Probe technology investments; refocuses "Navigator/SIM" toward a new medium class Exoplanet initiative that is executable within projected resources.

Programmatic Transfers:

Transfers remaining Technical Authority to Center Management & Operations.

Institutional Adjustments:

Institutional Adjustments reflect the Agency reallocation of overhead which includes Corporate G&A, CM&O, and Institutional Investments.

Heliophysics

Programmatic Content:

Funds a revitalized Explorer flight program of Small Exlporer and Mission of Opportunity missions; funds a revitalized suborbital rocket program for Heliophysics and Astrophysics; provides for development of the Solar Probe Lite mission; funds Radiation Belt Storm Probes Mission of Opportunity towards a 2012 launch readiness date.

Programmatic Transfers:

Transfers Deep Space Network and Ground Network to the Space Operations Mission Directorate; transfers Advanced Multi-Mission Operation System (AMMOS) to Planetary Science; transfers remaining Technical Authority to Center Management & Operations.

Institutional Adjustments:

Institutional Adjustments reflect the Agency reallocation of overhead which includes Corporate G&A, CM&O, and Institutional Investments.

Mission Directorate Budget Structure Adjustments

For FY 2009, the Science Mission Directorate reduced the Heliophysics theme by two programs, and restructured the Astrophysics Theme from ten programs to five programs as described and pictured on the next page.

In Astrophysics, the Navigator and Discovery Programs will become projects under the new Exoplanet Exploration Program. The Spitzer Project (from Astrophysics Research), and the James Webb Space Telescope, Hubble Space Telescope, and Stratospheric Observatory for Infrared Astronomy (SOFIA) Programs, will be projects under the new Cosmic Origins Program. The Chandra X-ray Observatory Project (from Astrophysics Research) and the Gamma-ray Large Area Space Telescope, International Space Science Collaboration, and Beyond Einstein Programs, will be projects under the new Physics of the Cosmos Program. The Explorer-class projects that are operating missions within the Astrophysics Research program are being moved to the Astrophysics Explorer Program.

The Heliophysics Theme discontinued the Deep Space Mission Systems and Near Earth Networks Programs. The Deep Space Network and Advanced Multi-Mission Operations System Projects were transferred from Deep Space Mission Systems to the Space Operations Mission Directorate and Planetary Science Theme, respectively. The Ground Networks and Research Range Projects were transferred from Near Earth Networks to the Space Operations Mission Directorate and the Heliophysics Research Theme respectively.

Mission Directorate: Science

FY 2008 Structure	FY 2008 Enacted	FY 2009 Pres Bud
Science	$4,706.2	$4,441.5
Earth Science	$1,280.3	$1,367.5
Research	$356.9	$364.9
Earth Systematic Missions	$530.1	$677.9
ESSP	$111.8	$88.6
ESS Multi Mission Ops	$167.8	$140.5
Technology	$47.3	$46.1
Applied Sciences	$40.4	$33.8
Education & Outreach	$18.9	$15.7
Planetary Science	$1,247.5	$1,334.2
Research	$324.0	$371.9
Discovery	$153.0	$247.0
New Frontiers	$133.3	$263.0
Mars Exploration	$553.5	$306.5
Technology	$84.8	$64.9
Astrophysics	$1,337.5	$1,162.5
Research	$265.0	$354.0
JWST	$448.3	$371.9
HST	$228.5	$156.0
SOFIA	$62.1	$72.0
GLAST	$33.3	$23.2
ISS Collaboration	$22.5	$36.6
Beyond Einstein	$29.0	$24.2
Navigator	$85.7	$25.2
Discovery	$78.9	$25.2
Explorer	$84.2	$74.5
Heliophysics	$840.9	$577.3
Research	$181.2	$184.8
Living With a Star	$217.1	$223.8
Solar Terrestrial Probes	$105.9	$123.1
Explorer	$61.0	$41.3
New Millenium	$23.8	$4.3
Near Earth Networks	$39.5	$0.0
Deep Space Mission Systems	$210.5	$0.0

FY 2009 Structure	FY 2008 Enacted	FY 2009 Pres Bud
Science	$4,706.2	$4,441.5
Earth Science	$1,280.3	$1,367.5
Research	$375.8	$380.6
Earth Systematic Missions	$530.1	$677.9
ESSP	$111.8	$88.6
ESS Multi Mission Ops	$167.8	$140.5
Technology	$47.3	$46.1
Applied Sciences	$40.4	$33.8
Planetary Science	$1,247.5	$1,334.2
Research	$242.1	$270.8
Discovery	$153.0	$247.0
New Frontiers	$133.3	$263.0
Mars Exploration	$553.5	$306.5
Outer Planets	$81.9	$101.1
Technology	$84.8	$64.9
Astrophysics	$1,337.5	$1,162.5
Astrophysics Research (less Op Msns)	$102.2	$152.3
Cosmic Origins	$807.3	$674.4
Physics of the Cosmos	$159.0	$157.0
Exoplanet Exploration	$162.0	$48.1
Astrophysics Explorer	$106.4	$130.6
Heliophysics	$840.9	$577.3
Research	$181.2	$184.8
Living With a Star	$217.1	$223.8
Solar Terrestrial Probes	$105.9	$123.1
Explorer	$61.0	$41.3
New Millenium	$23.8	$4.3
Near Earth Networks	$39.5	$0.0
Deep Space Mission Systems	$210.5	$0.0

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	1,198.5	1,280.3	1,367.5	1,350.7	1,250.9	1,264.4	1,290.3
Earth Science Research	349.5	375.8	380.6	388.2	390.6	400.7	409.3
Earth Systematic Missions	420.9	530.1	677.9	661.5	583.2	563.6	569.6
Earth System Science Pathfinder	167.9	113.8	88.6	58.8	37.4	50.0	54.9
Earth Science Multi-Mission Operations	168.0	167.8	140.5	159.1	157.9	166.5	170.9
Earth Science Technology	58.4	47.3	46.1	49.2	50.6	51.6	52.8
Applied Sciences	33.9	45.4	33.8	33.8	31.3	32.1	32.8
FY 2008 President's Budget Request	1,464.5	1,497.3	1,545.8	1,520.1	1,411.2	1,353.2	--
Earth Science Research	453.4	428.5	453.0	453.8	469.1	481.4	--
Earth Systematic Missions	523.8	608.0	693.0	576.0	387.9	387.9	--
Earth System Science Pathfinder	165.2	135.7	94.9	171.6	242.3	161.2	--
Earth Science Multi-Mission Operations	192.9	204.4	181.3	191.3	185.8	194.2	--
Earth Science Technology	56.6	57.0	58.7	62.6	64.2	65.5	--
Applied Sciences	46.8	40.3	41.3	41.1	38.0	38.9	--
Education and Outreach	25.9	23.5	23.6	23.7	23.9	24.1	--
Total Change from FY 2008 Request	**-266.0**	**-217.0**	**-178.3**	**-169.5**	**-160.3**	**-88.7**	**1,290.3**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Mission Directorate: Science
Theme: Earth Science

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-266.0**	**-217.0**	**-178.3**	**-169.5**	**-160.3**	**-88.7**	**1,290.3**
Earth Science Research	**-130.6**	**-76.1**	**-95.9**	**-89.3**	**-102.4**	**-104.8**	**409.3**
Programmatic Content	--	4.6	-15.7	-10.7	-21.8	-22.0	409.3
Programmatic Transfers	--	--	3.7	3.8	3.8	3.9	--
Institutional Adjustments	-130.6	-80.7	-83.9	-82.4	-84.4	-86.7	--
Earth Systematic Missions	**-102.1**	**-77.8**	**-15.1**	**85.4**	**195.3**	**175.6**	**569.6**
Programmatic Content	--	28.6	105.5	184.7	262.3	242.4	569.6
Programmatic Transfers	--	-0.1	-0.1	-0.1	-0.1	-0.1	--
Institutional Adjustments	-102.1	-106.3	-120.5	-99.2	-66.9	-66.7	--
Earth System Science Pathfinder	**2.7**	**-21.8**	**-6.3**	**-112.8**	**-205.0**	**-111.2**	**54.9**
Programmatic Content	--	-2.3	8.4	-83.5	-162.6	-83.2	54.9
Institutional Adjustments	2.7	-19.5	-14.7	-29.3	-42.4	-28.0	--
Earth Science Multi-Mission Operations	**-24.9**	**-36.6**	**-40.8**	**-32.1**	**-27.8**	**-27.6**	**170.9**
Programmatic Content	--	-0.7	-9.7	--	3.1	4.6	170.9
Institutional Adjustments	-24.9	-35.9	-31.1	-32.1	-30.9	-32.2	--
Earth Science Technology	**1.8**	**-9.8**	**-12.7**	**-13.4**	**-13.7**	**-13.9**	**52.8**
Programmatic Content	--	-0.7	-3.4	-3.6	-3.7	-3.8	52.8
Institutional Adjustments	1.8	-9.1	-9.3	-9.8	-10.0	-10.1	--
Applied Sciences	**-12.9**	**5.1**	**-7.5**	**-7.3**	**-6.7**	**-6.8**	**32.8**
Programmatic Content	--	12.4	--	--	--	--	32.8
Institutional Adjustments	-12.9	-7.3	-7.5	-7.3	-6.7	-6.8	--

Explanation of Program Changes

Earth Science Research

Shifted funding from Earth Science Research & Analysis to Space Laser Ranging (Geodesy).
Increased funding for Airborne Science Program to accomodate aircraft consolidation efforts, and improved technologies on existing aircraft.

Earth Systematic Missions

Reduced funding for Global Precipitation Measurement mission in 2009 - 2010 while maintaining the Core Spacecraft Launch Readiness Date. Transferred funding from Earth System Science Pathfinder line for operating missions based on Senior Review mission extensions. Large funding increase to initiate at least three new missions by 2013 in response to the Earth Decadal Study.

Earth System Science Pathfinder

Increases funding for Orbiting Carbon Observatory and Aquarius to maintain development schedule, and to accomodate Aquarius launch delay by the mission partner providing the spacecraft. Transferred funding to the Decadal Survey mission line to fund future mission development. Transferred funding to operating missions based on Senior Review mission extensions.

Earth Science Multi-Mission Operations

No significant change.

Earth Science Technology

No significant change.

Applied Sciences

No significant change.

Mission Directorate:	Science
Theme:	Earth Science

Theme Overview

How is the global integrated Earth system changing? Why is it changing? How does it support life? How does life impact the Earth system? How will this information benefit the Nation? These are questions that NASA's Earth Science activities are striving to answer. These questions are among the most important issues facing society today, and whose answers will enable greater economic growth, homeland security, and environmental stewardship.

Understanding the integrated Earth system requires knowledge of all Earth components and interactions between components. Advancing knowledge of the global integrated Earth system requires a comprehensive and sustained set of simultaneous observations of numerous variables covering many spatial and temporal scales.

Sophisticated Earth-system models codify our scientific knowledge and are used to predict future evolution on many time scales. NASA discoveries are enabled by a constellation of three operating satellite observatories (Aqua, Aura, and Terra), 10 special mission satellites (ACRIMSAT, CALIPSO, CloudSat, EO-1, GRACE, ICESat, Jason, QuikSCAT, SORCE, and TRMM), and an "A-Train" of satellites flying in formation to achieve super-observatory characteristics (Aqua, Aura, CALIPSO, CloudSat, and Parasol). The A-Train acquires unprecedented atmospheric chemistry and composition observations over the same region within 15 minutes.

Measurements from aircraft, unattended aircraft systems, and in-situ networks augment satellite data and help to calibrate and validate the satellite sensors. NASA observations, computing facilities, and research findings are used to improve global, integrated Earth-system models. NASA also has seven missions in either formulation or development for launches between FY 2008 and FY 2014.

"Earth Science and Applications From Space: National Imperatives for the Next Decade and Beyond," released in January 2007, is the first decadal survey for NASA's Earth Science. NASA will use it as the principal determinant of new Earth science mission priorities. The President's 2009 budget request for Earth Science includes a large funding increase to implement the Decadal Survey's recommendations, with the expectation of initiating at least three new missions by 2013.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The 2005 NASA Authorization Act and 2006 National Space Policy charge NASA to lead in the advancement of fundamental scientific knowledge of a global, integrated Earth system. NASA's capabilities in global Earth observations and models improve our understanding of the geographically varying distribution and rates of change of the global environment and its impacts on society. NASA's capability is a cornerstone for national and international global integrated Earth-system initiatives, including Presidential Initiatives (Integrated Earth Observations (2005), Vision for Space Exploration (2004), Ocean Action Plan (2004), Climate Change Research Initiative (2002)); Congressional Initiatives (National Oceanographic Partnership Program (1997), Global Change Research Act (1990), Clean Air Amendments Act (1990)), United Nations Scientific Assessments (IPCC (2007), Ozone Depletion (2006), Millennium Ecosystem (2005)), and the Arctic Council Arctic Climate Impact Assessment (2005).

NASA coordinates with the U.S. Geological Survey (USGS) and NOAA for space-based remote environmental sensing systems. NASA coordinates with USGS on LDCM and with DoD and NOAA for climate sensors on NPOESS, GOES-R, POES N-prime, QuikSCAT Follow-on, and OSTM Follow-on. NASA also coordinates with NOAA through user groups to improve data analysis approaches and to facilitate NOAA use of NASA Earth-system data records in NOAA's weather forecasts.

Relevance to the NASA Mission and Strategic Goals:

NASA has embarked on an ambitious plan to answer the questions of why is the environment changing, how will the environment change, what are the environmental impacts on humans, and how can humans mitigate the impact of environmental hazards.

In the efforts to understand and model the global integrated Earth system, Earth Science missions and analysis activities contribute to NASA's Subgoal 3A.

Relevance to education and public benefits:

Earth Science research motivates students and young scientists to pursue scientific careers by engaging them in educational activities and research to decipher signals of the global, integrated Earth system. NASA helps improve public understanding of advances and discoveries made in modeling the Earth as a global integrated system, and the potential societal benefits, such as improved forecasting for hazards such as hurricanes.

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 3	**Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.**					
Sub Goal 3A	**Study Earth from space to advance scientific understanding and meet societal needs.**					
Outcome 3A.1	**Progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.**		**Green**	**Green**	**Green**	**Green**
APG 9ES1	Demonstrate progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition (based on measurements from presently orbiting NASA and non-NASA assets). Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9ES2	Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	Earth System Science Pathfinder				Yellow
APG 9ES3	Develop missions in support of this Outcome, as demonstrated by completing the Glory mission Launch Readiness Review (LRR).	Earth Systematic Missions				Yellow
APG 9ES4	Develop mission in support of this Outcome, as demonstrated by completing Aquarius instrument integration and testing.	Earth System Science Pathfinder				None
APG 9ES5	Develop mission in support of this Outcome, as demonstrated by completing the CLARREO advanced concepts study.	Earth Systematic Missions				New
APG 9ES6	Conduct flight program in support of this Outcome as demonstrated by achieving mission success criteria for Aqua and CALIPSO.	Multiple Programs				None
Outcome 3A.2	**Progress in enabling improved predictive capability for weather and extreme weather events.**		**Green**	**Green**	**Green**	**Green**
APG 9ES7	Demonstrate progress in enabling improved predictive capability for weather and extreme weather events. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9ES8	Develop missions in support of this Outcome, as demonstrated by completing the Global Precipitation Mission (GPM) Confirmation Review.	Earth Systematic Missions				None
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Systematic Missions				None

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome 3A.3	**Progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models.**		**Green**	**Green**	**Green**	**Green**
APG 9ES10	Demonstrate progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9ES11	Develop missions in support of this Outcome, as demonstrated by completing the Landsat Data Continuity Mission (LDCM) Critical Design Review (CDR).	Earth Systematic Missions				White
APG 9ES12	Develop missions in support of this Outcome, as demonstrated by completing the DESDynI advanced concept study.	Earth Systematic Missions				New
APG 9ES2	Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	Earth System Science Pathfinder				Yellow
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Systematic Missions				None
Outcome 3A.4	**Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability.**		**Green**	**Green**	**Yellow**	**Green**
APG 9ES13	Demonstrate progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9ES14	Develop missions in support of this Outcome, as demonstrated by completing the SMAP advanced concepts study.	Earth Systematic Missions				New
APG 9ES8	Develop missions in support of this Outcome, as demonstrated by completing the Global Precipitation Mission (GPM) Confirmation Review.	Earth Systematic Missions				None
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Systematic Missions				None
Outcome 3A.5	**Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.**		**Green**	**Green**	**Yellow**	**Yellow**
APG 9ES15	Demonstrate progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution. Progress will be evaluated by external expert review.	Multiple Programs				Green

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9ES16	Develop mission in support of this Outcome, as demonstrated by completing the ICESat II advanced concepts study.	Earth Systematic Missions				New
APG 9ES2	Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	Earth System Science Pathfinder				Yellow
APG 9ES3	Develop missions in support of this Outcome, as demonstrated by completing the Glory mission Launch Readiness Review (LRR).	Earth Systematic Missions				Yellow
APG 9ES4	Develop mission in support of this Outcome, as demonstrated by completing Aquarius instrument integration and testing.	Earth System Science Pathfinder				None
APG 9ES6	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua and CALIPSO.	Multiple Programs				None
Outcome 3A.6	**Progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields.**		**None**	**Green**	**Green**	**Green**
APG 9ES11	Develop missions in support of this Outcome, as demonstrated by completing the Landsat Data Continuity Mission (LDCM) Critical Design Review (CDR).	Earth Systematic Missions				White
APG 9ES12	Develop missions in support of this Outcome, as demonstrated by completing the DESDynI advanced concept study.	Earth Systematic Missions				White
APG 9ES17	Demonstrate progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Systematic Missions				None
Outcome 3A.7	**Progress in expanding and accelerating the realization of societal benefits from Earth system science.**		**Green**	**Green**	**Green**	**Green**
APG 9ES18	Issue twelve reports with partnering organizations that validate using NASA research capabilities (e.g., observations and/or forecast products) could improve their operational decision support systems.	Applied Sciences				Green
APG 9ES19	Increase the number of distinct users of NASA data and services.	Earth Science Research				None
APG 9ES20	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science Research				None

Mission Directorate:	Science
Theme:	Earth Science

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Earth Science Theme					
APG 9ES21	Complete all development projects within 110% of the cost and schedule baseline.				White
APG 9ES22	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green
APG 9ES23	Peer-review and competitively award at least 90%, by budget, of research projects.				Green
APG 9ES24	Reduce time within which eighty percent of NRA research grants are awarded, from proposal due date to selection, by five percent per year, with a goal of 130 days.				Red

Performance Achievement Highlights:

- A key instrument aboard the Terra and Aqua spacecrafts--the Moderate Resolution Imaging Spectroradiometer (MODIS)--makes measurements of aerosol and cloud properties. Recently, the MODIS science team expanded their data products through a new aerosol algorithm called "Deep Blue," which provides much-improved measurements of aerosols over bright surfaces such as deserts. As a result, MODIS aerosol data products now include large continental areas previously not available. Deep Blue has proven itself to be such an improvement that the U.S. Navy has incorporated this aerosol retrieval algorithm in their operational atmospheric forecasting system.

- New NASA research is providing clues about how the seemingly subtle movement of air within and around the eye of hurricanes provides energy to keep this central "powerhouse" functioning. Using data captured from satellites during field experiments, scientists discovered air patterns that changed the way they would predict a storm's strength. The spinning flow of air parcels, or vortices, in the eye can carry warm, moist eye air into the eyewall, the thunderstorms that separate the eye from the rest of the hurricane. This acts as a turbocharger for the hurricane heat engine. The new results improve understanding of the mechanisms that play significant roles in hurricane intensity.

- NASA research on terrestrial productivity, land cover, and carbon cycling rely on high-quality satellite remote-sensing data products. Validation of these data products thus is critical and provides an important means for characterizing errors and uncertainties in remote-sensing measurements that affect model results. During FY 2007, NASA investigators summarized ongoing global land product validation in a special journal issue. Papers described validation of the major data products that are used to analyze terrestrial processes, land cover, and carbon cycling, and provided recommendations for the best use of current products while informing the design of future missions.

For more information, see Sub-goal 3A in the FY 2007 Annual Performance Report, included in this budget.

Quality

Program Assessment Rating Tool (PART):

The Earth-Sun System Theme, which included both Earth Science and Heliophysics, was subject to a PART review in 2005 and received a "Moderately Effective" rating (score of 84%). The assessment found that this program is well-defined, with a clear purpose, and has an effective strategic planning process, aligning it well to NASA's Mission. A key opportunity to increase effectiveness lies in continuing to improve efficiencies in mission operations, in reducing science data validation periods and in making NASA research available to a broader community. In FY 2008, the Earth-Sun System was separated into two distinct Themes: Earth Science, which will undergo its next PART review during the year; and Heliophysics which will be reviewed at a later date.

Areas recently identified for performance improvement include:
1) Reporting for major missions: estimated mission lifecycle cost upon entering development; key schedule milestones associated with each mission phase for those missions formally approved for formulation; mission cost and schedule progress achieved in each phase before entering the next; and any plans to re-baseline lifecycle cost and schedule; and
2) Assuring that priorities developed in the National Research Council's (NRC's) Earth Science Decadal Survey are reflected in the program's portfolio to the extent feasible.

The lifecycle cost and schedule figures for projects in development are provided quarterly to the Office of Management and Budget and annually to the Congress as the Major Program Annual Report. NASA continues to work the process and policy to refine this reporting.

The NRC's Earth Science Decadal Survey expressed support for NASA's Earth Science missions currently in development and recommended priorities for new missions. These priorities are reflected in the FY 2009 President's Budget, which includes increased funding in the current budget horizon for NASA to begin formulation of the first four missions defined, and, depending on the outcome of the formulation activities, to begin development of the most mature of the missions. These missions will yield significant societal benefits by improving our understanding of natural hazards, climate change, and weather and water cycle processes.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IRT	Varies	Each project has a independent review team (IRT) for review, at each major milestone, to evaluate project performance and readiness to proceed to the next phase. These reviews occur throughout the year.	Varies
Relevance	NASA Advisory Council (NAC)	05/2007	NASA Advisory Council (NAC) - Review science strategy and implementation strategy for the Earth Science programs	05/2008
Relevance	National Research Council	01/2007	National Research Council - Decadal Survey of effectiveness and quality of the Earth Science programs. First time a Decadal Survey developed for Earth Science.	2016

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Research

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	349.5	375.8	380.6	388.2	390.6	400.7	409.3
Research and Analysis	232.6	243.3	245.7	254.0	255.5	260.3	266.5
Computing and Management	91.3	103.1	104.9	104.7	107.3	110.1	111.8
Airborne Science	25.6	26.0	26.3	25.7	24.0	26.4	27.0
Near Earth Object Observations	0	3.4	3.7	3.8	3.8	3.9	4.0
FY 2008 President's Budget Request	479.2	451.9	476.6	477.6	493.0	505.5	0
Research and Analysis	287.5	268.2	279.9	292.2	294.9	301.3	0
Computing and Management	135.3	128.6	141.6	130.4	145.1	148.1	0
Suborbital Science Program	30.5	31.7	31.5	31.3	29.2	32.1	0
Earth Science Education & Outreach Activ	16.0	13.6	13.6	13.7	13.8	14.0	0
Fellowships and New investigators	9.9	9.9	10.0	10.0	10.1	10.2	0
Changes from FY 2008 Request	-129.8	-76.1	-96.0	-89.3	-102.4	-104.9	409.3

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY09 through FY13. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

The Earth Science Research Program improves the capability to document the global distribution of a range of important environmental parameters related to the Earth's atmosphere, hydrosphere, biosphere, cryosphere, and land surface; to understand the processes that drive and connect them; and to improve our capability to predict the future evolution of the Earth system, including climate, weather, and natural hazards.

Earth Science Research funds basic research and modeling efforts, the Airborne Science Project (which conducts research using airplanes and Uninhabited Air Systems), supercomputing efforts that support a variety of agencies, and education and outreach.

For more information, please see http://science.hq.nasa.gov/earth-sun/index.html.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Research

Program Relevance

The Earth Science Research Program contributes to the Outcomes under Strategic Plan Subgoal 3A: Study Earth from space to advance scientific understanding and meet societal needs.

This research is an important component of the U.S. Global Change Research Program (GCRP) and Climate Change Research Initiative (CCRI), both of which are components of the Climate Change Science Program (CCSP). Earth Science Research also contributes to the U.S. Weather Research Program, the Earthscope Program, and the Ocean Action Plan. Research plans and objectives for much of NASA's FY 2009 activities are described in the Climate Change Science Program Strategic Plan, and are reported to Congress annually, by the program and the subcommittee on Global Change Research, in the report, "Our Changing Planet." Some components of NASA's Earth Science Research Program (e.g., Earth surface and interior research) are not reported through the CCSP.

The Earth Science Research Program supports Outcomes 3A.1, 3A.2, 3A.3, 3A.4, 3A.5, 3A.6, and 3A.7.

Plans For FY 2009

The Science Mission Directorate will issue Research Opportunities in Space and Earth Science 2008 (ROSES-08), a research announcement covering all of the planned research solicitations in Earth Science Research for FY 2008; the FY 2009 budget will fund the competitively selected activities. Roughly a third of the Earth Science Research budget is competed each year through ROSES. The resulting grants are generally funded for three years following the selections. Given the average of a three-year funding cycle, many of the research activities carried out in FY 2009 will be tasks initiated in FY 2007 and FY 2008 based on solicitations included in ROSES-06 and ROSES-07, respectively. Selections based on ROSES 07 solicitations are on-going and are addressing a number of Earth Science research areas, including ocean circulation and estimation of sea-surface temperature and salinity, the effect of decreasing sea ice cover on climate, energy and water cycle, arctic research of the composition of the troposphere and the Earth's surface and interior.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Research

Project Descriptions and Explanation of Changes

Earth Science Research and Analysis (R&A)

Earth Science Research and Analysis funds research in all six Earth Science focus areas:

* Climate variability and change;
* Atmospheric composition;
* Carbon cycle, ecosystems, and biogeochemistry;
* Water and energy cycles;
* Weather; and
* Earth surface and interior.

The Research and Analysis Project addresses the earth system and the interactions of its components, characterizing them on a broad range of spatial and temporal scales to understand the naturally occurring and human-induced processes that drive the overall system.

EOS Science

Earth Observing System (EOS) Science funds interdisciplinary science teams, as well as calibration and validation activities that ensure the utility of spaceborne measurements.

In addition, funding for the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) / Airborne Synthetic Aperture Radar (AirSAR) / Thermal Infrared Multispectral (TIMS) instruments, a portion of Radarsat, and the National Institute of Standards and Technology Calibration activity were moved into the EOS Science line in the FY 2008 budget.

Airborne Science

Airborne Science (formerly Suborbital Science) funds NASA's airplane- and Uninhabited Air Systems (UAS)-based Earth Science efforts. The project supports the operation of a catalog of NASA-owned and leased aircraft, including the ER-2, DC-8, WB-57, P-3, Twin Otter, B-200, Aerosonde, Ikhana, and other UAS aircraft. These assets are deployed in campaigns conducted around the world to monitor extreme weather events (e.g., hurricanes) capture data for Earth Science modeling activities, and calibrate the instruments flying aboard Earth Science spacecraft (e.g., Aura). Airborne Science also funds technology development efforts designed to provide Earth Science researchers with improved instruments and datalinks to these aircraft.

Scientific Computing

Scientific Computing funds NASA's Earth Science supercomputing assets and projects at Goddard Space Flight Center. The Scientific Computing Project's primary purpose is to support Earth Science modeling activities based on data collected by Earth Science spacecraft.

High-End Computing Capability (HECC)

The High-End Computing Capability (HECC) project at Ames Research Center is focused around the Columbia supercomputer and the associated network connectivity, data storage, data analysis and visualization, and application software support. The Science Mission Directorate currently funds and manages the HECC resources, which serves the supercomputing needs of all NASA Mission Directorates as well as external users. Science Mission Directorate funding supports the operation, maintenance, and upgrade of NASA's supercomputing capability, while the Strategic Capabilities Assets Program exercises the oversight and insight functions.

Carbon Cycle Science Team

The Carbon Cycle Science Team conducts research using measurements from a variety of assets. The team will be significant users of data from the upcoming Orbiting Carbon Observatory and the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project missions, expanding their existing utilization of data from currently operating missions (e.g., Terra, Landsat, Earth Observing-1).

Data Assimilation Office

The Data Assimilation Office, also known as the Global Modeling and Assimilation Office (GMAO), located at Goddard Space Flight Center, creates global climate and environmental models using data from Earth Science satellites and aircraft. These products can then be used by investigators to further their research.

Space Geodesy

The Space Geodesy Project (previously known as Satellite Laser Ranging) provides highly accurate altitude data for the operation of Earth Science spacecraft and the calibration of their instruments. This is particularly important for missions such as Jason and the Gravity Recovery and Climate Experiment (GRACE), which require very precise positioning information for their measurements.

Mission Science Guest Investigator Program

The Mission Science Guest Investigator Program supports researchers using data from Earth Science spacecraft, but who are not formally part of the Mission Science Teams themselves.

Earth Science Education and Outreach Activity

The Education and Outreach Activity supports NASA educational outcomes and communicates the results from Earth Science missions and research through competitively selected projects. It also continues the worldwide implementation and U.S. coordination of the Global Learning and Observations to Benefit the Environment (GLOBE) Program, in partnership with the National Science Foundation.

Fellowships and New Investigators

The Fellowships and New Investigators project supports graduate and early-career research, respectively, that is relevant of Earth system research and applied science. The project supports graduate students pursuing masters or Ph.D. degrees in Earth system science as an element of the NASA Earth and Space Science Fellowship Program, poviding new fellowships annually. The project also supports the New Investigator Program that solicits new applications every two years as part of the Research Opportunities for Space and Earth Sciences (ROSES) effort.

Ozone Trends Science

The Ozone Trends Science project has an overall goal of producing a consistent, calibrated ozone time series that can be used for trend analyses and other studies. This is being done by combining data from a series of Total Ozone Mapping Spectrometer (TOMS) and Solar Backscatter Ultraviolet (SBUV) instruments, as well as new instruments like the Ozone Monitoring Instrument on Aura and the Global Ozone Monitoring Experiment-2 (GOME-2). A secondary purpose of this project is to provide algorithm development and calibration analysis (including providing prelaunch calibration support), for the series of NOAA SBUV/2 instruments, fulfilling obligations under a Memorandum of Understanding with NOAA.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Research

Directorate Support

The Directorate Support Project is the institutional budget for the Science Mission Directorate. It funds Headquarters institutional activities that impact the Mission Directorate (i.e., Space Studies Board, NASA Peer Review, printing and graphics, IT budget, NASA Postdoctoral Program, conference support, independent assessment studies, and other administrative tasks with Mission Directorate impact).

Near Earth Object Observation

This project is detecting, tracking, and characterizing Near Earth Objects such as asteroids and comets that come within 1.3 Astronomical Units of the Sun and that have the potential to collide with Earth. A network of ground-based telescopes and space-based sensors will support this project.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Issue competed, peer-reviewed research awards.	Research and Analysis; Airborne Science (flight opportunities)	None.
Maximize resource utilization (i.e., computing cycles) in supercomputer projects.	Scientific Computing; HECC	None.
Issue competed, peer-reviewed Guest Observer awards.	Guest Investigator	None.
Provide awards to educators for curriculum development; continue to support GLOBE program.	Earth Science Education and Outreach Activity	None.
Provide research awards to new scientists & engineers, & fellowships to grad students in Earth Science	Fellowships and New Investigators	None.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Research

Implementation Schedule

Project	Schedule by Fiscal Year (Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21)	Phase Dates	Beg	End
R&A, EOS Science, Carbon Cycle Science Team, Data Assimilation Office, Space Geodesy, and Mission Science Guest Investigator Program (all ongoing research efforts)		Tech		
		Form		
		Dev		
		Ops		
		Res	Jan-90	Dec-20
Airborne Science		Tech		
		Form		
		Dev		
		Ops	Jan-90	Dec-20
		Res		
Scientific Computing		Tech		
		Form		
		Dev		
		Ops	Jan-95	Dec-20
		Res		
HECC		Tech		
		Form		
		Dev	Jan-05	Aug-05
		Ops	Sep-05	Dec-20
		Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Research

Program Management

The Earth Science Theme manages the Research Program. GSFC implements Scientific Computing; ARC implements HECC.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
R&A	Science Mission Directorate		Partners include, but are not limited to: the National Oceanic and Atmospheric Administration (Department of Commerce); the National Science Foundation; the Department of Defense; and the U.S. Geological Survey (Department of the Interior). In addition, international entities engaged in Earth Science research participate in NASA's efforts.
EOS Science	Science Mission Directorate	Science Mission Directorate	Partners include, but are not limited to: the National Oceanic and Atmospheric Administration (Department of Commerce); the National Science Foundation; the Department of Defense; and the U.S. Geological Survey (Department of the Interior). In addition, international entities engaged in Earth Science research participate in NASA's efforts.
Carbon Cycle Science Team	Science Mission Directorate		Partners include, but are not limited to: the National Oceanic and Atmospheric Administration (Department of Commerce); the National Science Foundation; the Department of Defense; and the U.S. Geological Survey (Department of the Interior). In addition, international entities engaged in Earth Science research participate in NASA's efforts.
Mission Science Guest Investigators Program	Mission Science Guest Investigators Program		Partners include, but are not limited to: the National Oceanic and Atmospheric Administration (Department of Commerce); the National Science Foundation; the Department of Defense; and the U.S. Geological Survey (Department of the Interior). In addition, international entities engaged in Earth Science research participate in NASA's efforts.
Airborne Science	Earth Science Theme, Science Mission Directorate	GSFC/Wallops Flight Facility, DFRC, and ARC are the primary Centers involved in this project.	The Federal Aviation Administration, the Department of Defense, the Department of Energy, the National Science Foundation, and the National Oceanic and Atmospheric Administration (Department of Commerce).
Scientific Computing	Earth Science Theme, Science Mission Directorate	NASA Center for Computational Sciences, Goddard Space Flight Center	Department of Energy and the Department of Defense.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Research

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
High-End Computing Capability	Earth Science Theme, Science Mission Directorate	NASA Advanced Supercomputing, Ames Research Center	Department of Energy and the Department of Defense.
Data Assimilation Office (Global Modeling and Assimilation Office)	Earth Science Theme, Science Mission Directorate	Goddard Space Flight Center	None.
Space Geodesy	Earth Science Theme, Science Mission Directorate	Goddard Space Flight Center	None.
Earth Science Education and Outreach Activity	Science Mission Directorate	n/a (various non-NASA organizations)	National Science Foundation's Global Learning and Observations to Benefit the Environment (GLOBE).
Fellowships and New Investigators	Science Mission Directorate	n/a (various non-NASA organizations)	None.

Acquisition Strategy

The Earth Science Research Program is based on full and open competition. Grants are peer reviewed and selected based on NASA Research Announcements and other related announcements.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NAC Earth Science Subcommittee	2007	The NASA Advisory Council Science Subcommittee reviews content and progress towards Earth Science sub-goal in the NASA Strategic Plan of at least one Science Focus Area per year.	2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Programmatic Risk	No significant risk at this time.	

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**420.9**	**530.1**	**677.9**	**661.5**	**583.2**	**563.6**	**569.6**
Global Precipitation Measurement (GPM)	**23.8**	**74.4**	**125.8**	**161.7**	**129.8**	**140.0**	**113.3**
Glory Mission	**91.8**	**35.2**	**29.7**	**9.1**	**9.8**	**2.7**	**0**
Landsat Data Continuity Mission	**45.9**	**133.0**	**139.4**	**127.1**	**96.0**	**11.3**	**2.7**
NPOESS Preparatory Project	**47.3**	**70.0**	**94.4**	**46.3**	**8.6**	**8.9**	**9.2**
Decadal Survey Missions	**0.6**	**33.0**	**103.2**	**116.2**	**150.0**	**250.2**	**290.7**
Ocean Surface Topography Mission	**42.8**	**27.5**	**8.0**	**7.8**	**7.7**	**7.3**	**7.3**
Other Missions and Data Analysis	**168.7**	**157.0**	**177.4**	**193.4**	**181.2**	**143.1**	**146.3**
FY 2008 President's Budget Request	**523.8**	**608.0**	**693.0**	**576.0**	**387.9**	**387.9**	**0**
Global Precipitation Measurement (GPM)	**28.1**	**90.2**	**182.4**	**208.8**	**158.7**	**163.7**	**0**
Glory Mission	**60.0**	**42.7**	**32.7**	**11.1**	**11.3**	**1.9**	**0**
Landsat Data Continuity Mission (LDCM)	**113.5**	**160.2**	**192.6**	**154.5**	**38.7**	**4.0**	**0**
NPOESS Preparatory Project (NPP)	**80.1**	**91.0**	**93.6**	**20.2**	**6.8**	**7.6**	**0**
Decadal Survey Missions	**0**	**0**	**0.2**	**0.7**	**0.3**	**30.6**	**0**
Ocean Surface Topography Mission	**47.0**	**33.4**	**8.7**	**8.3**	**8.2**	**7.8**	**0**
Other Missions and Data Analysis	**195.2**	**190.4**	**182.9**	**172.4**	**163.8**	**172.3**	**0**
Changes from FY 2008 Request	**-103.0**	**-77.9**	**-15.1**	**85.5**	**195.3**	**175.7**	**569.6**

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Program Overview

The Earth Systematic Missions Program provides a number of Earth-observing satellites that contribute to the provision of long-term environmental data sets that can be used to study the evolution of the Earth system on a range of temporal scales. This information is used to analyze, model, and improve understanding of the Earth system. Data gathered by these spacecraft will enable improved predictions of climate, weather, and natural hazards. NASA works with the science community to identify science questions on the frontiers of science that have profound societal importance, and to which on-going remote sensing of the Earth can make a defining contribution. These science questions become the foundation of a research strategy, which defines requirements for scientific observations through the vantage point of space. Each of Earth Science's six focus areas has an implementation roadmap that shows what role space-based observations play in meeting overall science objectives. This effort also provides techniques and technologies that can be employed to predict climate, weather and natural hazards on planets we plan to explore.

For more information, see http://science.hq.nasa.gov/missions/earth.html.

Program Relevance

The Earth Systematic Missions Program develops, demonstrates, initiates, and operates the satellite capabilities necessary for systematic science measurements from space in order to develop an understanding of the Earth's system and its response to natural or human-induced changes and to improve prediction of climate, weather, and natural hazards. This satellite-based Earth science measurement capability is a critical tool for NASA scientists, and the science community at large, in their efforts to support three Presidential initiatives: the Climate Change Research Initiative, Global Earth Observation, and the Oceans Action Plan.

This program contributes to Strategic Outcomes 3A.1, 3A.2, 3A.3, 3A.3, 3A.4, 3A.5, and 3A.6.

Plans For FY 2009

The following activities will be undertaken in FY 2009:

- GPM will complete its Preliminary Design Review followed by Mission Confirmation Review,
- NPP will complete its satellite pre-environmental review,
- Glory will have its Launch Readiness Review, followed by the launch of the spacecraft, and
- LDCM will complete its instrument Critical Design Review and Mission Critical Design Review.

Nine of the ten operating spacecraft in the Earth Systematic Mission program were reviewed in 2007 as part of the biennial Senior Review. (Aura is still in its prime mission phase and was not reviewed. The EP/TOMS mission was decommissioned in early 2007 and was not a part of the Senior Review.) All nine missions were extended for the FY 2008 - FY 2009 period, with some modifications to their mission implementation plans. All missions including Aura will be a part of the 2009 Senior Review.

Project Descriptions and Explanation of Changes

Global Precipitation Measurement (GPM) Mission

Extending precipitation measurement beyond the current Tropical Rainfall Measuring Mission (TRMM) mission, GPM will provide: near-global measurement of precipitation, its distribution, and physical processes; rain rates and latent heating measurement; and more frequent and complete sampling of Earth's precipitation. The science focus areas served by GPM will include: climate variability and change; water and energy cycles; and weather.

Glory

Glory will provide measurements of global distribution of natural and anthropogenic aerosols from varying angles, in numerous spectral bands with multiple polarizations, as well as total solar irradiance measurements. The science focus areas served by Glory will include: atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; climate variability and change; and water and energy cycles.

Landsat Data Continuity Mission (LDCM)

Landsat Data Continuity Mission (LDCM) will provide visible and near-infrared images of the Earth surface in approximately nine frequency bands, with 30-meter resolution. LDCM will enable cross-sensor comparison of data from within the Landsat series. The science focus areas served by LDCM will include: carbon cycle, ecosystems, and biogeochemistry; and earth surface and interior. LDCM is being undertaken by NASA as a stand-alone "free-flyer" mission, planned for launch as soon as possible to provide continuity of Landsat data.

Ocean Surface Topography Mission (OSTM)

Ocean Surface Topography Mission (OSTM) will measure sea surface height to an accuracy of less than four centimeters every 10 days. The science focus areas served by OSTM will include: climate variability and change; and water and energy cycles. This mission is a follow-on to Jason.

NPOESS Preparatory Project (NPP)

NPP is a preparatory mission for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and will provide global imagery in a number of visible and infrared frequency bands, collect ozone data, and provide improved measurements of temperature and moisture profiles in the atmosphere. The science focus areas served by NPP will include: atmospheric composition; climate variability and change; carbon cycle, ecosystems, and biogeochemistry; water and energy cycles; and weather.

Decadal Survey Missions

This project supports missions that begin formulation in the near future to implement systematic measurements in response to priorities suggested by the National Research Council's Earth Science Decadal Survey.

Terra

Terra collects global data on the state of the atmosphere, land, and oceans, as well as their interactions with solar radiation and with one another. The science focus areas served by Terra include: atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; climate variability and change; earth surface and interior; water and energy cycles; and weather. Terra is a joint mission with Japan and Canada.

Aqua

Aqua monitors atmospheric, land, ocean, and ice variables for improved understanding of the Earth's water cycle and improved understanding of the intricacies of the climate system. The science focus areas served by Aqua include: atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; climate variability and change; water and energy cycles; and weather. Aqua is a joint mission with Brazil and Japan.

Aura

Aura measures atmospheric chemical composition, tropospheric/stratospheric exchange of energy and chemicals, chemistry-climate interactions, and air quality. The science focus areas served by Aura include: atmospheric composition; climate variability and change; and weather. Aura is a joint mission with the Netherlands, Finland, and the United Kingdom.

Earth Probe/Total Ozone Mapping Spectrometer (EP/TOMS)

The EP/TOMS satellite suffered a mission-ending communications failure in November 2006 and was decommissioned in the Spring of 2007. The science research element of ozone monitoring and trending was picked up by the atmospheric chemistry group supporting the NPOESS Ozone Mapping and Profiler Suite (OMPS) instrument.

Tropical Rainfall Measuring Mission (TRMM)

The Tropical Rainfall Measuring Mission (TRMM) measures precipitation, clouds, lightning, and radiation processes over tropical regions. TRMM is one of several spacecraft currently extending the long-term radiation budget record begun in the mid-1980s. The science focus areas served by TRMM include: climate variability and change; water and energy cycles; and weather. TRMM is a joint mission with Japan.

Active Cavity Radiometer Irradiance Monitor Satellite (ACRIMSat)

The Active Cavity Radiometer Irradiance Monitor Satellite (ACRIMSat) monitors total solar irradiance. The science focus areas served by ACRIMSat include: climate variability and change; and water and energy cycles.

Quick Scatterometer (QuikSCAT)

Quick Scatterometer (QuickSCAT) measures ocean surface wind vectors using the SeaWinds instrument. The science focus areas served by QuikSCAT include: climate variability and change; and weather.

Earth Observing-1 (EO-1)

The Earth Observing-1 (EO-1) spacecraft collects data to allow paired scene comparisons between the EO-1 Advanced Land Imager (ALI) and the Landsat-7 Enhanced Thematic Mapper Plus (ETM+). The science focus areas served by EO-1 include: carbon cycle, ecosystems, and biogeochemistry; and earth surface and interior.

Jason

Jason monitors ocean height to support the study of ocean circulation. The science focus areas served by Jason include: climate variability and change; and water and energy cycles. Jason is a joint mission with France.

Ice, Clouds, and Land Elevation Satellite (ICESat)

The Ice, Clouds, and Land Elevation Satellite (ICESat) measures elements of ice-sheet mass balance, cloud-top and land-surface topography, and vertical profiles of aerosol and cloud properties. The science focus areas served by ICESat include: climate variability and change; earth surface and interior; and water and energy cycles.

Solar Radiation and Climate Experiment (SORCE)

The Solar Radiation and Climate Experiment (SORCE) measures the total and spectral solar irradiance incident at the top of Earth's atmosphere. The science focus areas served by SORCE include: atmospheric composition; climate variability and change; and water and energy cycles.

Instrument Science Teams

Instrument science teams help define the scientific requirements for their respective instruments and generate the algorithms used to process the data into useful data products for the investigations. Additionally, the science teams are responsible for validating the algorithms and data products they produce. The Earth Systematic Missions Program is supported by the Precipitation Science Team, the Ocean Winds Science Team, and the Landsat Science Project Office.

Earth Systematic Missions Senior Review Competed Science

NASA's Earth Science Division uses Senior Reviews, which are held every two years, to assess the relative science value of missions in operation. These reviews are competitive in nature and serve as the basis for determining whether a mission which has completed its current approved phase should be extended.

Earth Science Program Management

Provides program management support for Earth Science missions, investigations, and activities.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Complete planned operations of currently operating missions.	Operating missions	None
Data collection.	EO-1	None
Launch 2 additional Earth Systematic Mission (ESM) missions.	Glory, NPP	None

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Implementation Schedule

Project	Schedule by Fiscal Year (Prior, 07–21)	Phase	Beg	End
Global Precipitation Measurement Mission (GPM)		Tech		
		Form	Jul-02	Oct-08
		Dev	Nov-08	Jun-13
		Ops	Jul-13	Jul-16
		Res		
Glory		Tech		
		Form	Oct-03	Nov-05
		Dev	Nov-05	Feb-09
		Ops	Mar-09	Mar-12
		Res		
Landsat Data Continuity Mission (LDCM)		Tech		
		Form	Oct-03	Feb-05
		Dev	Mar-07	Jul-11
		Ops	Jul-11	Jul-16
		Res		
Ocean Surface Topography Mission (OSTM)		Tech		
		Form	Dec-02	Mar-06
		Dev	Mar-06	Jun-08
		Ops	Jul-08	Jul-11
		Res		
NPOESS Preparatory Project (NPP)		Tech		
		Form	Mar-00	Nov-03
		Dev	Dec-03	Jun-10
		Ops	Jun-10	Oct-14
		Res		
Terra		Tech		
		Form		
		Dev		
		Ops	Oct-99	Sep-11
		Res		Sep-11
Aqua		Tech		
		Form		
		Dev		
		Ops	May-02	Sep-11
		Res		Sep-11
Aura		Tech		
		Form		
		Dev		
		Ops	Jul-04	Jul-10
		Res		Jul-12
Total Ozone Mapping Spectrometer (TOMS)		Tech		
		Form		
		Dev		
		Ops	Jul-96	Mar-07
		Res		
Tropical Rainfall Measuring Mission (TRMM)		Tech		
		Form		
		Dev		
		Ops	Nov-97	Sep-11
		Res		Sep-11
Active Cavity Radiometer Irradiance Monitor Satellite (ACRIMSat)		Tech		
		Form		
		Dev		
		Ops	Dec-99	Sep-09
		Res		Sep-11
Quick Scatterometer (QuikSCAT)		Tech		
		Form		
		Dev		
		Ops	Jun-99	Sep-11
		Res		Sep-11
Earth Observing-1 (EO-1)		Tech		
		Form		
		Dev		
		Ops	Nov-00	Sep-11
		Res		

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Project	Phase	Start	End
Jason	Tech		
	Form		
	Dev		
	Ops	Dec-01	Sep-11
	Res		
Ice, Clouds, and Land Elevation Satellite (ICESat)	Tech		
	Form		
	Dev		
	Ops	Jan-03	Sep-11
	Res		Sep-11
Solar Radiation and Climate Experiment (SORCE)	Tech		
	Form		
	Dev		
	Ops	Jan-03	Sep-11
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Program Management

GSFC manages NPP, LDCM, Glory, GPM, Terra, Aqua, Aura, EP/TOMS, TRMM, EO-1, SORCE,and ICESat. JPL manages OSTM, ACRIMSat, QuikSCAT, and Jason.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
GPM	GSFC	GSFC	JAXA - provides dual frequency precipitation radar and launch vehicle for GPM.
Glory	GSFC	GSFC	None.
LDCM	GSFC	GSFC	USGS - provides data processing/distribution and on-orbit operations for LDCM.
OSTM	JPL	JPL	CNES - provides spacecraft and 2 instruments for OSTM.
NPP	GSFC	GSFC	NOAA/IPO - provides 3 of 4 instruments and ground system for NPP.
Terra	GSFC	GSFC	Japan's Ministry of Economy, Trade and Industry (METI) provided the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). The Canadian Space Agency provided the Measurements of Pollution in The Troposphere (MOPITT) instrument.
Aqua	GSFC	GSFC	The National Space Development Agency (NASDA, now part of the Japan Aerospace Exploration Agency, or JAXA) provided the Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) instrument. Brazil's Instituto Nacional de Pesquisas Espaciais (INPE, the Brazilian Institute for Space Research) provided the Humidity Sounder for Brazil (HSB) instrument.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Aura	GSFC	GSFC	The National Environmental Research Council of the United Kingdom funded the High Resolution Dynamics Limb Sounder (HIRDLS); the instrument was designed by universities and laboratories in the U.K. and the U.S., including the University of Colorado, Oxford University, the National Center for Atmospheric Research (U.S.), and the Rutherford Appleton Laboratory (U.K.). The University of Edinburgh (U.K.) contributed to data processing algorithms and validation for the Microwave Limb Sounder (MLS). The Ozone Monitoring Instrument (OMI) was built by Dutch Space and TNO TPD in the Netherlands in cooperation with Finnish VTT and Patria Advanced Solutions Ltd. KNMI (Royal Netherlands Meteorological Institute) is the Principal Investigator Institute. Overall responsibility for OMI lies with the Netherlands Agency for Aerospace Programmes (NIVR), with the participation of the Finnish Meteorological Institute (FMI).
TRMM	GSFC	GSFC	The Japan Aerospace Exploration Agency (JAXA) provided the Precipitation Radar (PR) instrument and the launch vehicle (an H-II F6).
ACRIMSat	JPL	JPL	None.
QuikSCAT	JPL	JPL	None.
EO-1	GSFC	GSFC	None.
Jason	JPL	JPL	The French Centre National d'Etudes Spatiales (CNES, the National Center for Space Studies) is responsible for the Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) instrument; THALES built the instrument, and SMP provided the ground beacons. The CNES is also responsible for the Poseidon-2 nadir-viewing radar altimeter; Alcatel Space Industries was prime contractor for the instrument.
ICESat	GSFC	GSFC	None.
SORCE	GSFC	GSFC	None.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Acquisition Strategy

Landsat Data Continuity Mission (LCDM): The LDCM instrument was selected through open competition in FY 2007. The Ball Aerospace and Technologies Corporation will build the Operational Land Imaging (OLI) instrument for LDCM. LDCM spacecraft will be a Rapid Spacecraft Development Office selection in FY 2008.

Global Precipitation Measurement (GPM): The GPM instrument was selected through open competition in FY 2005. The Ball Aerospace and Technolgies Corporation will build the GPM Microwave Imager (GMI) instrument for GPM. The GPM Core Spacecraft will be an in-house development at GSFC.

The Dual-frequency Precipitation Radar (DPR) instrument and launch vehicle for the Core Spacecraft will be provided by a foreign partner, Japan Aerospace Exploration Agency (JAXA). The Constellation Spacecraft will be acquired by open competition through the GSFC Rapid Spacecraft Development Office. Its launch vehicle will be acquired via competitive process by Kennedy Space Center. The ground systems for both spacecraft will be selected through open competition.

Senior Reviews are held every two years to assess the relative science value of missions in operation. In FY 2007, all operating Earth Systematic Missions other than Aura went through the competitive Senior Review process to determine whether they should enter an extended mission phase after their current missions have been completed (many of these missions are already in the extended phase).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	4/2007	2007 Senior Review- All operating Earth Sytematic Missions except for Aura underwent this review. All missions were extended with modifications to their mission budgets.	04/2009

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Operational measurements	Delays in planned transfers of responsibility for operational measurements increase the costs of the ESM Program and limited the resources available to undertake planned new measurements.	NASA is working with NOAA to standardize the transfer of operational measurements.
Data gap	Gaps in Earth measurements can result if planned follow-on missions are not completed as scheduled.	NASA works with partner agencies to identify measurements that might be at risk of a potential gap, to determine the degree to which such gaps are problematic, and to develop options to minimize both the length of the gap and any science impact the gap may cause. For example, NASA has developed improvements in mission operations that often allow existing mission life to be extended.
Partnership uncertainties	Earth observations, global and multifunctional in nature, are frequently undertaken in partnership with other agencies and countries. While this increases the breadth of observations, it adds risk to individual projects with respect to partner funding and schedule.	The Earth Systematic Missions Program increasing utilizes a portfolio approach to selecting missions, including joint missions, so that science results are less dependent on the outcome of individual missions than they are on the achieved suite of missions in operation at any given time.
Operating mission engineering risk	Earth Science operating missions, especially those in their extended mission phase, face the normal array of engineering risks that could impact the mission. As spacecraft and their systems age, instruments and spacecraft systems (e.g., solar arrays, batteries, gyroscopes) degrade, increasing the risk to the mission.	NASA Centers involved with operating missions (primarily GSFC and JPL) routinely monitor spacecraft and instrument health and develop mitigation strategies in coordination with SMD to deal with technical challenges, as needed. A variety of options are available, including reducing instrument usage time, making corrections via software uploads, and accepting higher levels of risk.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Measurement (GPM)

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	**23.8**	**74.4**	**125.8**
FY 2008 President's Budget Request	**28.1**	**90.2**	**182.4**
Total Change from 2008 President's Budget Request	**-4.2**	**-15.8**	**-56.5**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Measurement (GPM)

Project Purpose

The Global Precipitation Measurement (GPM) mission will initiate the measurement of global precipitation, making possible high spatial resolution precipitation measurements available at a three-hour or less refresh rate over much of the globe. A joint mission with the Japan Aerospace Exploration Agency (JAXA), GPM will provide the first opportunity to calibrate measurements of global precipitation--including the distribution, amount, rate, and associated heat released--across tropic, mid-latitude, and polar regions.

The GPM mission has the following scientific objectives:

(1) Advance precipitation measurement capability from space through combined use of active and passive remote-sensing techniques. These advanced measurements will be used to calibrate dedicated and operational passive microwave sensors with the goal of achieving global sampling.
(2) Advance understanding of global water/energy cycle variability and fresh water availability. Improved measurements of the space-time variability of global precipitation will substantially close the water/energy budget and elucidate the interactions between precipitation and other climate parameters.
(3) Improve climate prediction by providing the foundation for better understanding of surface water fluxes, soil moisture storage, cloud/precipitation microphysics and latent heat release in the Earth's atmosphere.
(4) Advance Numerical Weather Prediction (NWP) skills through more accurate and frequent measurements of instantaneous rain rates with better error characterizations, and the development of improved assimilation methods.
(5) Improve flood-hazard and fresh-water-resource prediction capabilities through better temporal sampling and wider spatial coverage of high-resolution precipitation measurements, and innovative designs in hydro-meteorological modeling.

For more information see http://science.hq.nasa.gov/missions/earth.html.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Measurement (GPM)

Project Preliminary Parameters

The GPM Project includes a Core Spacecraft and an additional NASA-provided passive microwave spacecraft (Constellation), both of which will measure precipitation across two latitudes. The real power of this mission is in the ability of the core spacecraft to leverage, for the first time, passive microwave measurements from other operating and planned "satellites of opportunity" by calibrating their measurements to its own. The exact sampling rate over different areas of the globe will depend on the number and orbits of the satellites of opportunity, but given the prevalence of passive microwave instruments on operational satellite systems, the global sampling will be robust.

The NASA Core Spacecraft will fly in a 65 degree inclined orbit at an altitude of 407 kilometers; the 65 degree orbit provides better latitude coverage than TRMM (which is 35 degrees). The Core Spacecraft includes two scientific instruments which will provide active and passive microwave measurements of precipitation.

The JAXA-supplied Dual-frequency Precipitation Radar (DPR) is characterized by cross-track swath widths of 245 km and 120 km, for the Ku precipitation radar (KuPR) and Ka-band precipitation radar (KaPR), respectively, providing a three-dimensional observation of rain and an accurate estimation of rainfall rate. The KuPR (13.6 GHz) is an updated version of the highly successful unit flown on the TRMM mission. The KuPR and the KaPR will be co-aligned on the GPM core spacecraft bus such that that the five kilometer footprint location on the earth will be the same.

The GPM Microwave Imager (GMI) is a conically-scanning radiometer which will provide significantly improved spatial resolution over the TRMM Microwave Imager (TMI).

NASA's passive microwave spacecraft will fly in a 40 degree inclined orbit; this orbit covers the destructive hurricane region; the satellites of opportunity will fly at multiple altitudes and inclines.

The Core Spacecraft will be launched from Tanegashima Island, Japan on an H-IIA launch vehicle and NASA's Constellation satellite will be launched from the Kennedy Space Center on a Taurua-XL. The collection of the DPR data will be transmitted to the ground using the TDRSS multiple access (MA) and single access (SA) service.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Measurement (GPM)

Estimated Project Deliverables

The GPM Core Spacecraft is planned for a launch in June 2013 to begin a three-year prime mission (five-year goal), followed by a launch in June 2014 of the NASA Constellation, a passive microwave spacecraft. When calibrated with existing and planned passive microwave measurements, GPM will provide global measurements of precipitation with a sampling frequency of three hours or less over much of the globe.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Core Spacecraft	GSFC	Provides platform for the GMI and JAXA-supplied DPR instruments	Same	Same
Constellation Spacecraft	GSFC	Provides platform for the second GMI instrument	Same	Same
Dual-frequency Precipitation Radar (DPR)	JAXA	Provides a cross-track swath widths of 245 km and 120 km, for the Ku precipitation radar (KuPR) and Ka-band precipitation radar (KaPR).		Same
GPM Microwave Imager (GMI)	GSFC	Provides 13 microwave channels ranging in frequency from 10 GHz to 183 GHz; four high frequency, millimeter-wave, channels about 166 GHz and 183 GHz. 1.2 m diameter antenna	Same	Same
Launch Vehicle	JAXA	H-IIA	Same	Same

Estimated Project Schedule

GPM entered formulation in July 2002. Milestone dates beyond the formulation phase are preliminary estimates pending completion of formulation. Constellation Spacecraft launch date is currently under review.

Milestone Name	Formulation Agreement Estimate	FY 2008 PB Request	FY 2009 PB Request
Formulation			
KDP-C	Dec 2003		Jan 2009
Core Spacecraft launch readiness date (LRD)	Nov 2010	Jun 2013	Jun 2013
Constellation Spacecraft launch readiness date (LRD)		Jun 2014	Jun 2014

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Measurement (GPM)

Project Management

Goddard Space Flight Center (GSFC) has project management responsibility. The Agency Program Management Council has program oversight responsibility.

The Earth Sciences Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Core Spacecraft	GSFC	GSFC	None
Core Spacecraft: GMI	GSFC	GSFC	None
Core Spacecraft: DPR	GSFC	GSFC	JAXA
Constellation Spacecraft	GSFC	To Be Determined	To Be Determined
Constellation Spacecraft: GMI	GSFC	GSFC	None
Launch vehicle and services	GSFC	None	JAXA

Acquisition Strategy

The GPM instrument was selected through open competition in FY 2005. The Ball Aerospace and Technologies Corporation will build the GPM Microwave Imager (GMI) instrument for GPM. The GPM core spacecraft will be an in-house development at GSFC. The DPR instrument and launch vehicle for the Core Spacecraft will be provided by a foreign partner (JAXA). The Constellation Spacecraft will be acquired by open competition through the GSFC Rapid Spacecraft Development Office (RSDO). Its launch vehicle will be acquired via competitive process by KSC. The ground systems for both spacecraft will be selected through open competition.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	12/2005	Non-Advocate Review/Preliminary Design Review (PDR)	11/2008

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Constellation elements	Exact global sampling depends on operations of "spacecraft of opportunity" that are not part of this project.	NASA is developing data algorithms that allow GPM to make the broadest possible use of microwave instruments on other spacecraft; NASA participates in inter-agency and international planning processes for operational Earth observation measurements to maximize the leverage opportunities for GPM.
Spacecraft Development Schedule	Delay threatens LRD	Rebaseline NASA development schedule and harmonize with JAXA's.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**127.4**	**91.8**	**35.2**	**29.7**	**9.1**	**9.8**	**2.7**	**--**	**--**	**305.7**
Formulation	70.8	--	--	--	--	--	--	--	--	70.8
Development / Implementation	56.6	91.8	35.2	25.1	--	--	--	--	--	208.7
Operations / Close-out	--	--	--	4.6	9.1	9.8	2.7	--	--	26.2
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0
FY 2008 President's Budget Request	**127.4**	**60.0**	**42.7**	**32.7**	**11.1**	**11.3**	**1.9**	**--**	**--**	**287.0**
Formulation	70.8	--	--	--	--	--	--	--	--	70.8
Development / Implementation	56.6	57.0	34.8	20.4	--	--	--	--	--	168.8
Operations / Close-out	--	--	--	6.4	9.1	9.3	1.6	--	--	26.4
Other	0.0	3.0	7.9	5.9	2.0	2.0	0.3	--	--	21.0
Changes from FY 2008 Request	**--**	**31.8**	**-7.5**	**-3.0**	**-2.0**	**-1.5**	**0.9**	**--**	**--**	**18.7**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	34.8	0.4	4.7	--	--	--	--	--	39.9
Operations / Close-out	--	--	--	-1.8	--	0.5	1.1	--	--	-0.2
Other	--	-3.0	-7.9	-5.9	-2.0	-2.0	-0.2	--	--	-21.0

Note: FY 2009 President's Budget Request is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY 2008.

Explanation of Project Changes

The acquisition cost for the Aerosol Polarimetry Sensor instrument has grown. Additional workforce needed to address instrument issues and maintain schedule have also contributed to the increased funding requirements.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Project Purpose

Glory's science objectives are to:
* Determine the global distribution, microphysical properties, and chemical composition of natural and anthropogenic aerosols and clouds with accuracy and coverage sufficient for a reliable quantification of the aerosol direct and indirect effects on climate.
* Continue measurement of the total solar irradiance to determine the Sun's direct and indirect effect on Earth's climate.

The Glory mission will contribute to NASA's research regarding the atmospheric conditions that influence climate and improve understanding of the natural and man-made factors that contribute to climate change. It will also enable a greater understanding of the seasonal variability of aerosol properties. Both advances are essential components of predicting climate change. Solar radiation is the dominant, direct energy input into the terrestrial ecosystem, affecting all physical, chemical, and biological processes. Aerosols interact with atmospheric conditions in complex ways that can have large effects on climate.

For more on the scientific questions addressed by Glory, visit http://glory.gsfc.nasa.gov/.

Project Parameters

The Glory mission consists of two scientific instruments, the Aerosol Polarimetry Sensor (APS) and the solar Total Irradiance Monitor (TIM), aboard a dedicated NASA spacecraft. The Glory satellite will fly in the low Earth orbit "A-Train" constellation (five spacecraft flying in close proximity to provide detailed observations of the Earth system) to assess the effectiveness of combining aerosol data with data from multiple instruments for enhanced scientific value.

The Aerosol Polarimetry Sensor is an advanced polarimeter used for measurements that will increase our understanding of black carbon soot and other aerosols as causes of climate change. The APS will provide unprecedented measurements of the global distribution of natural and anthropogenic aerosols and clouds with accuracy and coverage sufficient for a reliable quantification of the aerosol direct and indirect effects on climate. The APS is being developed by Raytheon Space and Airborne Systems, El Segundo, California.

The Total Irradiance Monitor (TIM) instrument provides measurement continuity for the 28-year solar irradiance data record by extending the measurement currently provided by NASA's Solar Radiation and Climate Experiment (SORCE). University of Colorado's Laboratory for Atmospheric and Space Physics is developing the TIM sensor, the instrument's Sun pointing platform, and the TIM science operations center.

Orbital Science Corporation, Dulles, Virginia, is developing the spacecraft and the ground system/mission operations center, and will integrate the instruments. Orbital also provides mission systems engineering support and performs mission operations.

Kennedy Space Center is responsible for Glory launch services. The mission will launch on a Taurus XL from Vandenberg Air Force Base, California.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Project Commitments

Glory will launch in March 2009 to begin a three-year prime mission (with a five-year goal) to gather scientific measurements of atmospheric aerosols and solar irradiance.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Aerosol Polarimetry Sensor (APS)	Raytheon	Provide unprecedented measurements of the global distribution of natural and anthropogenic aerosols	Same	Same
Total Irradiance Monitor (TIM)	U of Colorado LASP	Maintain an uninterrupted solar irradiance data record	Same	Same
Spacecraft	Orbital	Refurbishment of VCL mission bus	Same	Same
Launch vehicle	Orbital	Taurus XL	Same	Same
Ground System Ops, TIM Science Ops, APS Science Ops	Orbital / Colorado University-Boulder LASP /GSFC Institute for Space Studies	Combination of the commercial ground stations and the networks that connect them	Same	Same
Mission Ops	Orbital	Operations of the spacecraft and the generation of command uplink	Same	Same
Data Archive	GSFC Earth Science Distributed Active Archive Center (GES DAAC)	Archival and distribution of mission data	Same	Same

Schedule Commitments

Glory was confirmed for development on December 13, 2005.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
Mission Confirmation Review	11/2005	12/2005	12/2005
Mission Pre-ship review	8/2008	8/2008	1/2009
Launch	12/2008	12/2008	3/2009

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Development Cost and Schedule Summary

The Base Year Development Cost Estimate for Glory of $192.9 million has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Glory Mission	2007	168.9	2008	220.9	31	Launch Readiness	12/31/2008	3/31/2009	3

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**168.9**	**220.9**	**52.0**
Aircraft/Spacecraft	13.1	24.2	11.1
Payloads	48.0	78.3	30.3
Systems I&T	3.6	2.7	-0.9
Launch Vehicle/Services	54.5	55.3	0.8
Ground Systems	1.1	0.8	-0.3
Science/Technology	13.4	12.7	-0.7
Other Direct Project Cost	35.2	46.9	11.7

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Project Management

Goddard Space Flight Center has Project Management responsibility. The Science Mission Directorate Program Management Council has program oversight responsibility.

The Earth Science Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
APS	GSFC	GSFC	None
TIM	GSFC	GSFC	None

Acquisition Strategy

All procurements for Glory Mission were competitively awarded.

Aerosol Polarimetry Sensor: Raytheon Space and Airborne Systems.
Total Irradiance Monitor: University of Colorado Laboratory for Atmospheric and Space Physics.
Spacecraft/spacecraft support: Orbital Science Corporation.

There are no remaining major procurements, as all instrument and spacecraft contracts are in place.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	GSFC	02/2007	Detailed cost and schedule review to assess progress in meeting established LRD within baseline budget.	3/2008

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
APS Instrument	Instrument contractor poor performance will cause increased cost and possible impact to launch readiness date.	HQ and GSFC are monitoring detailed milestone metrics and schedule trends.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Landsat Data Continuity Mission (LDCM)

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	**45.9**	**133.0**	**139.4**
FY 2008 President's Budget Request	**113.5**	**160.2**	**192.6**
Total Change from 2008 President's Budget Request	**-67.6**	**-27.2**	**-53.2**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Project Purpose

Unprecedented changes in land cover and use are having profound consequences for weather and climate change, ecosystem function and services, carbon cycling and sequestration, resource management, the national and global economy, human health, and society. The Landsat data series, begun in 1972, is the longest continuous record of changes in the Earth's surface as seen from space and the only satellite system designed and operated to repeatedly observe the global land surface at moderate resolution. Landsat data are available at an affordable cost, providing a unique resource for people who work in agriculture, geology, forestry, regional planning, education, mapping, and global change research.

The purpose of the Landsat Data Continuity Mission (LDCM) is to extend the record of multi-spectral, moderate resolution Landsat-quality data, and to meet U.S. Government operational and scientific requirements for observing land use and land change.

Project Preliminary Parameters

LDCM is being formulated for a Launch Readiness Date (LRD) that will minimize a potential data gap in the archive due to the fuel-limited life of Landsat-7. The Landsat-7 end-of-life is currently estimated to be October 2010, while the LDCM is currently estimated for launch in July 2011.

LDCM consists of a single science instrument (the Operational Land Imager), a spacecraft, and a mission operations ground system. The LDCM is in formulation and system level requirements are in development to provide the following system-level performance parameters:

Earth Spatial-Temporal Coverage: 16-day repeat coverage of the global land mass.

Spatial Resolution: 30 meters.

Radiometric Performance: accuracy, dynamic range, and precision sufficient to detect land cover change using historic Landsat data.

Data: 185-km-cross-track-by-180-km-along-track multi-spectral image of the Earth surface.

Mission Life: five years.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Landsat Data Continuity Mission (LDCM)

Estimated Project Deliverables

LDCM will launch in 2011 and operate for five years.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Operational Land Imager (OLI)	Ball Aerospace and Technology Corporation	Provide Landsat-equivalant data to extend the Landsat data of Earth's land surface for five years.	Same	Provider chosen
Spacecraft	TBD	Provide performance and reliability commensurate with OLI data requirements.	Same	Same
Launch Vehicle	ULA	Provide launch service access to space.	Same	Same
Mission operations ground system	TBD	Provide capability for command and control, mission scheduling, long-term trending and analysis, and flight dynamics analysis.	Same	Same

Estimated Project Schedule

In FY 2008, the LDCM Project will award the LDCM spacecraft contract and the Mission Operations Element (MOE) system development contract (in coordination with the USGS), complete the preliminary design of the Operational Land Imager (OLI), and conduct the Mission Confirmation Review. LDCM will enter mission development.

Preliminary design will comprise the majority of the technical effort in FY 2008, with critical design and fabrication completion in FY 2009 and 2010. System integration and test will begin in FY 2010-2011. Observatory integration and testing, as well as environmental testing, will take place in FY 2010 for launch vehicle integration in early FY 2011.

Milestone Name	Formulation Agreement Estimate	FY 2008 PB Request	FY 2009 PB Request
Formulation			
Award OLI contract	June 2007	June 2007	July 2007
Confirmation Review	Jan 2008	Jan 2008	Jan 2009
Critical Design Review (CDR)	Feb 2009	Feb 2009	May 2009
PSR	May 2011	May 2011	May 2011
Launch	Jan 2011	Jan 2011	July 2011

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Landsat Data Continuity Mission (LDCM)

Project Management

Goddard Space Flight Center is responsible for project management. The Science Mission Directorate Program Management Council has program oversight responsibility. The Earth Science Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Operational Land Imager	GSFC	GSFC	None
Spacecraft	GSFC	To be determined	None
Ground System	GSFC	To be determined	DOI-USGS
Mission Operations	GSFC	To be determined	DOI-USGS

Acquisition Strategy

NASA's acquisition plan includes acquiring separate elements of the LDCM mission through open competition, with GSFC acting as the mission integrator and leading the element source selections. NASA issued a contract award for the development of the Operational Land Imager to Ball Aerospace and Technology Corporation in July 2007. NASA plans to use the Rapid Spacecraft Development Office (RSDO) contract to acquire the LDCM spacecraft, with an anticipated contract award in the first quarter of CY 2008.

NASA, in coordination with the U.S. Geological Survey (USGS), plans to issue a separate Request For Proposal for the LDCM mission operations ground system that is anticipated to be awarded in the second quarter of CY 2008. NASA plans to issue all the solicitations with five one-year options for extended sustaining engineering support for extended mission operations, if required.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	HQ and GSFC	3/2007	Systems Requirements Review/Mission Design Review (SRR/MDR)	4/2008

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Focal Plane Array (FPA) Development Risk	The technical risk in LDCM is low to moderate. The system component with the greatest associated risk is the Focal Plane Array (FPA). The FPA has proven flight heritage, but intrinsic development risk which could impact the LDCM schedule.	Risk mitigation strategies are based upon proven NASA methodologies that include the required instrument manufacturer risk mitigation strategy implementation and correlated Government expert oversight, an extensive peer-review process, enhanced FPA deliverables and test scenarios, and in-plant expert representation.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**507.3**	**47.3**	**70.0**	**94.4**	**46.3**	**8.6**	**8.9**	**9.2**	**11.4**	**803.3**
Formulation	47.7	--	--	--	--	--	--	--	--	47.7
Development / Implementation	459.6	47.3	70.0	94.4	46.3	--	--	--	--	717.6
Operations / Close-out	--	--	--	--	--	8.6	8.9	9.2	11.4	38.1
Other	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2008 President's Budget Request	**513.2**	**80.1**	**91.0**	**93.6**	**20.2**	**6.8**	**7.6**	**--**	**13.8**	**826.4**
Formulation	47.7	--	--	--	--	--	--	--	--	47.7
Development / Implementation	465.5	57.2	74.2	76.6	10.9	--	--	--	--	684.4
Operations / Close-out	--	--	--	--	5.7	5.7	6.3	--	11.4	29.1
Other	0.0	22.9	16.8	17.0	3.6	1.1	1.3	--	2.4	65.2
Changes from FY 2008 Request	**-6.0**	**-32.8**	**-21.1**	**0.8**	**26.1**	**1.8**	**1.3**	**9.2**	**-2.4**	**-23.1**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	-5.9	-9.9	-4.2	17.8	35.4	--	--	--	--	33.2
Operations / Close-out	--	--	--	--	-5.7	2.9	2.6	9.2	--	9.0
Other	0.0	-22.9	-16.9	-17.0	-3.6	-1.1	-1.4	0.0	-2.4	-65.3

Note: FY 2009 President's Budget Request is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY 2008.

Explanation of Project Changes

The changes to the NPP budget are primarily due to the late delivery of the Visible Infrared Imaging Radiometer Suite (VIIRS) instrument.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Project Purpose

The NPOESS Preparatory Project (NPP) is a joint mission with National Oceanic and Atmospheric Administration and the U.S. Air Force to extend key environmental measurements. The satellite will provide atmospheric and sea surface temperatures, humidity sounding, land and ocean biological productivity, and cloud and aerosol properties.

The NPP mission has two objectives: First, NPP will provide a continuation of global change observations following the Earth Observing System missions Terra and Aqua, specifically, atmospheric and sea surface temperatures, humidity sounding, land and ocean biological productivity, and cloud and aerosol properties. Second, NPP will provide the National Polar-orbiting Operational Environmental Satellite System (NPOESS) with risk-reduction demonstration and validation for the critical NPOESS sensors, algorithms, and processing.

Project Parameters

The NPP spacecraft is based on a modified Ball Commercial Platform 2000 bus with a five-year design life. The NPP orbit is a polar, Sun-synchronous orbit at a nominal altitude of 824 kilometers. The four instruments are newly developed sensors based on heritage NASA sensors. The Advanced Technology Microwave Sounder (ATMS) is being developed by NASA, and the other three instruments are being developed by the NOAA/Department of Defense Integrated Program Office.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Project Commitments

NPP will launch in June 2010 and undertake the following scientific measurements over its five-year operating life: atmospheric and sea surface temperatures, humidity soundings, land and ocean biological productivity, and cloud and aerosol properties.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Visible Infrared Imaging Radiometer Suite (VIIRS)	Raytheon SBRS	Provide global imagery in visible and infrared frequency bands: 0.3 to 14 microns / 400 m resolution.	Same	Same
Ozone Mapping and Profiler Suite (OMPS)	Ball Aerospace	Collection of total column and vertical profile ozone data with 300-380 nm / LIMB 290-1000 nm .	Same	Same
Cross-Track Infrared Sounder (CrIS)	ITT Aerospace	Temperature and moisture profiles at 3.9-15.4 microns.	Same	Same
Advanced Technology Microwave Sounder (ATMS)	NG Electronic Systems	Temperature and moisture profiles at 22 channels / 23-183 ghz.	Same	Same
Spacecraft	Ball Aerospace	5-year design life, Weight 2228 kg, Power 1400 watts.	Same	Same
Launch vehicle	Boeing	Delta II 7920.	Same	Same
Ground system	Raytheon	Command, Control, and Communication Segment (C3S) and Interface Data Processing Segment (IDPS).	Same	Same

Schedule Commitments

The NPP mission completed Mission Confirmation Review (MCR) in November 2003.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
CrIS Flight Model Delivery	Oct 2005	Jan 2007	May 2008
ATMS Flight Model Delivery	Apr 2005	Oct 2005	Oct 2005
OMPS Flight Model Delivery	Sep 2005	Mar 2008	Aug 2008
VIIRS Flight Model Delivery	Nov 2005	Jul 2008	Apr 2009
Operations Readiness Review	Jun 2006	Apr 2009	Dec 2009
Launch	Oct 2006	Sep 2009	Jun 2010

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Development Cost and Schedule Summary

The Base Year Development Cost Estimate for the NPOESS Preparatory Project (NPP) of $604.2 million has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
NPOESS Preparatory Project (NPP)	2006	592.9	2008	703.8	19	Launch Readiness	4/30/2008	6/30/2010	26

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**592.9**	**703.8**	**110.9**
Aircraft/Spacecraft	160.0	158.8	-1.2
Payloads	194.2	156.8	-37.4
Launch Vehicle/Services	72.9	93.3	20.4
Ground Systems	48.2	47.7	-0.5
Other Direct Project Cost	117.6	216.8	99.2
Science/Technology	0.0	30.4	30.4

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Project Management

GSFC is responsible for NPP project management. Agency PMC has program oversight responsibility. NOAA/DOD IPO is responsible for managing development of OMPS, CrIS and VIIRS instruments. Responsible official is the Earth Science Division Director.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	GSFC	None	None
ATMS Development	GSFC	None	None
OMPS Development	GSFC	None	NOAA / DoD (NPOESS-IPO)
CrIS Development	GSFC	None	NOAA / DoD (NPOESS-IPO)
VIIRS Development	GSFC	None	NOAA / DoD (NPOESS-IPO)
Data archive and storage	GSFC	None	NOAA / DoD
Ground Systems and Ops	GSFC	None	NOAA / DoD (NPOESS-IPO)

Acquisition Strategy

Spacecraft and ATMS were procured competitively. The VIIRS, OMPS, and CrIS were procured competitively via the NPOESS Integrated Program Office.

The procurement award for each element were as follows:
Ball Aerospace: Spacecraft and OMPS Development;
NG Electronic Systems: ATMS Development;
ITT Aerospace: Crls Development;
Raytheon SBRS: VIIRS Development; and
Raytheon: Ground systems and operations.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	NPP IRT	08/2005	Mission Operations Review/Successfully completed.	03/2008

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Instrument Delivery Delay	Additional delays in the delivery of instruments are very likely. This would result in observatory integration delays, test delays, cost increases, schedule slip, and possible gaps in data continuity.	NASA and NOAA/IPO team working together to identify further work-arounds to minimize impacts.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Ocean Surface Topography Mission

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**101.0**	**42.8**	**27.5**	**8.0**	**7.8**	**7.7**	**7.3**	**7.3**	**0.7**	**210.1**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	101.0	42.8	27.5	--	--	--	--	--	--	171.3
Operations / Close-out	--	--	--	8.0	7.8	7.7	7.3	7.3	0.7	38.8
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2008 President's Budget Request	**101.0**	**47.0**	**33.4**	**8.7**	**8.3**	**8.2**	**7.8**	**--**	**0.8**	**215.3**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	101.0	42.8	27.5	--	--	--	--	--	--	171.3
Operations / Close-out	--	--	--	8.0	7.8	7.7	7.3	--	0.7	31.5
Other	0.0	4.2	5.9	0.7	0.5	0.5	0.5	--	0.1	12.5
Changes from FY 2008 Request	**--**	**-4.3**	**-5.8**	**-0.6**	**-0.6**	**-0.6**	**-0.5**	**7.3**	**0.0**	**-5.1**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	--	--	--	--	--	--	--	--	--
Operations / Close-out	--	--	--	--	--	--	--	7.3	--	7.3
Other	--	-4.3	-5.8	-0.6	-0.6	-0.6	-0.5	0.0	0.0	-12.4

Note: FY 2009 President's Budget Request is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY 2008.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Ocean Surface Topography Mission

Project Purpose

The Ocean Surface Topography Mission (OSTM) will provide continuity of ocean topography measurements beyond TOPEX/Poseidon (T/P) and Jason, for determining ocean circulation, climate change, and sea-level rise.

Project Parameters

OSTM will have a three-year mission life with a five-year extended-mission goal. It will carry five primary scientific instruments: the Advanced Microwave Radiometer (AMR); the Global Positioning System (GPS) Payload; the Laser Retroreflector Array (LRA); Nadir Altimeter; and the Doppler Orbitography by Radiopositioning Integrated by Satellite (DORIS) instruments. OSTM will measure sea surface height to an accuracy of less than 4 centimeters every 10 days. In addition, the French Space Agency, Centre Nationale D'Etudes Spatiale (CNES), is providing secondary instruments.

Project Commitments

OSTM will launch in June 2008 to begin a three-year prime mission to undertake measurements for scientific and operational users.

Schedule Commitments

OSTM was confirmed for development in March 2006.

Project Management

The Jet Propulsion Laboratory (JPL) is responsible for project management. The Science Mission Directorate and JPL's Program Management Councils have program oversight responsibility. The Earth Science Division Director is the responsbile official.

Acquisition Strategy

The AMR is to be built in-house by JPL. The GPS payload, LRA, and launch vehicle were all procured competitively. The Nadir Altimeter, DORIS, secondary instruments and spacecraft are all being provided by CNES, a foreign partner, at no cost to NASA.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	167.9	113.8	88.6	58.8	37.4	50.0	54.9
Orbiting Carbon Observatory (OCO)	84.8	35.6	25.4	9.0	1.4	0	0
Aquarius	62.4	48.6	33.8	27.9	5.1	4.0	2.9
Other Missions and Data Analysis	20.6	29.6	29.4	21.9	30.8	46.0	52.0
FY 2008 President's Budget Request	165.2	135.7	94.9	171.6	242.3	161.2	0
Orbiting Carbon Observatory (OCO)	75.7	40.9	12.6	6.4	0	0	0
Aquarius	73.4	60.6	33.5	6.7	4.8	3.4	0
Other Missions and Data Analysis	16.0	34.1	48.8	158.4	237.5	157.8	0
Changes from FY 2008 Request	2.7	-21.9	-6.3	-112.8	-205.0	-111.2	54.9

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

The Earth System Science Pathfinder Program (ESSP) addresses unique, specific, highly-focused mission requirements in Earth Science research. ESSP includes a series of relatively low-to-moderate cost, small-to-medium sized, competitively selected, Principal Investigator-led missions. These missions, which are built, tested and launched in a short time interval, complement the larger Earth Systematic Missions (ESM). They are capable of supporting a variety of scientific objectives related to Earth science, including studies of the atmosphere, oceans, land surface, polar ice regions, and solid Earth. Investigations include development and operation of remote-sensing instruments and the conduct of investigations using data from these instruments.

ESSP currently has two missions in development (Orbiting Carbon Observatory and Aquarius) and three operating missions (Gravity Recovery and Climate Experiment [GRACE], CloudSat, and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations [CALIPSO]). Future ESSP missions will be selected from proposals submitted in response to Announcements of Opportunity.

ESSP supports missions that complement those of the larger Earth Systematic Missions which are designed to facilitate on-going or operational measurements.

For more information see http://earth.nasa.gov/essp/index.html/.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

Program Relevance

Earth System Science Pathfinder missions provide science data, techniques, and technologies that can be employed to predict climate, weather, and natural hazards on Earth, and have relevance for predicting these conditions for other planetary bodies.

ESSP contributes to the Outcomes under Strategic Subgoal 3A.

Plans For FY 2009

1) Orbiting Carbon Observatory mission Pre-Ship Review, Operations Readiness Review, and launch.

2) Completion of the Aquarius instrument and delivery to the SAC-D spacecraft for integration.

3) GRACE and CloudSat were reviewed as part of the 2007 Senior Review. Both missions were approved for renewal through FY 2009. All three operating missions (GRACE, CloudSat, and CALIPSO) will be reviewed during the 2009 Senior Review process.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

Project Descriptions and Explanation of Changes

Orbiting Carbon Observatory (OCO)

The Orbiting Carbon Observatory (OCO) will improve understanding of atmospheric carbon dioxide sources and sinks, a critical element in making more reliable climate predictions. The science focus areas served by OCO will include: atmospheric composition; and carbon cycle, ecosystems, and biogeochemistry.

Aquarius

Aquarius will observe and model seasonal and year-to-year variations of sea-surface salinity and how these variations relate to changes in the water cycle and ocean circulation. The science focus areas served by Aquarius will include: climate variability and change; and water and energy cycles.

Earth Explorer Future Missions

Future Earth System Science Pathfinder projects will implement unique, specific, highly focused missions in response to priorities suggested by the National Research Council's Earth Science Decadal Survey.

Gravity Recovery and Climate Experiment (GRACE)

The Gravity Recovery and Climate Experiment (GRACE), launched in 2002, was the first ESSP mission. GRACE measures Earth's gravity field and its variations with time. Science focus areas served by GRACE include: climate variability and change; Earth surface and interior; and water and energy cycles.

CloudSat

CloudSat measures cloud characteristics to increase understanding of the role of optically thick clouds in Earth's radiation budget. The science focus areas served by CloudSat include: climate variability and change; and weather.

Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)

The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) mission measures the vertical distribution of clouds and aerosols. The science focus areas served by CALIPSO include: atmospheric composition; climate variability and change; water and energy cycles; and weather.

ESSP Senior Review Competed Science

The NASA Earth Science Division uses Senior Reviews, which are held every two years, to assess the relative science value of missions in operation. These reviews are competitive in nature and serve as the basis for determining whether a mission, which has completed its current approved phase, should be extended.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Senior Review (SR) to make recommendations on mission extensions	GRACE, CloudSat, and CALIPSO	
Launch spacecraft	Orbiting Carbon Observatory	LRD moved from Sept. 2008 to Dec. 2008
Integrate Aquarius instrument with SAC-D spacecraft	Aquarius	LRD moved from July 2009 to May 2010

Implementation Schedule

Project	Schedule by Fiscal Year (Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21)	Phase Dates	Beg	End
OCO		Tech		
		Form	Oct-03	Apr-05
		Dev	May-05	Dec-08
		Ops	Dec-08	Dec-10
		Res		
Aquarius		Tech		
		Form	Oct-03	Sep-05
		Dev	Oct-05	Apr-10
		Ops	May-10	May-13
		Res		
Gravity Recovery and Climate Experiment (GRACE)		Tech		
		Form		
		Dev		
		Ops	Mar-02	Sep-11
		Res		
CloudSat		Tech		
		Form		
		Dev		
		Ops	Apr-06	Sep-11
		Res		
Cloud-Aerosol Lidar and Infrared Pathfinder Satellite (CALIPSO)		Tech		
		Form		
		Dev		
		Ops	Apr-06	Apr-09
		Res		Apr-11

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

Program Management

The Agency Program Management Council has program oversight responsibility.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Aquarius	JPL	JPL	Argentina's Comision Nacional De Actividades Espaciales (CONAE), National Oceanic and Atmospheric Administration, Naval Research Laboratory, National Center for Atmospheric Research.
Orbiting Carbon Observatory (OCO)	JPL	JPL	Laboratoire des Sciences du Climat ed de l'Environment (LSCE), France; Universitat Bremen, Germany; National Institute of Water & Atmospheric Research, New Zealand; Climate Monitoring & Diagnostic Laboratory, NOAA; Space Research Organization Netherlands, The Netherlands; Institut fur Umweltphysik, Bremen, Germany.
Gravity Recovery and Climate Experiment (GRACE)	Earth Science Division	JPL	Deutches Zentrum fur Luft- und Raumfahrt (DLR, the German Aerospace Center); Office National d'Etudes et de Recherches Aerospatiale (ONERA) of France; GeoForschungsZentrum (German National Research Centre for Geosciences); National Oceanic and Atmospheric Administration; National Geospatial-Intelligence Agency.
CloudSat	Earth Science Division	JPL	Canadian Space Agency; U.S. Air Force; Department of Energy.
Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)	Earth Science Division	LaRC	France's Centre National d'Etudes Spatiales (CNES, the National Center for Space Studies) and Alcatel; SODERN; Institut Pierre Simon Laplace, France.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

Acquisition Strategy

Future ESSP missions will be selected competitively via Announcements of Opportunity (AO). The AO process uses peer review for the science content of the proposed missions, as well as thorough independent review of their technical, management, and cost elements.

In FY 2007, GRACE and CloudSat went through the biennial competitive Senior Review process and were approved for continued extended mission operations.

GRACE Project Team: Amarillo Independent School District; Applied Physics Laboratory, Johns Hopkins University; Llano Independent School District, Messalonskee School System; GSFC, Center for Space Research; Univ. of Texas at Austin. Analytical Mechanics Associates; Elizabeth Board of Education, Killeen Independent School District; MIT, Dept of Earth, Atmospheric & Planetary Sciences; Mid-Prairie Community School District; KSC; LaRC; Space Systems Loral; Sunray Independent School District; Texas Space Grant Consortium; Univ. of Colorado, Physics Department; Ohio State Univ., Civil & Environmental Engineering and Geodetic Science; Stanford Telecon; TRW; DJO, DASA, Jena-Optronik, Gm.
CloudSat Project Team: Colorado State Univ. PI and team, E&PO effort; Ball Aerospace ; Cooperative Institute for Research in the Atmosphere (CIRA; Colorado State Univ.) operates Data Processing Center. LaRC Atmospheric Sciences Data Center delivers data products to CIRA. GSFC delivers data products to CIRA. European Centre for Medium-Range Weather Forecasts met forecast data to CIRA. GLOBE program (Boulder, Colorado) prime education partner. USAF Space Test Program conducts mission operations out of Kirtland AFB, Albuquerque, NM.

CALIPSO Project team: LaRC systems engineering, payload mission ops, science data validation, data processing and archiving. Ball Aerospace CALIOP and wide-field camera, payload integration, LV support, science data downlink. Hampton Univ. manages quid pro quo validation effort, E&PO effort, and leads International Science Advisory Panel

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	04/2007	GRACE and CloudSat were reviewed as part of the Earth Science biennial Senior Review process. Both missions were ranked very high for data quality and relevance to the NASA Earth Science Theme objectives.	04/2009

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Operating Mission Risk	Earth Science operating missions, especially those in their extended mission phase, face the normal array of engineering risks that could impact the mission. As spacecraft and their systems age, instruments and spacecraft systems (e.g., solar arrays, batteries, gyroscopes) degrade, increasing the risk to the mission.	NASA Centers involved with operating missions (primarily GSFC and JPL) routinely monitor spacecraft and instrument health and develop mitigation strategies in coordination with NASA HQ to deal with technical challenges, as needed. A variety of options is available, including reducing instrument usage time, making corrections via software uploads, and accepting higher levels of risk.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Orbiting Carbon Observatory (OCO)

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**113.6**	**84.8**	**35.6**	**25.4**	**9.0**	**1.4**	**--**	**--**	**--**	**269.8**
Formulation	30.9	--	--	--	--	--	--	--	--	30.9
Development / Implementation	82.7	84.8	35.6	16.2	--	--	--	--	--	219.3
Operations / Close-out	--	--	--	9.2	9.0	1.4	--	--	--	19.6
Other	0.0	0.0	0.0	0.0	0.0	0.0	--	--	--	0.0
FY 2008 President's Budget Request	**113.6**	**75.7**	**40.9**	**12.6**	**6.4**	**--**	**--**	**--**	**--**	**249.2**
Formulation	30.9	--	--	--	--	--	--	--	--	30.9
Development / Implementation	82.7	68.0	35.8	--	--	--	--	--	--	186.5
Operations / Close-out	--	--	--	11.8	6.0	--	--	--	--	17.8
Other	0.0	7.7	5.1	0.8	0.4	--	--	--	--	14.0
Changes from FY 2008 Request	**--**	**9.1**	**-5.4**	**12.9**	**2.6**	**1.4**	**--**	**--**	**--**	**20.6**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	16.8	-0.2	16.2	--	--	--	--	--	32.8
Operations / Close-out	--	--	--	-2.6	3.0	1.4	--	--	--	1.8
Other	--	-7.7	-5.2	-0.7	-0.4	0.0	--	--	--	-14.0

Note: FY 2009 P.B.R. is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY2008.

Explanation of Project Changes

A re-planning effort was initiated due to issues with the Orbiting Carbon Observatory instrument and its manufacturer. Persistent schedule delays caused project management at the Jet Propulsion Laboratory (JPL) to transfer a significant amount of instrument work in-house in an effort to preserve the launch date. However, continued contract cost growth, coupled with significant scope and cost transferred to JPL, led to an inability to maintain the September 2008 launch date or meet the approved budget. Accordingly, project re-planning was initiated to establish an achievable launch date with a credible budget. The overall project schedule has been delayed three months to a December 15, 2008 launch.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Orbiting Carbon Observatory (OCO)

Project Purpose

The data received from the Orbiting Carbon Observatory (OCO) will provide an improved understanding of CO_2 sinks, a critical element in making reliable climate predictions.

Two important Earth Science questions the OCO Mission will help address are:
* What human and natural processes are controlling atmospheric CO_2?
* What are the relative roles of the oceans and land ecosystems in absorbing CO_2?

Project Parameters

The OCO is a two-year mission, which will fly in a Sun-synchronous polar orbit that provides near global coverage of the sunlit portion of the Earth with a 16-day repeat cycle. The orbit's early afternoon equator crossing time maximizes the available signal and minimizes diurnal biases in CO_2 measurements associated with photosynthesis.

The OCO flight system uses hardware components, software and processes with spaceflight heritage. OCO's three-axis stabilized bus design is derived from the LEOStar-2 spacecraft class currently in production at Orbital Science Corporation. The design and architecture of the OCO spacecraft bus is based on the successful Solar Radiation and Climate Experiment (SORCE) and Galaxy Explorer (GALEX) missions.

The spacecraft structure is made of honeycomb panels that form a hexagonal shape. This structure houses the instrument and the spacecraft bus components. Panels with solar cells are attached and stowed such that the whole structure fits inside the small fairing of the Taurus launch vehicle. For the OCO mission, the spacecraft has been elongated to accommodate the instrument and the instrument has been embedded into the structure of the spacecraft. The instrument consists of a single telescope feeding three high-resolution grating spectrometers. The optics will be cooled to approximately 270 Kelvin and the Focal Plane Arrays (FPAs) to approximately 120 Kelvin. The instrument is designed to measure CO_2 and O_2 near-infrared absorptions from reflected sunlight. Remote sensing retrieval algorithms will process these data to yield estimates of the column-averaged CO_2 dry air mole fraction, XCO_2. The total weight of the observatory is about 530 kilograms (1170 pounds).

Project Commitments

OCO will launch in December 2008 to begin a two-year prime mission.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
OCO Mission	JPL	Atmospheric CO_2 measurements to better understand CO_2 sources and sinks and seasonable variability.	Same	Same

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Orbiting Carbon Observatory (OCO)

Schedule Commitments

The OCO will provide the first space-based measurements of atmospheric carbon dioxide (CO_2) with the precision, resolution, and coverage needed to characterize its sources and sinks on regional scales and quantify their variability over the seasonal cycle. OCO was competitively selected from proposals submitted in response to Earth System Science Pathfinder Announcement of Opportunity 3 to enter a Risk Mitigation Phase (RMP) in July 2002. Following the RMP, the project was authorized to proceed to a formulation phase in December 2003. The OCO mission was authorized by NASA's Science Mission Directorate (SMD) to proceed to Development on May 12, 2005. In April 2007, the SMD approved a replan of the OCO project, including a launch delay to December 2008.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
Mission Confirmation Review	April 2005	April 2005	April 2005
CDR	August 2006	August 2006	August 2006
Launch Readiness	September 2008	September 2008	December 2008

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Orbiting Carbon Observatory (OCO)

Development Cost and Schedule Summary

The Base Year Development Cost Estimate for the Orbiting Carbon Observatory of $199.3 million has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Orbiting Carbon Observatory (OCO)	2007	186.5	2008	219.6	18	Launch Readiness	9/30/2008	12/31/2008	3

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**186.5**	**219.6**	**33.1**
Aircraft/Spacecraft	52.1	53.6	1.5
Payloads	25.7	60.8	35.1
Launch Vehicle/Services	53.7	54.0	0.3
Ground Systems	10.7	12.9	2.2
Science/Technology	10.6	11.6	1.0
Other Direct Project Cost	33.7	26.7	-7.0

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Orbiting Carbon Observatory (OCO)

Project Management

JPL is responsible for project management. The Science Mission Directorate and JPL Program Management Councils have program oversight responsibility.

The Earth Science Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	JPL	None	None
Instrument	JPL	JPL	None
Ground System	JPL	JPL	None
Launch Vehicle	JPL	KSC	None

Acquisition Strategy

All mission elements were included in the proposal that was selected competitively as part of Earth System Science Pathfinder Announcement of Opportunity 3.

There are no planned major procurements, as all instrument and spacecraft contracts are in place.

Project element procurements were awarded to Orbital Science Corporation for the spacecraft, and Hamilton Sundstrand for the instrument.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	OCO Standing Review Board	04/2007	Assembly, Test, and Launch Operations Readiness Review	01/2008

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Instrument Integraton and Test Schedule	Limited schedule reserve for Instrument Integration and Test phase may impact the overall project schedule.	Project to identify opportunities to recapture schedule reserve by adding additional shifts or reassigning current Integration and Test plan. Overall goal is to avoid impacts to the mission -critical path.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Aquarius

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**87.3**	**62.4**	**48.6**	**33.8**	**27.9**	**5.1**	**4.0**	**2.9**	**--**	**272.0**
Formulation	35.6	--	--	--	--	--	--	--	--	35.6
Development / Implementation	51.7	62.4	48.6	33.8	26.2	--	--	--	--	222.7
Operations / Close-out	--	--	--	--	1.7	5.1	4.0	2.9	--	13.7
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0
FY 2008 President's Budget Request	**87.3**	**73.4**	**60.6**	**33.5**	**6.7**	**4.8**	**3.4**	**--**	**--**	**269.7**
Formulation	35.6	--	--	--	--	--	--	--	--	35.6
Development / Implementation	51.7	61.2	51.8	26.9	--	--	--	--	--	191.6
Operations / Close-out	--	--	--	1.1	5.7	4.0	2.8	--	--	13.6
Other	0.0	12.2	8.8	5.5	1.0	0.8	0.6	--	--	28.9
Changes from FY 2008 Request	**--**	**-10.9**	**-12.1**	**0.3**	**21.2**	**0.4**	**0.5**	**2.9**	**--**	**2.3**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	1.2	-3.2	6.9	26.2	--	--	--	--	31.1
Operations / Close-out	--	--	--	-1.1	-4.0	1.1	1.2	2.9	--	0.1
Other	--	-12.1	-8.9	-5.5	-1.0	-0.7	-0.7	0.0	--	-28.9

Note: FY 2009 President's Budget Request is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY 2008.

Explanation of Project Changes

Changes in the budget are directly attributable to the launch delay caused by a slip in the spacecraft development schedule. During FY 2007 the Argentine Comision Nacional de Actividades Espaciales (CONAE) determined that a July 2009 Launch Readiness Date (LRD) was not feasible for its spacecraft, SAC-D. The NASA/CONAE Joint Steering Group met to discuss the status of the schedule and, during this meeting, CONAE proposed an LRD of May 2010. Subsequently, the Science Mission Directorate Program Management Council met on November 16, 2007, and approved a rebaselined May 2010 LRD.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Aquarius

Project Purpose

The Aquarius mission will investigate the links between the global water cycle, ocean circulation, and climate. It will observe and model variations of sea surface salinity, and how these relate to changes in the water cycle and ocean circulation. This will yield an unprecedented view of the oceans' role in climate and weather.

Project Parameters

Aquarius is an instrument on Argentina's National Committee of Space Activities (CONAE) spacecraft, Satellite de Aplicaciones Cientificas-D (SAC-D). The combined NASA and CONAE instruments and spacecraft form the Aquarius/SAC-D observatory. This observatory will be launched into a polar, Sun-synchronous orbit that allows global coverage of ice-free ocean surfaces consistent with Aquarius/SAC-D science observational targets. The Aquarius instrument includes an L-band microwave radiometer (1.413 GHz) and scatterometer (1.26 GHz). The radiometer will measure the surface brightness temperature, which is related to the surface emissivity and physical temperature of the seawater. The surface emissivity is determined by the dielectric constant of seawater, which is related to salinity. The scatterometer is required to provide coincident information of sea surface roughness, a critical correction term for retrieval of sea surface salinity.

Project Commitments

Aquarius will launch in May 2010 to begin a three-year prime mission to measure sea surface salinity (SSS) with the precision, resolution, and coverage needed to characterize salinity variations and investigate the linkage between ocean circulation, Earth's water cycle, and climate variability.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Aquarius Instrument (integrated radiometer/ scatterometer)	JPL	L-band microwave radiometer at 1.413 GHz; scatterometer at 1.26 GHz; SSS measurements with root-mean-sq random errors and systematic biases <= 0.2 psu on 150 km sq scales over ice-free oceans.	Same	Same
Spacecraft	CONAE	SAC-D	Same	Same
Launch Vehicle	Boeing	Delta II	Same	Same
Data Management	GSFC	N/A	Same	Same
Operations	CONAE	Command and telemetry	Same	Same

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Aquarius

Schedule Commitments

The Aquarius mission entered a Risk Mitigation Phase (RMP) in July 2002. Following the RMP, the project was authorized to proceed to a formulation phase in December 2003. The Aquarius mission was authorized by the NASA Science Mission Directorate to proceed to Development on October 12, 2005. In November 2007, the NASA Science Mission Directorate Program Management Council approved a rebaseline of Aquarius, including a launch delay to May 2010.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
Mission Confirmation Review	September 2005	September 2005	September 2005
Mission CDR	August 2007	August 2007	April 2008
Aquarius Instrument Pre-ship Review [FY08 APG]	May 2008	May 2008	May 2008
Launch	March 2009	July 2009	May 2010

Development Cost and Schedule Summary

The Base Year Development Cost Estimate for Aquarius of $215.9 million has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Aquarius	2007	192.6	2008	203.3	6	Launch Readiness	7/1/2009	5/1/2010	10

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**192.6**	**203.3**	**10.7**
Payloads	55.4	67.3	11.9
Launch Vehicle/Services	78.9	75.9	-3.0
Ground Systems	5.5	5.7	0.2
Science/Technology	10.9	12.7	1.8
Other Direct Project Cost	41.9	41.7	-0.2

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Aquarius

Project Management

The Jet Propulsion Laboratory is responsible for project management. The Science Mission Directorate Program Management Council is responsible for program oversight.

The Earth Science Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Launch Vehicle	KSC	KSC	None
Ground System	JPL	GSFC	None
Aquarius Instrument	JPL	JPL	None
Spacecraft	CONAE	None	CONAE
Radiometer	JPL	GSFC	None
Data management	GSFC	GSFC/JPL	None
Mission operations	CONAE	None	CONAE

Acquisition Strategy

Aquarius was competitively selected from proposals submitted in response to Earth System Science Pathfinder (ESSP) Announcement of Opportunity 3. All elements of the project were included in that selection, and there are no other planned major procurements.

The launch vehicle procurement was awarded to Boeing. Goddard Space Flight Center and the Jet Propulsion Laboratory were selected for the remaining project elements not provided by CONAE.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Aquarius Standing Review Board	10/2007	10/07 -- Review technical, cost, schedule status. 5/08 -- Instrument Pre-Ship Review.	05/2008

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Spacecraft Development Delays	Further delays could impact launch date.	Monitor CONAE Progress and confirm commitments; reassess available schedule reserves.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	168.0	167.8	140.5	159.1	157.9	166.5	170.9
Earth Science Multi-Mission Operations	168.0	167.8	140.5	159.1	157.9	166.5	170.9
FY 2008 President's Budget Request	192.9	204.4	181.3	191.3	185.8	194.2	0
Earth Science Multi-Mission Operations	192.9	204.4	181.3	191.3	185.8	194.2	0
Changes from FY 2008 Request	-24.9	-36.5	-40.8	-32.2	-27.8	-27.6	170.9

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

The Earth Science Multi-Mission Operations Program acquires, preserves, and distributes observational data to support Earth Science focus areas in conformance with national science objectives. Facilities involved in this undertaking include data-handling, data processing, and archiving systems.

NASA's principal Earth Science information system is the Earth Observing System Data and Information System (EOSDIS), which has been operational since August 1994. EOSDIS acquires, processes, archives, and distributes Earth Science data and information products created from satellite data, which arrive at the rate of more than four trillion bytes (4 terabytes) per day. Having successfully created this system, NASA is using advances in information technology to expand its capabilities while providing continuous service to the user community.

The Evolution of EOSDIS Elements (EEE) effort is: increasing efficiency and operability; increasing data usability by the research, application, and modeling communities; providing services and tools needed to enable use of NASA's Earth Science data in next-decadal models, research results, and decision support system benchmarking; and improving support for end users. The evolved system is being phased in -- a process that began in FY 2006 -- with milestones developed through 2008. The budget request for FY 2009 and beyond incorporates cost savings that will result from this effort. A system plan for 2015 will guide further improvements.

NASA Earth Science information is archived at eight Distributed Active Archive Centers (DAACs) located across the United States. The DAACs specialize by topic area, and make their data available to researchers around the world. For more information, please see http://eos.nasa.gov/eosdis.

Research opportunities related to EOSDIS are available through the Advanced Collaborative Connections for Earth System Science (ACCESS) and Making Earth System data records for Use in Research Environments (MEaSUREs) programs. Participants in these programs are solicited through the Research Opportunities in Space and Earth Sciences (ROSES), the NASA Research Announcement soliciting basic and applied research proposals.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

Program Relevance

The Earth Science Multi-Mission Operations Program contributes to the Outcomes under Strategic Plan Subgoal 3A: Study Earth from space to advance scientific understanding and meet societal needs.

Plans For FY 2009

The Earth Science Multi-Mission Operations Program will continue the operation of EOSDIS, the DAACs and its accompanying functions, as well as Core System Science Data Processing Systems. The maintenance of these systems is important to the collection of data from Earth Science satellites in orbit, as well as to the continuity of Earth Science research efforts.

The first steps of the Evolution of EOSDIS Elements (EEE) effort, begun in 2006, are on track and meeting expectations. Some efforts will be completed by the end of first quarter FY 2008, and others by end of second quarter FY 2008. Savings and operational benefits from the first steps begin in FY 2008, and are fully appreciated starting in FY 2009 and beyond. NASA plans to continue the support of the EEE to enable a smooth transition to the new architecture between now and 2015.

The MEaSUREs and ACCESS selection recommendations are being made during September 2007 to support FY 2008 award start-ups. These Cooperative Agreements are proving very valuable for keeping research and modeling communities actively involved with the EOSDIS architecture, and informing core infrastructure evolution decisions.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

Project Descriptions and Explanation of Changes

EOSDIS

EOSDIS is the central data handling system for NASA's Earth Science efforts. EOSDIS components funded in the project include:
* Product Generation for the research community, using algorithms and software developed by EOS investigators;
* Data Archive, Management, and Distribution, ensuring the preservation of data, products, related algorithms, and system-configuration history;
* Information Management, enabling researchers to rapidly locate and retrieve data critical to their work; and
* User Support for research scientists, educators, students, and users in public agencies responsible for operational applications of the data, as well as for the general public. Nominal EOSDIS development ended in FY 2007. All future development and improvements to the system will be planned through the Evolution of EOSDIS Elements process.

Multi-Mission Operations

This project funds the Elements of EOSDIS Evolution, aimed at improving the efficiency and effectiveness of EOSDIS while reducing the cost, and the Distributed Active Archive Centers, which collect, disseminate, and archive Earth Science data at eight centers across the Nation:

- The Alaska SAR Facility, which collects Synthetic Aperture Radar data, and information on sea ice, polar processes, and geophysics;
- The GSFC Earth Sciences Data and Information Services Center, which collects information on atmospheric composition, atmospheric dynamics, global precipitation, ocean biology, ocean dynamics, and solar irradiance;
- The Langley Research Center DAAC, which collects data on Earth's radiation budget, clouds, aerosols, and tropospheric chemistry;
- The Land Processes DAAC, which collects land processes data;
- The National Snow and Ice Data Center, which collects snow and ice data, as well as information about the cryosphere and climate;
- The Oak Ridge National Laboratory DAAC, which collects data on biogeochemical dynamics, and ecological data for studying environmental processes;
- The Physical Oceanography DAAC, which collects information on oceanic processes and air-sea interactions; and
- The Socioeconomic Data and Applications Center, covering population, sustainability, geospatial data, multilateral environmental agreements, natural hazards, and poverty.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Provide services and tools needed to enable use of NASA's Earth Science data in next-decadal models, research results, and decision support system benchmarking.	EOSDIS and DAACs	New

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

Implementation Schedule

Project	Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21	Phase	Beg	End
EOSDIS and Multi-Mission Operations (including DAACs)		Tech		
		Form		
		Dev		
		Ops	Aug-94	Dec-15
		Res		
Elements of EOSDIS Evolution (phased start-up beginning in FY 2008)		Tech		
		Form	Nov-04	Nov-05
		Dev	Dec-05	Mar-08
		Ops	Apr-08	Dec-20
		Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Science Mission Directorate and the Program Management Council have oversight responsibility for this program. The Earth Science Data and Information System Project Office at GSFC has primary responsibility for the program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
EOSDIS (development of EOSDIS systems)	GSFC	Earth Science Data and Information Systems Project Office, GSFC (EOSDIS development)	Key participants in EOSDIS include the space agencies of Europe, Canada, Germany, France, and Japan. Other U.S. agency partners include the National Oceanic and Atmospheric Administration (Department of Commerce), U.S. Geological Survey (Department of the Interior), and the Department of Defense.
ACCESS, MEaSUREs (peer-reviewed data research opportunities)	SMD	NASA Headquarters	None.
Multi-Mission Operations (operations and maintenance of Core EOSDIS systems; DAACs)	GSFC	Earth Science Data and Information Systems Office, Goddard Space Flight Center	Key participants in the Multi-Mission Operations project include the space agencies of Europe, Canada, Germany, France, and Japan. Other U.S. agency partners include the National Oceanic and Atmospheric Administration (Department of Commerce), U.S. Geological Survey (Department of the Interior), and the Department of Defense.

Acquisition Strategy

DAAC Product Reviews have been recommended as part of the Evolution of EOSDIS Elements process. These Product Reviews are a key scientific input into best data archive management practice. NASA will ensure safe stewardship of the data through its life cycle. Earth system archive holdings will be regularly peer reviewed for scientific merit.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Earth Science Steering Com.	11/2005	Review of EOSDIS Evolution to approve "Step 1" plans for Evolution of EOSDIS Elements.	11/2008
Quality	DAAC Data Priority Workshops	01/2006	DAAC archive holdings peer reviewed for scientific merit.	TBD

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
None at this time.	n/a	n/a

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Technology

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	58.4	47.3	46.1	49.2	50.6	51.6	52.8
Advanced Technology Initiatives	14.6	8.9	8.3	9.0	9.5	9.7	9.9
Instrument Incubator	32.1	26.6	25.9	28.2	28.4	28.8	29.5
Advanced Info Systems Technology	11.6	11.8	11.9	12.0	12.7	13.1	13.4
FY 2008 President's Budget Request	56.6	57.0	58.7	62.6	64.2	65.5	0
Advanced Technology Initiatives	15.4	10.5	9.9	10.6	11.2	11.4	0
Instrument Incubator	27.4	32.5	34.7	37.7	37.9	38.5	0
Advanced Info Systems Technology	13.8	14.0	14.2	14.3	15.1	15.5	0
Changes from FY 2008 Request	1.8	-9.7	-12.6	-13.4	-13.7	-13.9	52.8

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

Advanced technology plays a major role in enabling the Earth research and applications programs of the future that will provide an improved understanding of the total Earth system and the effects of natural and human-induced changes on the global environment. The Earth Science Technology Program (ESTP) provides the Earth Science Division with new capabilities, enabling previously unforeseen or infeasible science investigations, enhancing existing measurement capabilities, and reducing the cost, risk, and development times of Earth science measurements.

The Earth Science Technology Office (ESTO) provides strategic, science-driven technology assessments and requirements development. The program implements a science focused technology program by pursuing promising scientific and engineering concepts through open competition solicitations.

For more information, please see: http://esto.nasa.gov.

Program Relevance

Advanced technologies enable space-based measurements that look at how the Earth system works. They contribute to applications that serve national interests. Technology advancements are crucial to enabling previously unforeseen or unfeasible science investigations, and adding to existing measurement capabilities by reducing cost, risk, or development time.

The Earth Science Technology Program contributes to Outcomes under Strategic Plan Subgoal 3A.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Technology

Plans For FY 2009

ESTP will plan and implement development of new remote-sensing and information systems technologies for infusion into future science missions in order to enable, or dramatically enhance, measurements and data system capabilities. Planning will start with measurement priorities established by the science community, leading to systematically developed technology requirements and priorities that will be captured in a web-accessible database. Studies will be conducted to assess measurement options for meeting technology performance requirements. Implementation will be performed through solicitations in three elements: Instrument Incubator, Advanced Information Systems Technology, and Advanced Technology Initiatives.

Project Descriptions and Explanation of Changes

Instrument Incubator

This project develops new and innovative instruments and measurement techniques at the system level, including laboratory development and airborne validation.

Advanced Information Systems Technology

This project develops end-to-end information technologies that enable new Earth-observation measurements and information products.

Advanced Technology Initiatives

This project implements a broad array of technology developments for state-of-the-art components for instruments and Earth- and space-based platforms.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Annually advance a portion of funded technology developments by one technology readiness level.	ESTP	None
Annually mature several technologies to the point of readiness for demonstration.	ESTP	None
Annually enable or improve one new science measurement capability.	ESTP	None

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Technology

Program Management

The Science Mission Directorate has oversight responsibility of the program office. The project elements below each contain a portfolio of tasks that vary with new selections.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Instrument Incubator	ESTO	NASA Centers	None.
Advanced Info Systems	ESTO	NASA Centers	None.
Advanced Tech Initiatives	ESTO	NASA Centers	None.

Acquisition Strategy

Tasks are procured primarily through full and open competition.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NAC - Earth-Sun System	03/2004	Radar/Radiometry Technology Needs. Validated current mission.	03/2009

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Technology Infusion	Selecting only those technologies that are certain to mature and be infused precludes the pursuit of promising and needed technologies that are innovative but risky.	ESTP will pursue a portfolio of technologies that balance innovation and risk with requirements that are clearly traceable to the strategic objectives of the Earth Science Theme.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Applied Sciences

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	33.9	45.4	33.8	33.8	31.3	32.1	32.8
Pathways	33.9	45.4	33.8	33.8	31.3	32.1	32.8
FY 2008 President's Budget Request	46.8	40.3	41.3	41.1	38.0	38.9	0
Pathways	46.8	40.3	41.3	41.1	38.0	38.9	0
Changes from FY 2008 Request	-12.9	5.1	-7.5	-7.3	-6.7	-6.8	32.8

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

The Applied Sciences Program expands NASA Earth Science research and observations for practical uses, such as resource management and planning, decision-making, and improved predictions and policies. NASA implements projects that carry forth this mission through partnerships with public, private, and academic organizations. These partnerships focus on innovative approaches for using Earth system science information to improve decision making and resource management across a range of applications. Examples include improved public health tracking systems for deadly diseases, advances in prediction of weather conditions for airplane pilots, and improved tracking of air pollutants for decision making on biomass burning and industrial practices.

Program Relevance

The Applied Sciences Program leverages NASA's investments in Earth system research and satellite missions to ensure the widest possible use of its scientific and technological breakthroughs. The program works across a range of application areas, including climate, ecosystems, agriculture, water resources, air quality, disaster management, public health, and aviation weather. NASA collaborates with operational agencies, and regional and state organizations, to ensure relevance and applicability.

The Applied Sciences Program contributes to Outcome 3A.7.

Plans For FY 2009

For 2009, the Applied Sciences Program will continue to work across the range of application areas noted above, with special focus on two: mitigating and adapting to climate variability and change; and protecting and monitoring our coastal communities.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Applied Sciences

Project Descriptions and Explanation of Changes

Earth Science Applications (formerly Pathways - National Applications)

The project conducts Research and Development activities with partnering organizations to utilize NASA Earth Science observations, data, and research in environmental decision making and resource management. The project also includes a small number of activities that crosscut and support the tasks, including cross-cutting projects, workforce development, and outreach.

Explanation of Changes: The name of this project, formerly called "Pathways," has been changed to "Earth Science Applications" for improved clarity. The Pathways project worked across 12 national applications, but now covers seven. This change does not eliminate any of the former 12 areas, rather it focuses the program on a more manageable number.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Issue completed peer reviewed research awards.	Applied Sciences	None
Maximize resource utilization through restructuring and streamlining processes and operations across the program.	Applied Sciences	None

Program Management

Applied Sciences Program responsibility resides within the Earth Science Division of the Science Mission Directorate.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Earth Science Applications	NASA HQ	GSFC, LaRC, SSC, JPL, MSFC, and ARC	EPA, NOAA, USDA, FAA, DOE, and CDC; regional, national , and international organizations (e.g., the Western Governor's Association, Southern Governor's Growth Policy Board, American Water Resources Association, Coastal States Organization, Group on Earth Observations, and UNESCO); Academic institutions; and, Corporate entities.

Acquisition Strategy

The Applied Sciences Program will use the annual Science Mission Directorate Research Opportunities in Space and Earth Science (ROSES) competitive solicitations as the primary method to acquire projects to integrate NASA Earth science research results into decision support tools. The Applied Sciences Program will continue to develop and nurture partnerships with federal agencies and national organizations to identify key topics for the competitive solicitations.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Applied Sciences

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	National Research Council	10/2007	The Applied Sciences Program strategy and implementation.	12/2009

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Partner Interest	NASA Earth science measurements and models may present types of information that the partners have limited experience using, and they may be reluctant to consider unfamiliar data product types.	The program addresses this risk through strong involvement with partners at the outset of a project and by inclusion of data-product-related training as needed.
Partner Commitment	Partners may be reluctant to invest resources and personnel to adopt data from research satellites, especially satellites that do not have a planned successor for long-term data availability. In addition, partners' funding may change.	To address this risk, the program encourages partners to focus on types of measurements (e.g., sea surface temperature) rather than data from a specific satellite. The program focuses on documenting the performance of the NASA products in the decision support systems to communicate the value to the partners' decision making and budget priorities.

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**1,215.6**	**1,247.5**	**1,334.2**	**1,410.1**	**1,537.5**	**1,570.0**	**1,608.7**
Planetary Science Research	181.9	242.1	270.8	315.8	355.6	373.2	382.6
Discovery	128.3	153.0	247.0	258.3	256.0	326.1	140.5
New Frontiers	106.6	132.2	263.9	250.3	232.3	227.7	236.9
Mars Exploration	634.9	553.5	386.5	299.6	344.5	341.1	413.8
Outer Planets	79.0	81.9	101.1	216.7	279.4	230.6	362.0
Technology	84.8	84.8	64.9	69.3	69.6	71.3	73.0
FY 2008 President's Budget Request	**1,411.2**	**1,395.8**	**1,676.9**	**1,720.3**	**1,738.3**	**1,748.2**	**--**
Planetary Science Research	278.8	370.5	402.9	416.2	428.5	402.9	--
Discovery	179.9	184.9	320.7	370.2	355.2	341.1	--
New Frontiers	158.1	147.3	296.0	277.5	267.9	274.5	--
Mars Exploration	721.1	625.7	594.8	592.5	624.0	665.5	--
Technology	73.4	67.6	62.6	63.9	62.7	64.2	--
Total Change from FY 2008 Request	**-195.7**	**-148.4**	**-342.6**	**-310.2**	**-200.9**	**-178.2**	**1,608.7**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the five-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-195.7**	**-148.4**	**-342.6**	**-310.2**	**-200.9**	**-178.2**	**1,608.7**
Planetary Science Research	**-96.9**	**-128.5**	**-132.1**	**-100.4**	**-72.9**	**-29.7**	**382.6**
Programmatic Content	-79.0	-70.0	-33.4	1.2	32.2	73.2	382.6
Programmatic Transfers	--	-3.6	-39.0	-40.8	-41.2	-41.3	--
Institutional Adjustments	-17.9	-54.9	-59.7	-60.8	-63.9	-61.6	--
Discovery	**-51.6**	**-31.9**	**-73.7**	**-111.8**	**-99.3**	**-15.0**	**140.5**
Programmatic Content	--	1.1	-16.6	-46.9	-37.9	43.5	140.5
Institutional Adjustments	-51.6	-33.0	-57.1	-64.9	-61.4	-58.5	--
New Frontiers	**-51.5**	**-15.0**	**-32.1**	**-27.2**	**-35.6**	**-46.8**	**236.9**
Programmatic Content	--	--	--	5.5	--	--	236.9
Institutional Adjustments	-51.5	-15.0	-32.1	-32.7	-35.6	-46.8	--
Mars Exploration	**-86.1**	**-72.2**	**-208.2**	**-293.0**	**-279.5**	**-324.4**	**413.7**
Programmatic Content	--	-13.8	-156.5	-250.5	-235.3	-276.2	413.7
Institutional Adjustments	-86.1	-58.4	-51.7	-42.5	-44.2	-48.2	--
Outer Planets	**79.0**	**81.9**	**101.1**	**216.7**	**279.5**	**230.6**	**362.0**
Programmatic Content	--	81.9	101.1	216.7	279.5	230.6	362.0
Programmatic Transfers	79.0	--	--	--	--	--	--
Technology	**11.4**	**17.3**	**2.4**	**5.5**	**6.9**	**7.1**	**73.0**
Programmatic Content	--	-1.4	-18.6	-16.4	-15.2	-15.5	39.9
Programmatic Transfers	23.6	29.4	30.7	31.5	31.6	32.3	33.1
Institutional Adjustments	-12.2	-10.7	-9.7	-9.6	-9.5	-9.7	--

Explanation of Program Changes

Planetary Science Research

Funds a healthy Research and Analysis program; augments Lunar Science to include a series of small robotic lunar satellites; and will start the formulation and development work for the small lunar orbiter in FY 2008 and FY 2009. Cassini has been transferred to the Outer Planets Program.

Discovery

Reflects mission support for Dawn mission launched in September 2007; selections of three Missions of Opportunity (Deep Impact Extended Investigation of Comets (DIXI), Extrasolar Planet Observations and Characterization (EPOCh), and StardustNext); and three full-class missions (Origins Spectral Interpretation Resource Identification and Security (OSIRIS), Gravity Recovery and Interior Laboratory (GRAIL), and Vesper) concept study selections. Also, adjusts for GRAIL mission selection to continue into Phase B, the formulation phase.

New Frontiers

Realigns Juno funding profile consistent with a 2011 launch date; New Frontiers 3 Announcement of Opportunity to be released in late CY 2008.

Mars Exploration

Delays Scout 2011 to 2013, redirects the Mars Program to focus on Mars Sample Return mission after Scout 2013 opportunity, expands U.S. participation on the ESA/ExoMars mission by selecting two instrument Missions of Opportunity for study and technology development, maintains funds for a 2016 mission, and funds a healthy Mars Research and Data Analysis program.

Outer Planets

Adds an Outer Planets Flagship mission.

Technology

Realigns the In-Space Propulsion (ISP) and Radioisotope Power Systems (RSP) to focus on core-critical technology needs.

Mission Directorate:	Science
Theme:	Planetary Science

Theme Overview

Planetary Science is a grand human enterprise that seeks to discover the nature and origin of the celestial bodies among which we live, and to explore whether life exists beyond Earth. The scientific imperative for Planetary Science, the quest to understand our origins, is universal. How did we get here? Are we alone? What does the future hold? These overarching questions lead to more focused, fundamental science questions about our solar system: How did the Sun's family of planets and minor bodies originate? How did the solar system evolve to its current diverse state? What are the characteristics of the solar system that led to the origin of life? How did life begin and evolve on Earth and has it evolved elsewhere in the solar system? What are the hazards and resources in the solar system environment that will affect the extension of human presence into space?

To achieve progress in addressing these six fundamental science questions, NASA relies on a balanced program. There are six programs within the Planetary Science Theme -- Discovery, New Frontiers, Research, Technology, Mars Exploration, and the Outer Planets Programs.

Discovery has two full-class operating spacecraft, one radar instrument operating on an ESA Mars Express mission, one mission in its formulation phase, and four Missions of Opportunities.

New Frontiers has one operating spacecraft and one mission currently in its formulation phase.

Research supports two operating missions with international partners, as well as Research and Analysis, Sample and Data Curation, data dissemination and analysis, and Lunar Science Research.

The Mars Program has three spacecraft and two rovers in operation, one instrument operating on an ESA Mars Express mission, one mission in development, one mission in its formulation phase, and project activities for technology, next decade missions, and research.

The Technology Program includes advanced in-space propulsion systems and advanced power generation and storage.

The Outer Planets Program includes one operating mission and the Outer Planets Flagship mission.

Mission Directorate:	Science
Theme:	Planetary Science

Relevance

Relevance to national priorities, relevant fields, and customer needs:

Planets and satellites of the solar system and the ancient icy bodies far from the Sun are "Rosetta stones" that can tell unique stories about the evolution of the solar system. As researchers learn more about the origins of living organisms on Earth and about the solar system's planets and moons, they may learn that life has arisen in places beyond Earth.

The robotic exploration will generate knowledge about our solar system needed to identify the most promising human exploration missions. This knowledge will also help enable safe human space exploration in the forbidding environments they will encounter.

Relevance to the NASA Mission and Strategic Goals:

The Planetary Science Theme supports the NASA Mission, "To pioneer the future in space exploration, scientific discovery, and aeronautics research," and Strategic Goal 3: "Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration."

Planetary Science supports NASA's achievement of Sub-goal 3C: Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.

Robotic exploration is an integral part of an overall strategy to extend human presence throughout the solar system.

Relevance to education and public benefits:

The Planetary Science Theme uses its missions, research programs, and the human resources of the space science community to enhance the quality of American science, mathematics, and technology education, particularly at the pre-college level. The Planetary Theme is dedicated to sharing the excitement of discoveries and knowledge generated by space science missions and research, with the public, and thus contributing to educating and inspiring the next generation of scientists and technical workers needed for the 21st century.

Public benefits from Planetary Science include a growing understanding of the solar system and Earth's significance within it. Planetary Science's Discovery, Mars, and Research Programs were among the first at NASA to require a plan for education and public outreach, as NASA recognized the importance of communicating the excitement of space exploration to the public.

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 3	**Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.**					
Sub Goal 3C	**Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.**					
Outcome 3C.1	**Progress in learning how the Sun's family of planets and minor bodies originated and evolved.**		**Green**	**Green**	**Green**	**Green**
APG 9PS1	Demonstrate progress in learning how the Sun's family of planets and minor bodies originated and evolved. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9PS2	Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	New Frontiers				White
APG 9PS3	Develop missions in support of this Outcome, as demonstrated by completing the GRAIL mission Preliminary Design Review (PDR).	Discovery				None
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Mars Exploration				Green
Outcome 3C.2	**Progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds.**		**Green**	**Green**	**Green**	**Green**
APG 9PS2	Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	New Frontiers				White
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Mars Exploration				Green
APG 9PS5	Demonstrate progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9PS6	Develop missions in support of this Outcome, as demonstrated by selecting the next Scout mission.	Mars Exploration				None
APG 9PS7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	Mars Exploration				None

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome 3C.3	**Progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system.**		**Green**	**Green**	**Green**	**Green**
APG 9PS2	Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	New Frontiers				White
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Mars Exploration				Green
APG 9PS6	Develop missions in support of this Outcome, as demonstrated by selecting the next Scout mission.	Mars Exploration				None
APG 9PS7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	Mars Exploration				None
APG 9PS8	Demonstrate progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system. Progress will be evaluated by external expert review.	Multiple Programs				Green
Outcome 3C.4	**Progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence.**		**Green**	**Green**	**Green**	**Green**
APG 9PS10	Develop missions in support of this Outcome, as demonstrated by selecting instruments for the first Lunar Science Research mission.	Planetary Science Research				New
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Mars Exploration				Green
APG 9PS7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	Mars Exploration				None
APG 9PS9	Demonstrate progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence. Progress will be evaluated by external expert review.	Multiple Programs				Green

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Planetary Science Theme					
APG 9PS11	Complete all development projects within 110% of the cost and schedule baseline.				Red

Mission Directorate:	Science
Theme:	Planetary Science

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9PS12	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green
APG 9PS13	Peer-review and competitively award at least 95%, by budget, of research projects.				Green
APG 9PS14	Reduce time within which eighty percent of NRA research grants are awarded, from proposal due date to selection, by five percent per year, with a goal of 130 days.				Red

Performance Achievement Highlights:

- Using Mars Reconnaissance Observer (MRO) observations, researchers delineated the locations of phyllosilicates, the alteration products of minerals sustaining contact with water. The data show that these minerals are widespread in the highlands of Mars, but restricted to the most ancient areas dating to the Noachian era, the oldest of three periods during which Mars' surface formed. The research provides new and important information about early Mars, the interaction of water with the crust, and consequences of the evolution of the planet's interior.

- Using observations by the Cassini spacecraft of Saturn's moon Enceladus, scientists detected water vapor and the decomposition products of water, as well as small amounts of molecular nitrogen and methane. This suggests that the interior of Enceladus is warm enough to contain liquid water and is, or once was, favorable to catalytic chemistry that would permit the synthesis of complex organic compounds. This makes Enceladus an exciting subject for further research to discover if the moon would be hospitable to primitive life and to reveal how such a small, icy body could have a warm core.

- Ongoing MRO mapping and analysis of sedimentary deposits in Holden crater on Mars found well-bedded deposits emplaced during two distinct wet intervals during the Noachian era, the oldest of three periods during which Mars's surface formed. During the first of these wet intervals, there was a lake in the crater that included the deposition of phyllosilicates. The second interval was shorter lived and related to flooding occurring when water impounded in the nearby Uzboi Vallis breached the crater rim and drained into the Holden crater. Access to these deposits, perhaps during a future landed mission, could yield important information about the conditions within these ancient lake environments and whether they may have been habitable.

For more information, see Sub-goal 3C in the FY 2007 Annual Performance Report, included in this budget.

Quality

Program Assessment Rating Tool (PART):

The Planetary Science Theme was subject to a PART review in 2003 and 2006 and received an "Effective" rating both times. The assessment found that this program is well-defined and well-managed, with a clear purpose and direct ties to NASA's Mission. The program has relevant research priorities that reflect the priorities of the planetary science community and successfully applies lessons learned from past mission failures.

Areas recently identified for performance improvement include:
- Reporting for major missions on: estimated mission lifecycle cost upon entering development; key schedule milestones associated with each mission phase for those missions formally approved for formulation; mission cost and schedule progress achieved in each phase before entering the next; and any plans to re-baseline lifecycle cost and schedule; and

- Exploring options for modifying the current approach to its competed planetary science programs to allow for a healthy mix of missions of various size and scope, potentially including missions to the outer planets.

The lifecycle cost and schedule figures for projects in development are provided quarterly to the Office of Management and Budget and annually to the Congress as the Major Program Annual Report. NASA continues to work the process and policy to refine this reporting.

The FY 2009 President's Budget includes an Outer Planets Flagship mission. After evaluating science, technical risk, and cost considerations, NASA selected Europa, Ganymede, and Titan mission concepts for further definition study. The final selection of mission target will be made by late FY 2008. Once the target is selected, an accelerated pre-Phase A effort which leverages the past two years of study will be initiated, culminating in a Mission Concept Review in late 2008 and start of Phase A formulation activities in early 2009.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NASA Advisory Council	09/2007	Reviews science and program implementation strategies and relevancies to the NASA strategies and goals. Recommendations include rebalance the program, with R&A restoration; development of science plan; and better cost and risk management for missions.	02/2008
Relevance	National Research Council	12/2003	Decadal Survey of Planetary Science priorities/Published Decadal Report entitled "New Frontiers and the Solar System: An Integrated Exploration Strategy". Work on the next Decadal Survey will begin in 2008.	09/2013
Relevance	COMPLEX, MEPAG, OPAG, VExAG	12/2007	2003 Solar System Exploration Roadmap/Outcome includes publication of the 2006 Solar System Exploration Roadmap and the 2006 Mars Architecture.	05/2008
Relevance	National Research Council	12/2007	Assess NASA/Planetary Science performance against the NRC decadal Survey recommendations. Recommendations include Adding Neptune/Triton mission in the next decadal survey, a more robust technology investments, restoring Astrobiology R&A funding, actively plan for the Mars Sample Return, and others.	12/2017

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**181.9**	**242.1**	**270.8**	**315.8**	**355.6**	**373.2**	**382.6**
Planetary Science Research and Analysis	111.7	127.8	142.4	145.1	150.4	155.2	159.0
Lunar Science Research	0	22.7	105.0	122.0	140.0	150.0	151.9
Operating Missions and Analysis	20.4	19.1	19.5	21.4	22.2	22.3	22.7
Education and Directorate Management	49.8	72.4	3.9	27.4	43.1	45.7	49.0
FY 2008 President's Budget Request	**184.1**	**273.3**	**307.1**	**320.9**	**346.9**	**355.6**	**0**
Planetary Science Research and Analysis	100.4	133.7	132.7	125.3	127.9	132.4	0
Lunar Science Rsrch	0	27.0	55.0	75.4	97.1	97.0	0
Operating Missions and Analysis	22.9	22.6	24.4	26.7	27.3	27.7	0
Education and Directorate Management	60.8	90.0	95.0	93.5	94.5	98.5	0
Changes from FY 2008 Request	**-2.3**	**-31.3**	**-36.3**	**-5.0**	**8.8**	**17.6**	**382.6**

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

The Planetary Research Program develops theoretical tools and laboratory data needed to analyze flight data, makes possible new and better instruments to fly on future missions, and analyzes the data returned. These capabilities allow Planetary Science to answer specific questions and develop an overall understanding of the origin and evolution of the solar system. This program represents an essential complement to flight missions, providing the scientific research and the theoretical foundation to allow the Nation to fully utilize the unique data sets returned from the missions exploring the solar system. It is also the primary interface with NASA for university faculty and graduate students in this field.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

Program Relevance

Planetary Science Research supports NASA's Mission "To pioneer the future in space exploration, scientific discovery, and aeronautics research."

This program supports NASA Strategic Goal 3: Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration. More specifically, the program supports the Outcomes of Subgoal 3C: Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.

Select 4 to 5 nodes supporting the NASA Lunar Science Institute based on a Cooperative Agreement Solicitation released in FY 2008.

In addition, this program provides key support in training the next generation of mission team members, principal investigators, and project scientists, as well as educates the general public.

Plans For FY 2009

Release Research Announcements soliciting Research and Analysis proposals and make selections.

Continue planetary science data archiving and releasing of this data to the science community in a timely manner for further scientific analysis.

Continue curation and distribution of solar system samples (Astromaterials) returned by NASA planetary missions such as Stardust.

Perform the Rosetta fly-by of Asteroid Steins (September 2008).

Continue to provide for Hayabusa (MUSES-C) navigation and Deep Space Network Tracking and coordinating Science Analysis to support an Earth Return in 2010.

A science definition team (SDT) will be formed that will define key instrument measurement characteristics for Lunar atmosphere and dust environment for the first lunar orbiter. From the SDT results we will solicit and select instruments to fly on NASA's next lunar orbiter after Lunar Reconnaisance Orbiter (LRO) and Gravity Recovery and Interior Laboratory (GRAIL). A second SDT will be formed to begin to define the instruments needed for the follow-on lander missions.

Project Descriptions and Explanation of Changes

Research & Analysis (R&A)

The scope of Research and Analysis (R&A) is wide because the effort must provide the new theories and instrumentation that enable the next generation of flight missions. R&A also provides the foundation for the formulation of new scientific questions and strategies. Discoveries and concepts developed in the R&A Project are the genesis of scientific priorities, missions, instrumentation, and investigations. R&A supports research tasks in areas such as: astrobiology and cosmochemistry; the origins and evolution of planetary systems; and the atmospheres, geology, and chemistry of the solar system's planets (other than Earth). Additionally, it provides for instrument and measurement concepts, and supports the initial definition and development of instruments for future Discovery, New Frontiers, or Mars missions. A new and fully competed call for missions studies will identify a range of outer planets science targets and mission options that could be achieved at various budget levels, creating a "menu" of mission options that NASA could pursue in the future. The R&A program funding is being increased to create a healthy and competitive Planetary research program. The R&A program will increase the award rate for most areas and award larger grant sizes. This should enable the science community to do more quality research while spending less time writing research proposals.

Lunar Science

The Lunar Science Project is a multi-element SMD program containing flight mission development and operations activities, instruments for lunar missions of opportunity, research and analysis efforts, data archiving, and the NASA Lunar Science Institute (NLSI).

NASA is considering options for: a small lunar orbiter (Lunar Atmosphere and Dust Environment Explorer) to address the lunar dust environment and the lunar atmosphere; small landers targeted for lunar-geophysical studies; and future networks of landers.

Two NASA lunar mini-lander missions will form the first U.S. nodes in the International Lunar Network (ILN) of geophysical stations. NASA envisions that the first two small landers will launch in the 2013-2014 time frame. NASA will provide a competitive opportunity for the lander instruments.

The Planetary Data System (PDS) will ingest the large data volumes expected from the Lunar Reconnaissance Orbiter (LRO) mission developed by Exploration Sciences Mission Directorate. In FY 2009 NASA will be releasing a competitive call for proposals for instruments for lunar missions from other space agencies in the Stand-Alone Mission of Opportunity notification. In the area of R&A activities, NASA will continue to release the Lunar Advanced Science and Exploration Research (LASER) call for proposals. LASER will also be soliciting competed opportunities to analyze scientific data from the LRO mission.

During FY 2009 NLSI will complete its first set of four or five research nodes. The NLSI nodes are the largest non-flight mission groups that SMD funds and contains five - eight FTE per year each. The nodes will be competed every three years. NLSI was newly established in FY 2008 and is an organization that supplements and extends the existing small NASA lunar science programs competed through LASER. NLSI is managed by Ames Research Center and is modeled on the NASA Astrobiology Institute, with dispersed teams across the Nation working together to help lead the Agency's research activities related to NASA's lunar exploration goals. The competitively selected team investigations will focus on one or more aspects of lunar science investigations of the Moon (including lunar samples), from the Moon, and on the Moon to advance lunar science.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

Rosetta & Hayabusa (MUSES-C)

Rosetta, a European Space Agency/NASA comet rendezvous mission, launched in March 2004 and will arrive at comet Churyumov-Gerasimenko in 2014. The prime scientific objective of the Rosetta mission is to study the origin of comets, the relationship between cometary and interstellar material and the implications of comets with regard to the origin of the solar system. Hayabusa (MUSES-C), a joint Japanese/NASA mission to study asteroid Itokawa and return a sample, is currently planning for an Earth Return in 2010.

Planetary Data Systems (PDS) & Astromaterials Curation

The Planetary Data Systems (PDS) and Astromaterials Curation Projects provide funds for data archives, sample-holding facilities, and analysis tools needed to perform research. PDS is the active data archive for NASA's Planetary Science Theme. The Astromaterials Curation Facility, at Johnson Space Center, provides services for all returned planetary materials that do not require planetary protection laboratories.

Directorate Management

This project reflects Science Mission Directorate-wide management reserve. It is used to support unforeseen administrative and programmatic requirements that cannot and/or should not be funded by other programs and projects.

FIRST Robotics

For Inspiration and Recognition of Science and Technology (FIRST) is a non-profit organization dedicated to increasing interest in science, technology, engineering and mathematics among youth in the United States. There are annual activities and events to expose students to challenging applications of engineering and science. The FIRST Robotics competition consists of national contests in which high school students team with engineers from government, industry, and universities to get hands-on experience and mentoring from engineering and technical professionals.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Release of Research Announcements soliciting R&A proposals (annual selections)	Research & Analysis (R&A)	R&A augmentation allows for increased award rates, larger average grant sizes, and more research.
Release the Lunar Advanced Science and Exploration Research opportunity and make selections of research projects, postdoc fellows, and associated lunar EPO work.	Lunar Science Research	Same
Deliver science data to PDS consistent with science archive plan (within 6 months).	Cassini	Cassini moved from Planetary Research to Outer Planet Flagship.
Meeting commitments to the International Partners as agreed to in the MOU.	Rosetta and Hayabusa	Same
Archive and release mission data to the science community within 6 months of downlink.	Planetary Data System (PDS)	Same
Store new samples of Astromaterials and distribute them as requests are approved by CAPTEM.	Astromaterials Curations	Same

Implementation Schedule

Project	Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21	Phase Dates	Beg	End
R&A, PDS, Curation	Res: FY08–FY12	Tech		
		Form		
		Dev		
		Ops		
		Res	Oct-07	Sep-12
Rosetta	Ops: Prior–FY17	Tech		
		Form		
		Dev		Mar-04
		Ops	Mar-04	Sep-17
		Res	Sep-08	Sep-17
Hayabusa	Ops: Prior–FY11	Tech		
		Form		
		Dev		May-03
		Ops	May-03	Sep-11
		Res	Jun-10	Sep-11
Lunar Science	Res: FY08–FY20	Tech		
		Form		
		Dev		
		Ops		
		Res	Oct-07	Sep-20

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

Program Management

NASA Headquarters is responsible for R&A and Lunar Science; Jet Propulsion Lab (SPLAY) has operations responsibility for Rosetta and Hayabusa; Goddard Space Flight Center (GSFC) is responsible for the Planetary Data System (PDS) project management.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research & Analysis	HQ	Multiple (NASA Centers, Universities, industries, etc.)	None
Rosetta	JPL	JPL	The European Space Agency (ESA) built the spacecraft, provided the launch vehicle, and operates the spacecraft.
Hayabusa (Muses -C)	JPL	JPL	Japan Aerospace Exploration Agency (JAXA) responsibilities include the spacecraft, launch vehicle, and operations.
Planetary Data System (PDS)	GSFC	JPL and other Discipline Nodes	None
Astromaterials Curation	JSC	JSC	NSF and Smithsonian Institution for Antarctic meteorites
Lunar Science	HQ	ARC, GSFC, MSFC	None

Acquisition Strategy

The R&A and Lunar Science Research FY 2008 budget will fund competitively selected activities from the ROSES-07 (Research Opportunities in Space and Earth Science) Omnibus NRA.

All major acquisitions for Rosetta (JPL), Hayabusa (JPL), Planetary Data System (PDS [JPL, GSFC, and other]), and Astromaterial Curation (JSC) are in place. The following institutions operate the PDS nodes: Atmospheres Node (NMSU; Geosciences Node (Wash U St. Louis); HiRISE Data Node (UAZ); Imaging Node (USGS Flagstaff); Planetary Plasma Interactions Node (UCLA); Radio Science (SETI); Rings Node (SETI); Small Bodies Node (U of MD); JPL and ARC. A small lunar orbiter will be formulated by ARC, and the small lunar landers will be formulated by MSFC.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Panel of scientists	10/2007	Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM) reviews recent curation activities and future plans/Curation of Genesis, Stardust, and Apollo lunar samples are on track and meeting distribution requests; the Curation Project performing well overall.	03/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Research Program Risk	There are no significant programmatic risks within the Research Program.	N/A

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	128.3	153.0	247.0	258.3	256.0	326.1	140.5
GRAIL	0	0	122.4	122.8	113.1	24.9	5.7
Moon Mineralogy Mapper	6.6	2.6	2.7	2.6	0.5	0	0
Discovery Future	13.1	103.9	50.4	49.1	65.4	239.8	90.7
Discovery Research	11.9	10.0	18.8	16.5	15.7	16.9	17.3
Operating Missions and Data Analysis	96.8	36.5	52.6	67.3	61.3	44.6	26.8
FY 2008 President's Budget Request	179.9	184.9	320.7	370.2	355.2	341.1	0
Moon Mineralogy Mapper	8.1	3.1	3.6	2.1	0	0	0
Discovery Future	57.6	126.5	261.0	307.8	289.7	277.7	0
Discovery Research	15.8	11.8	12.1	12.5	12.8	13.2	0
Operating Missions and Data Analysis	98.4	43.4	43.9	47.8	52.7	50.2	0
Changes from FY 2008 Request	-51.5	-31.9	-73.7	-111.8	-99.2	-14.9	140.5

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Program Overview

Robotic space exploration holds tremendous opportunity for exploration and discovery. Even with the vast amount of knowledge gained since exploration of the solar system began, there are many unanswered questions about the origin and evolution of our own solar system. NASA's Discovery Program gives scientists the opportunity to find innovative ways to uncover the mysteries of the solar system. It provides lower-cost, highly-focused planetary science investigations designed to enhance our understanding of the solar system and its evolution. The Discovery Program offers the scientific community the opportunity to assemble teams to design exciting, focused science investigations that complement NASA's larger planetary science missions.

All completed Discovery missions (NEAR, Mars Pathfinder, Lunar Prospector, Deep Impact, Stardust, and Genesis) have achieved groundbreaking science, with each taking a unique approach to space exploration. Current Discovery missions include: ASPERA-3, MESSENGER, Dawn, Moon Mineralogy Mapper (M3), EPOXI, StardustNExT, and GRAIL.

ASPERA-3 is an instrument aboard the European Space Agency's Mars Express spacecraft that has been in operation since 2004. MESSENGER, a mission to Mercury, will provide the first images covering the entire planet, and collect detailed information on the composition and structure of Mercury's crust, its geologic history, the nature of its thin atmosphere and active magnetosphere, and the makeup of its core and polar materials. M3 was selected as a Mission of Opportunity in February 2005. It will be part of the scientific payload for the Indian Space Research Organization's Chandrayaan-1 mission to the Moon. The EPOXI mission melds two compelling science investigations: the Deep Impact Extended Investigation (DIXI) and the Extrasolar Planet Observation and Characterization (EPOCh). Both investigations will be performed using the Deep Impact spacecraft, which finished its prime mission in 2005. The scientific goal of the GRAIL mission, a newly selected Discovery full-class project, is to determine the structure of the lunar interior from crust to core.

Additional details on the GRAIL mission are contained in the GRAIL "Project in Formulation" pages.

For more information regarding the Discovery Program, see http:/discovery.nasa.gov.

Program Relevance

The Discovery Program supports NASA Mission by enhancing our understanding of the solar system as it is today, as well as solar system's formation and evolution, and by protecting the public, our workforce, and our environment while achieving our science. The Discovery Program supports NASA Strategic Goal 3 by providing frequent flight opportunities for solar system exploration with high quality, high-value scientific investigations that can be accomplished under a not-to-exceed cost cap.

The Discovery Program supports Outcomes 3C.1 through 3C.4.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Plans For FY 2009

The MESSENGER spacecraft will complete second (10/2008) and third (9/2009) fly-bys of Mercury during FY 2009.

The Dawn spacecraft launched successfully in September 2007 and will be cruising toward a Mars gravity assist in March 2009.

ASPERA-3 will continue to collect data as it orbits Mars on an extended mission of Mars Express.

The M3 instrument, scheduled to launch in 2008 as a part of the Indian Space Research Organization's (ISRO) Chandrayaan-1 payload, will collect science measurements.

Gravity Recovery and Interior Laboratory (GRAIL), the newly selected Discovery full-class mission, will complete its Preliminary Design Review by the end of FY 2009.

An Announcement of Opportunity (AO) for the next Discovery mission will be released by 2009.

Project Descriptions and Explanation of Changes

MESSENGER

MESSENGER, a mission to Mercury, launched on August 3, 2004, will collect the first images to provide coverage of the entire planet and collect detailed information on the composition and structure of Mercury's crust, its geologic history, the nature of its thin atmosphere and active magnetosphere, and the makeup of its core and polar materials. MESSENGER flew past the Earth for a gravity assist in August 2005, and flew past Venus twice in FY 2007 to use that planet's gravity to move the spacecraft's trajectory closer to Mercury. The spacecraft had its first flyby of Mercury in January 2008.

ASPERA-3

ASPERA-3 is a Mission of Opportunity. It is one of seven instruments aboard the European Space Agency's Mars Express spacecraft in orbit around Mars, with a goal to study the interaction of the solar wind and Martian atmosphere. The measurements taken by this instrument will help answer the question of how strongly the interplanetary plasma and electromagnetic fields affect the Martian atmosphere.

Dawn

The Dawn mission is just beginning a journey to the two largest and most massive asteroids in our solar system, Vesta and Ceres. Dawn launched from Cape Canaveral in September 2007, the Dawn spacecraft will encounter and orbit Vesta four years later, then travel an additional three years to reach and orbit Ceres.

Moon Mineralology Mapper (M3)

The Moon Mineralogy Mapper (M3) instrument will be part of the scientific payload for India's Chandrayaan-1 mission to the Moon. The primary objectives of the M3 are to assess the mineral resources of the Moon, and characterize and map the composition of the surface at high spatial resolution. It will launch via a Polar Satellite Launch Vehicle from Satish Dhawan Space Center, India, in 2008. The M3 payload will cruise 5.5 days, reach its final polar orbit of the Moon at an altitude of 100 kilometers and operate during the next two years (with four two-month periods with optimal imaging geometry and global access).

Discovery 2006 Announcement of Opportunity

Three full-class missions of opportunity were submitted: Origins Spectral Interpretation, Resource Identification and Security (OSIRIS): Vesper, a Venus chemistry and dynamics orbiter that would advance our knowledge of the planet's atmospheric composition and dynamics; and Gravity Recovery and Interior Laboratory (GRAIL). The down-select in Fall 2007 resulted in GRAIL being given approval to move forward into its Preliminary Design Phase (Phase B) in December 2007. These proposals were among approximately two dozen submitted in response to NASA's Discovery Program 2006 Announcement of Opportunity in April.

Additionally, NASA selected three missions of opportunity (DIXI, EPOCh, and Stardust NExT) on June 19, 2007.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

EPOCh and Stardust NExT

On June 19, 2007 three 2006 Discovery missions of opportunity were selected:
The Deep Impact eXtended Investigation (DIXI) of comets will use the existing Deep Impact spacecraft for an extended flyby mission to a second comet to take pictures of its nucleus to increase our understanding of the diversity of comets.

The Extrasolar Planet Observations and Characterization (EPOCh) mission will use the high-resolution camera on the Deep Impact spacecraft to search for Earth-sized planets around other stars.

The Stardust NExT will use the existing Stardust spacecraft for a flyby of comet Tempel 1. Since the Deep Impact mission visited Tempel 1 in 2005, the comet has made another close approach to the sun, possibly changing its surface. This flyby is to look for surface changes to Tempel 1 since 2005.

GRAIL

The Gravity Recovery and Interior Laboratory (GRAIL) will perform high-quality gravity field mapping of the Moon to determine its interior structure. GRAIL was selected in December 2007 and given approval to proceed into its Preliminary Design Phase (Phase B). GRAIL is currently schedule for a launch in September 2011.

Discovery Research

The Discovery Research line provides funding for: Discovery Data Analysis; Sample Return Laboratory Instruments (SRLI)which supports development of new instruments for use in terrestrial laboratories to analyze samples returned from NASA Planetary Science missions; Data Analysis Program (DAP); and participating scientists for the MESSENGER mission.

As stated in the ROSES NRA, the DAP is "...to enhance the scientific return of the completed Discovery missions by broadening the science participation in the analysis of data collected and samples returned ...." Specifically, the DAP allows scientists not previously associated with Discovery missions an opportunity to perform data analysis of the data archived in the Planetary Data System or samples (such as those from Stardust) stored at the JSC curation facility, which is also funded by this project. Data access through the Discovery Research project allows a much broader, and perhaps more objective analysis of the data and samples, and also allows research to continue for many years after the mission has been completed.

Discovery Program Management

Discovery Program Management provides for the management of the Discovery selected flight missions. This line also provides for the development of Announcements of Opportunity (AOs), and supports independent panel reviews and selections process.

Discovery Future

Provides funds for future Discovery flight missions to be selected via a competitive Announcement of Opportunity (AO) process.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Launch an average of one mission per 24 months .	Discovery Program	Same
Complete current prime and funded extended operating missions.	Dawn, MESSENGER, ASPERA-3, EPOCh and StardustNExT	ASPERA-3 approved for 2nd extension; selected EPOCh and NExT as new MoO under the 2006 Discovery AO.

Implementation Schedule

Project	Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21	Phase Dates	Beg	End
MESSENGER		Tech		
		Form	Jul-99	Jun-01
		Dev	Jun-01	Aug-04
		Ops	Aug-04	Sep-12
		Res		
ASPERA-3		Tech		
		Form		
		Dev	Sep-00	Jun-03
		Ops	Jun-03	May-11
		Res		
Dawn		Tech		
		Form	Dec-01	
		Dev	Feb-04	Sep-07
		Ops	Sep-07	Nov-15
		Res		
Moon Mineralogy Mapper (M3)		Tech		
		Form	Mar-05	Feb-06
		Dev	Mar-06	Mar-08
		Ops	Mar-08	Sep-10
		Res		
Extrasolar Planet Observation and Characterization (EPOCh) and Deep Impact eXtended Investigation (DIXI)		Tech		
		Form		
		Dev		
		Ops	Jun-07	Oct-11
		Res		
Stardust NExT		Tech		
		Form		
		Dev		
		Ops	Jun-07	Feb-11
		Res		
Gravity Recovery and Interior Laboratory (GRAIL)		Tech		
		Form	Oct-07	Dec-08
		Dev	Dec-08	Sep-11
		Ops	Oct-11	Jul-12
		Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Program Management

MSFC is responsible for Discovery program management. Scientific mission priorities and assignment of responsibilities reside with the Science Mission Directorate. The Planetary Science Director is the responsible official for this program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
MESSENGER	MSFC	None	None
ASPERA-3	MSFC	None	Sweden; European Space Agency (ESA).
Dawn	MSFC	None	German Aerospace Center (DLR); Los Alamos National Labs (LANL).
Moon Mineralogy Mapper (M3)	MSFC	None	Indian Space Research Organization (ISRO), spacecraft provider. USGS.
Extrasolar Planet Observation and Characterization and Deep Impact eXtended Investigation	MSFC	None	Max-Planck-Institute in Garsching, Germany
Stardust-NExT (Stardust-New Exploration of Tempel)	MSFC	None	None
GRAIL	MSFC	None	None

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Acquisition Strategy

With the exception of future NASA Announcements of Opportunity, all major acquisitions are in place.

Southwest Research Institute employs the Principal Investigator and Lead Scientist for ASPERA-3.

The University of California at Los Angeles sponsors the Principal Investigator and Lead Scientist for the Dawn mission.

Brown University sponsors the Principal Investigator and Lead Scientist for M3. SAIC, University of Hawaii, and University of Tennessee are also participants.

The Department of Terrestrial Magnetism at the Carnegie Institution of Washington employs the Principal Investigator and Lead Scientist for MESSENGER.

The University of Maryland employs the Principal Investigator for the EPOXI Mission of Opportunity, the combined Extrasolar Planet Observation and Characterization (EPOCh), and the Deep Impact Extended Investigation (DIXI) of comets.

Cornell University employs Principal Investigator for the Stardust New Exploration of Tempel 1 (NExT) Mission of Opportunity.

The Massachusetts Institute of Technology (MIT) employs the Principal Investigator and leads the Gravity Recovery and Interior Laboratory (GRAIL) mission.

The Discovery Program solicits proposals for full planetary missions and missions of opportunity. The proposals are put together by teams led by a PI which may include firms, small business, government and universities. The initial phase of each competitive selection is a concept study, and several missions and missions of opportunity are generally selected for this phase. At the completion of the study phase, one or more concepts may be selected for development, based on their continued scientific merit, technical, management and cost viability, and the availability of funding.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	10/2007	Verified compliance with Agency requirements for program implementation. Results were favorable.	9/2009

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Future launch vehicle cost and availability	As launch vehicle costs continue to grow, they place additional pressure on cost-capped Discovery programs.	Consider requesting an increase in the Discovery cost cap to specifically cover increases in launch costs that are beyond project control.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Formulation:	Gravity Recovery and Interior Laboratory

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	**--**	**--**	**122.4**
Total Change from 2008 President's Budget Request	**0.0**	**0.0**	**122.4**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the five-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Project Purpose

The Gravity Recovery and Interior Laboratory (GRAIL) was selected in December 2007 under the 2006 Discovery Announcement of Opportunity. The overarching scientific goal of the GRAIL mission is to determine the structure of the lunar interior from crust to core. The GRAIL mission will also advance our understanding of the thermal evolution of the Moon and extend our knowledge gained from the Moon to the other terrestrial-type planets.

GRAIL will conduct six lunar science experiments:
- map the structure of the crust and lithosphere;
- study the moon's asymmetric thermal evolution;
- determine the subsurface structure of impact basins and the origin and of masons (i.e., high-gravity areas);
- study the temporal evolution of crustal brecciation and magmatism;
- constrain the structure of the deep lunar interior from lunar tides; and
- place limits on the size of the possible lunar inner core.

GRAIL achieves its science objectives by placing twin spacecraft in a low altitude (50 km), and nearly circular, polar orbit. The two spacecraft will perform high-precision range-rate measurements between them. Analysis of changes in the spacecraft-to-spacecraft range-rate data caused by gravitational differences will provide direct and high-precision measurements of the lunar gravity. GRAIL will ultimately provide a global, high-accuracy (<10 mGal), high-resolution (30 km) gravity map of the moon. The instrument is based on the successful Earth orbiting Gravity Recovery and Climate Experiment mission.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Formulation:	Gravity Recovery and Interior Laboratory

Project Management

The Gravity Recovery and Interior Laboratory Project is part of the Discovery Program managed by Marshall Space Flight Center. The Principal Investigator from Massachusetts Institute of Technology has delegated day-to-day project management to JPL.

Acquisition Strategy

All major acquisitions are in place. GRAIL was selected competitively in December 13, 2007 under a Discovery Program Announcement of Opportunity (AO-NNH06ZDA001O).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	N/A	Assess cost, schedule, and risk status of project/Findings for the review showed that cost and schedule for the 2011 launch are consistent with the project's plans.	12/2008

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Launch Vehicle	Continued availability of Delta II line and launch pad at affordable costs.	Work with Launch Support Program and contractor to assure availability of vehicle.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	106.6	132.2	263.9	250.3	232.3	227.7	236.9
Juno	87.8	108.3	245.0	225.2	168.0	14.4	17.8
Other Missions and Data Analysis	18.8	23.9	19.0	25.1	64.3	213.3	219.1
FY 2008 President's Budget Request	158.1	147.3	296.0	277.5	267.9	274.5	0
Juno	124.1	120.2	272.9	242.6	190.9	16.0	0
Other Missions and Data Analysis	34.0	27.0	23.1	35.0	76.9	258.5	0
Changes from FY 2008 Request	-51.5	-15.1	-32.1	-27.2	-35.6	-46.8	236.9

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

The New Frontiers Program, comprised of medium-sized missions, constitutes a critical element of NASA's solar system exploration capability. Proposed science targets for the New Frontiers Program have included Pluto and the Kuiper Belt, Jupiter, Venus, and sample returns from Earth's Moon and a comet nucleus. The program is designed to accomplish high-quality planetary science investigations using efficient management approaches. The program's prime objectives are to enhance our understanding of the solar system as it is today, and of the solar system's formation and evolution.

New Horizons and Juno are New Frontiers selected flight missions. New Horizons will conduct reconnaissance of Pluto and its moon Charon. Juno's overarching scientific goal is to understand the origin and evolution of Jupiter.

For more information, see http://newfrontiers.msfc.nasa.gov.

Program Relevance

The New Frontiers Program supports NASA Strategic Goal 3 by providing frequent flight opportunities for high-quality, high-value scientific investigations that can be accomplished under a not-to-exceed cost cap. More specifically, the program contributes to Outcomes 3C.1 through 3C.4.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

Plans For FY 2009

The Juno Mission will complete the Preliminary Design Review (PDR)/Non-Advocate Review (NAR) in FY 2008, and will start Critical Design Review (CDR) by the end of FY 2009, a Key Decision Point Review (KDP).

By FY 2009, New Horizons will have passed the orbit of Saturn on its cruise to Pluto. It is on track for a July 2015 arrival. The cruise period will include periodic spacecraft and instrument checkouts.

The third New Frontiers AO will be released late in calendar year (CY) 2008. Concept studies selection is expected by the end of CY 2009.

Project Descriptions and Explanation of Changes

New Horizons

On January 19, 2006, the New Horizons mission was successfully launched on an Atlas V launch vehicle. New Horizons will reach Pluto and its moon, Charon, in July 2015. New Horizons will conduct a reconnaissance of the Pluto-Charon system, mapping their surface composition and surface temperatures, characterizing their geology, characterizing the atmosphere of Pluto, searching for an atmosphere around Charon, and searching for rings and additional satellites around Pluto.

Juno

The Juno mission to Jupiter science goals are to: determine the oxygen to hydrogen ratio to determine water abundance and constrain core mass in order to decide among alternative theories of planetary origin; understand Jupiter's interior structure and dynamical properties, including internal convection and the size and mass of its core, through mapping of its gravitational and magnetic fields; map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes; and characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras. Juno uses a simple, spin-stabilized spacecraft in an elliptical polar orbit that minimizes radiation exposure by flying under Jupiter's radiation belts at perijove and outside them at apojove. Juno's baseline orbit remains continuously in sunlight, resulting in benign and stable thermal conditions. Spin stability eliminates complex, power-hungry attitude control components such as reaction wheels. Additional detail can be found in the Juno Project section of this document.

New Frontiers Program Management

This project manages the New Frontiers selected flight missions, and provides for the development of Announcements of Opportunity. The project also supports independent panel review and selection processes.

New Frontiers Future

The New Frontiers Future Project provides funds for future New Frontiers flight missions to be selected via a competitive Announcement of Opportunity process.

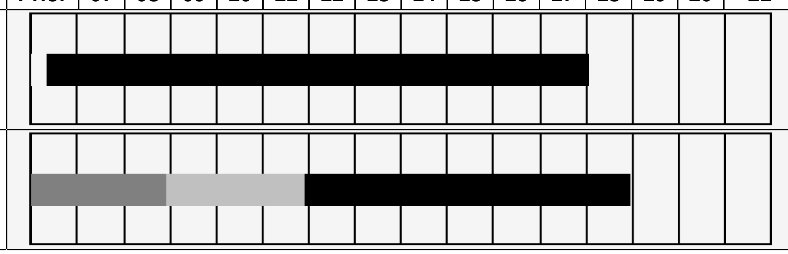
Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Launch an average of one mission per 52 months	New Frontiers Program	Same

Implementation Schedule

Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21



Project	Phase	Beg	End
New Horizons	Tech		
	Form	Nov-01	Mar-03
	Dev	Mar-03	Jan-06
	Ops	Jan-06	Sep-17
	Res		
Juno	Tech		
	Form	Jul-04	Aug-08
	Dev	Aug-08	Aug-11
	Ops	Aug-11	Aug-18
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Science Mission Direct assigns scientific mission priorities and program responsibilities. Marshall Space Flight Center has New Frontiers program management responsibility. The Director of Planetary Science is the responsible program official.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
New Horizons	MSFC	APL	None
Juno	MSFC	JPL	Italian Space Agency (ASI)

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

Acquisition Strategy

Future acquisitions of New Frontiers missions are carried out under open Announcement of Opportunity (AO) competitions. The New Frontiers Program will solicit proposals for an entire mission (including instruments), put together by teams led by PIs and comprised of people from industry, small businesses, government, and academia.

Major acquisitions for the New Horizons (APL) and Juno (JPL) projects are in place.

The Principal Investigator for New Horizons has been transferred from SouthWest Research Institute, Boulder, to NASA Headquarters; Johns Hopkins University/Applied Physics Laboratory has project management responsibility.

The Juno Principal Investigator is from the SouthWest Research Institute, San Antonio; Jet Propulsion Laboratory provides mission project management; Lockheed Martin Space Systems will build the spacecraft.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	05/2006	Verified compliance with Agency requirements for program implementation. Results were favorable.	9/2009

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Formulation:	Juno

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	**87.8**	**108.3**	**245.0**
FY 2008 President's Budget Request	**124.1**	**120.2**	**272.9**
Total Change from 2008 President's Budget Request	**-36.3**	**-12.0**	**-28.0**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the five-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Project Purpose

Juno was selected on July 15, 2005 under the New Frontiers Announcement of Opportunity. The overarching scientific goal of the Juno mission is to improve our understanding of the origin and evolution of Jupiter. However, as the archetype of giant planets, Jupiter can also provide knowledge that will improve our understanding of both the origin of our solar system and of planetary systems being discovered around other stars. The investigation focuses on the four science objectives:

Origin: Determine the oxygen-to-hydrogen ratio to determine water abundance and constrain core mass to decide among alternative theories of planetary origin.

Interior: Understand Jupiter's interior structure and dynamic properties through mapping of its gravitational and magnetic fields, including internal convection and the size and mass of its core.

Atmosphere: Map variations in atmospheric composition, temperature, and cloud opacity and dynamics, to depths greater than 100 bars, at all latitudes.

Magnetosphere: Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.

These objectives have been rated very highly in the National Academy of Sciences' Solar System Exploration Decadal Survey and Sun-Earth Connections Decadal Survey. The Astrophysics Decadal Survey identified the study of star formation, their planetary systems, as well as giant and terrestrial planet birth and evolution as high priority. Juno fulfills key goals outlined in recent NASA and NRC studies and is relevant to NASA's Vision for Space Exploration.

Project Preliminary Parameters

Juno achieves the science objectives by using a simple spinning, solar-powered spacecraft to make global maps of the gravity, magnetic fields, and atmospheric composition of Jupiter from a unique elliptical polar orbit with a close perijove. The spacecraft carries precise, high-sensitivity radiometers, magnetometers, and gravity science systems. Juno's 32 orbits extensively sample Jupiter's full range of latitudes and longitudes. From its polar perspective Juno combines in-situ and remote sensing observations to explore the polar magnetosphere and determine what drives Jupiter's remarkable auroras.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Formulation:	Juno

Estimated Project Deliverables

Juno launch date is August 2011, and after a five-year cruise to Jupiter, Jupiter Orbit Insertion (JOI) is scheduled for October 2016. Juno will perform one year of science operations.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Waves	University of Iowa	Measures radio and plasma emissions; 4 m elec. dipole and search coil	Same	Same
Jupiter Energetic particle Detector Instrument (JEDI)	John Hopkins Applied Physics Lab (APL)	Measures auroral distributions of electrons and ions; TOF vs. energy, ion & electron sensors	Same	Same
Gravity Science	Jet Propulsion Lab (JPL)	Maps Jupiter's gravitational field to determine structure of core; X & Ka-band precision Doppler	Same	Same
Flux-Gate Magnetometer (FGM)	GSFC	Maps Jupiter's Magnetic Field (Vector)	Same	Same
Scalar Helium Magnetometer (SHM)	Jet Propulsion Lab (JPL)	Maps Jupiter's Magnetic Field (Magnitude)	Same	Same
Launch Vehicle	KSC	C3 = 32.0 km2/s2, Capability=3545 kg	Same	Same
UV Spectrometer (UVS)	Southwest Research Institute (SwRI)	FUV spectral imager for auroral emissions	Same	Same
Microwave Radiometer (MWR)	Jet Propulsion Lab (JPL)	6 wavelengths (1.3-50 cm); sounds atmosphere to determine water and ammonia abundances	Same	Same
Spacecraft	Lockheed Martin	Solar-powered, spin-stabilized spacecraft in an elliptical polar orbit that minimizes radiation exposure	Same	Same
Jovian Auroral Distributions Experiment (JADE)	Southwest Research Institute (SwRI)	Ion mass spectrometer & electron analyzers; measures auroral distributions of electrons and ions	Same	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Formulation:	Juno

Estimated Project Schedule

Formulation started at project selection in July 2005. With approval to proceed, the project would enter implementation in August 2008.

Milestone Name	Formulation Agreement Estimate	FY 2008 PB Request	FY 2009 PB Request
Formulation			
PDR	5/2008	same	same
CDR	3/2009	same	same
ATLO Readiness	3/2010	same	same
Launch	8/2011	same	same

Project Management

Juno is part of the New Frontiers Program, with program management at Marshall Space Flight Center. The Principal Investigator, from Southwest Research Institute, has delegated day-to-day Juno project management to the Jet Propulsion Laboratory.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Plasma Waves Experiment (WAVE)	Jet Propulsion Lab (JPL)	None	None
Jupiter energetic particle instrument (JEDI)	Jet Propulsion Lab (JPL)	None	None
Management; Microwave radiometer, Scalar Helium Magnetometer, and Gravity Science Experiment	MSFC/New Frontiers Program Office	Jet Propulsion Lab (JPL)	None
Vector Fluxgate Magnetometer (FGM)	Jet Propulsion Lab (JPL)	Goddard Space Flight Center (GSFC)	None
UVS and JADE instruments	MSFC/New Frontiers Program Office	None	None
Flight System, Integration and Test	Jet Propulsion Lab (JPL)	None	None
Overall responsibility for the development, implementation, operation, and success of the mission	MSFC/New Frontiers Program Office	None	None
JunoCam	Jet Propulsion Lab (JPL)	None	None
KaBand and IR science	Jet Propulsion Lab (JPL)	None	Italian Space Agency (ASI)

Acquisition Strategy

All major acquisitions are in place. Juno was selected competitively in July 15, 2005 under a New Frontiers Program Announcement of Opportunity (AO-03-OSS-03).

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Formulation:	Juno

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	10/2006	Assess cost, schedule, and risk status of project/Findings for the review showed that cost and schedule for the 2011 launch are consistent with the project's plans.	05/2008

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Solar Array Performance	Solar array performance could potentially be less than expected in the low-intensity, low-temperature and high-radiation environment of Jupiter.	Performing early radiation tests on solar cells; conservative estimates of performance.
Stellar Reference Unit (SRU) performance	Possible degraded SRU performance on a spinning spacecraft in a high-radiation environment.	Initiated competitive study contracts and radiation testing to select SRU with best performance to meet project needs.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	634.9	553.5	386.5	299.6	344.5	341.1	413.8
2009 Mars Science Lab	416.8	305.5	223.3	69.0	54.6	37.6	0
Mars Scout (2013)	5.3	57.7	6.7	68.5	152.5	170.7	121.8
Mars Research and Analysis	14.2	27.4	24.9	25.9	26.7	27.1	27.5
Operating Missions and Data Analysis	171.8	149.4	131.6	136.2	110.7	105.7	264.5
JPL Building	26.8	13.4	0	0	0	0	0
FY 2008 President's Budget Request	721.1	625.7	594.8	592.5	624.0	665.5	0
2009 Mars Science Lab	378.4	345.0	238.2	73.6	58.2	40.1	0
Mars Scout (2013)	0	65.3	155.0	170.8	121.6	38.4	0
Mars Research and Analysis	29.2	31.1	35.0	34.9	34.7	35.5	0
Operating Missions and Data Analysis	264.6	169.1	166.6	313.3	409.6	551.5	0
JPL Building	48.8	15.2	0	0	0	0	0
Changes from FY 2008 Request	-86.1	-72.2	-208.3	-293.0	-279.6	-324.4	413.8

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Program Overview

Mars is the most Earth-like planet in our solar system, with land mass approximately equivalent to the Earth's and what appear to be familiar features such as riverbeds, past river deltas, and volcanoes. Mars holds valuable scientific clues to the development of the solar system, planets, and maybe life itself. The Mars Program has been developed to conduct a rigorous, incremental, discovery-driven exploration of Mars to determine the planet's physical, dynamic, and geological characteristics.

The Mars Phoenix lander successfully launched in August 2007, and is now on its way to Mars. It will arrive in late May 2008, and begin its exploration of the northern polar region, looking for evidence of water and fingerprints of life. Mars Reconnaissance Observer has used several of its instruments in coordinated observations to provide important new information about early Mars, the interaction of water with the crust, as well as the consequences for the tectonic evolution and the evolution of the planet's magma. It has also been a key contributor to finding a safe landing site for Phoenix, and has supported landing site selection for the Mars Science Laboratory. The Mars Rovers, Spirit and Opportunity, continued their exploration of the surface of Mars, and have returned a wealth of new results. Coordinated surface and orbital measurements indicate that liquid water might have existed close to the surface at some point in the past. Opportunity has also begun its descent into the Victoria crater, which will provide a detailed look into Mars' past as it explores the crater's exposed layers. Before ceasing to function early in FY 2007, the Mars Global Surveyor camera was able to spot several gullies that formed during the lifetime of the mission, which may have been formed by water. Although still controversial, detailed analysis suggests that liquid water probably flowed on the surface of Mars within the last seven years. The Mars Global Surveyor was also able to find newly formed impact craters on the surface of Mars.

For more information, see http://mars.jpl.nasa.gov.

Program Relevance

The activities within the Mars Program gather data that will enable NASA to search for evidence of life on Mars, to understand the history of the solar system, and to prepare for future human exploration by making measurements and discoveries that will characterize hazards and identify useable resources.

The program contributes primarily to Outcomes 3C.2, 3C.3, and 3C.4.

Plans For FY 2009

The next Mars Scout mission will be selected in FY 2008, in preparation for launch in 2013.

Mars Science Laboratory (MSL) will be in the final stages of preparation for its launch readiness date in September 2009.

Instrument developments (scheduled for selection in FY 2008) for the European Space Agency's ExoMars mission, will complete technology development studies needed to qualify for possible later selection for flight, in support of a 2013 launch date.

Detailed architectural studies of a Mars Sample Return mission will begin. These studies will be coordinated with our international partners.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Project Descriptions and Explanation of Changes

Mars Odyssey

In its extended mission phase, the primary scientific objectives of Mars Odyssey include monitoring of inter-annual variations of Mars climate and surface processes, new and improved elemental maps, extended monitoring of charged-particle radiation for human hazard assessment, acquiring future mission landing site data, and continuing as a key telecommunications asset at Mars. Funding to extend mission operations past FY 2009 may be available pending the outcome of the Mars mission review each year and availability of Extended Mission funding.

Mars Exploration Rovers (Spirit and Opportunity)

The rovers will continue to explore geological settings on the surface of Mars using a suite of remote sensing and in-situ instruments. The objective is to expand our understanding of the history and the geological processes that shaped Mars, particularly those involving water. Funding to extend mission operations past FY 2009 may be available pending the outcome of the Mars mission review each year and availability of Extended Mission funding.

Mars Reconnaissance Orbiter

The Mars Reconnaissance Orbiter (MRO), which began its science mapping phase at the beginning of FY 2007, has three general objectives: provide high-resolution spectral maps and images for interpretation of the geology of the Martian crust; use ground-penetrating radar to map compositional discontinuation and layering under the surface; and create planetary-scale maps of critical atmospheric properties. MRO is also the key telecommunications asset for the first half of the next decade at Mars. Although MRO's primary science phase extends only through December, 2008, additional funding may be available to extend science operations pending the outcome of the annual Mars mission review and availability of Extended Mission funding.

Mars Express

Mars Express is a mission launched by the European Space Agency and the Italian Space Agency, which has been exploring the atmosphere and surface of Mars from polar orbit since arriving in 2003. The mission's main objective is to search for sub-surface water from orbit. NASA participates in the scientific analysis of mission data, including the recent investigations into the mysterious deposits of the Medusae Fossae Formation.

Mars Mission Operations

Mars missions require special software tools for spacecraft navigation and communication, which are provided in cooperation with the Advanced Multi-Mission Operations System (AMMOS) project.

Mars Extended Operations

Once missions have concluded their primary mission phase, further funding for extended operations is allocated based on the findings of a senior review board. Their review of each mission enables them to make recommendations for the allocation of the extended operations budget based on scientific merit.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Mars 2007 Scout (Phoenix)

The Phoenix lander, currently en route to Mars, is the first Mars Scout mission and is led by the Principal Investigator from the University of Arizona. Phoenix will characterize the chemistry, mineralogy and isotopic composition of evolved gases in surface and subsurface soils and ices at a landing site in the high latitudes of the northern hemisphere. It will land on Mars on May 25, 2008.

Mars Science Laboratory

The Mars Science Laboratory (MSL) takes a major step forward in Mars exploration, both technically and scientifically, using a long-duration rover, and 10 payload elements for definitive mineralogical and organics measurements and a new entry, descent, and landing system. The primary scientific objective is to explore and quantitatively assess a local region on Mars as a potential habitat for past or present life. MSL will lay the ground work for future scientific missions, including Mars Sample Return, and will provide key information for human exploration. Additional detail can be found in the MSL Project section of this document.

Mars Scout 2013

NASA has selected for concept study development two proposals from members of the science community for future robotic missions to Mars. Both Scout missions are orbiters performing Mars aeronomy measurements. These missions would increase understanding of Mars' atmosphere, climate change and past habitability in greater detail than ever before. NASA intends to select one of the two proposals during 2008 for full development as a Mars Scout mission. The mission was originally planned to launch in 2011, but due to a conflict of interest which arose during evaluation will now have a launch opportunity in 2013.

ExoMars

NASA has selected two instrument proposals from the science community for technology development studies. These instruments are for potential inclusion in the European mission ExoMars, scheduled for launch in 2013. In 2008 NASA will make the decision whether to proceed to full development.

Mars Next Decade

The Mars Exploration Program plans future missions to Mars that build on scientific discoveries from past missions and incorporate the lessons learned from previous mission successes and failures. Missions in planning include a Mars mission in 2016 and Mars Sample Return.

Mars Technology

The Mars Technology Program is responsible for technology-development plans that are consistent with NASA's Mars Exploration vision, and implementing and infusing those technologies into future missions. Future missions will demand new technologies to provide better landing accuracy, access to high-priority sites, increased mobility, longer-lived, more robust and higher-output energy systems, and access to the subsurface for sample acquisition and in situ analysis.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Mars Research & Analysis

NASA invests in research and analysis of Mars mission data in order to understand how geologic, climatic, and other processes have worked to shape Mars and its environment over time, as well as how they interact today.

Mars Program Management

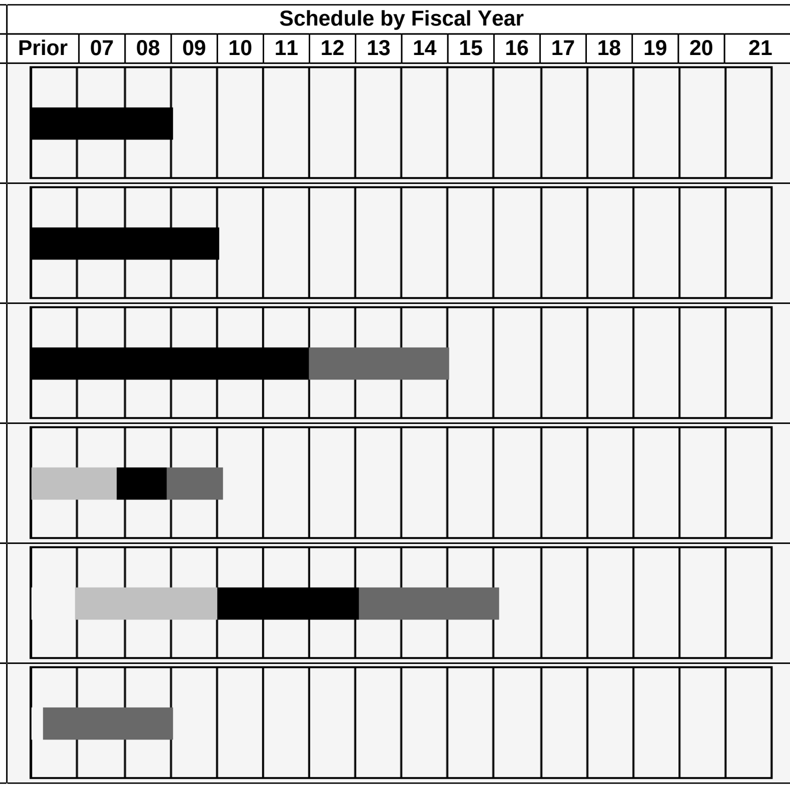
The Jet Propulsion Laboratory is responsible for implementing the Mars Exploration Program, and fulfills its managerial responsibilities within this budget. This includes the allocation, on an as-needed basis, of program reserve funds.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
MEP will provide continual operational presence on Mars	Mars Exploration	None
At least one Mars mission will be launched at every opportunity (every 26 months)	Mars Exploration	No planned NASA launch to Mars in 2011

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Implementation Schedule



Project	Phase	Beg	End
Mars Odyssey	Tech		
	Form	Apr-97	Apr-99
	Dev	Apr-99	Apr-01
	Ops	Apr-01	Sep-08
	Res		
Mars Exploration Rovers (Spirit & Opportunity)	Tech		
	Form	May-00	Aug-01
	Dev	Aug-01	Jun-03
	Ops	Jun-03	Sep-09
	Res		
Mars Reconnaissance Orbiter (MRO)	Tech		
	Form	Jan-01	Jul-02
	Dev	Jul-02	Aug-05
	Ops	Aug-05	Sep-11
	Res	Oct-11	Sep-14
Mars Scout (Phoenix)	Tech		
	Form	Aug-03	Mar-05
	Dev	Mar-05	Aug-07
	Ops	Aug-07	Aug-08
	Res	Aug-08	Oct-09
Mars Science Laboratory (MSL)	Tech		
	Form	Nov-03	Aug-06
	Dev	Aug-06	Sep-09
	Ops	Sep-09	Oct-12
	Res	Oct-12	Oct-15
Mars Express	Tech		
	Form	Jan-00	Sep-00
	Dev	Sep-00	Jun-03
	Ops	Jun-03	Dec-05
	Res	Dec-05	Sep-08

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Jet Propulsion Laboratory has responsibility for implementation of the Mars Exploration Program. The Director of Planetary Science is the responsible official for this program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Mars Exploration Rovers	NASA HQ	JPL	None
MRO	NASA HQ	JPL	None
Phoenix	NASA HQ, JPL	University of Arizona	None
MSL	NASA HQ	JPL	Department of Energy; International partners include Canada, Spain, and Russia.

Acquisition Strategy

The Mars Exploration Program (MEP) has set a goal of open competition for all missions. All major acquisitions for MRO, Phoenix, and MSL are in place; Ball Aerospace developed the primary optical instrument for MRO, while Lockheed Martin was the spacecraft design/systems integrator. Lockheed Martin Aerospace and Boeing are providing support for Phoenix. Malin Space Systems and Honeybee Robotics are providing support for MSL.

A major competitive acquisition for the second Mars Scout is underway. All research and technology is procured through the ROSES announcement and a competitive, peer-review selection process.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	10/2006	A Program Implementation Review was conducted in late FY 2006. Review determined the Mars program was functioning well and continuing to make important contributions to science and the Vision, but was short on reserve funding.	10/2008
Performance	IPAO	06/2007	MSL Critical Design Review determined that MSL design would meet mission goals.	02/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Program flexibility	Flight windows for Mars missions occur approximately once every 26 months. As a result, schedule delays can result in missing the launch opportunity altogether.	Schedule and budget reserves are evaluated for their adequacy before a mission proceeds into implementation. Program-level reserves are also held and may be used to mitigate schedule risks.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	553.0	416.8	305.5	223.3	69.0	54.6	37.6	--	--	1,659.8
Formulation	515.6	--	--	--	--	--	--	--	--	515.6
Development / Implementation	37.4	416.8	305.5	220.0	5.4	--	--	--	--	985.1
Operations / Close-out	--	--	--	3.3	63.6	54.6	37.6	--	--	159.1
Other	--	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0
FY 2008 President's Budget Request	552.4	378.4	345.0	238.2	73.6	58.2	40.1	--	--	1,686.0
Formulation	515.1	--	--	--	--	--	--	--	--	515.1
Development / Implementation	37.3	342.6	311.0	211.1	5.4	--	--	--	--	907.4
Operations / Close-out	--	--	--	3.0	63.5	54.5	37.5	--	--	158.5
Other	0.0	35.8	34.0	24.1	4.7	3.7	2.6	--	--	105.0
Changes from FY 2008 Request	0.6	38.4	-39.5	-14.9	-4.6	-3.7	-2.5	--	--	-26.2
Formulation	0.5	--	--	--	--	--	--	--	--	0.5
Development / Implementation	0.1	74.2	-5.5	8.9	--	--	--	--	--	77.7
Operations / Close-out	--	--	--	0.3	0.1	0.1	0.1	--	--	0.6
Other	0.0	-35.8	-34.0	-24.1	-4.7	-3.8	-2.6	--	--	-105.0

Note: FY 2009 P.B.R. is in direct dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the five-year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY 2008.

Explanation of Project Changes

Since preparing the FY 2008 budget, Mars Science Laboratory has encountered cost and schedule difficulties, requiring additional funds to be added in FY 2008 and FY 2009.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Purpose

The Mars Science Laboratory (MSL) Project will make detailed measurements of element composition, elemental isotopes and abundance, mineralogy, and organic compounds to determine if Mars has, or ever had, an environment capable of supporting life within the regions it will explore.

MSL has four science objectives: assess the biological potential of at least one selected site on Mars; characterize the geology and geochemistry of the landing region at all appropriate spatial scales; identify planetary processes relevant to past habitability; and characterize the broad spectrum of the Martian surface radiation environment.

For more information, see the MSL homepage at http://marsprogram.jpl.nasa.gov/missions/future/msl.html.

Project Parameters

The MSL is a surface rover which will collect Martian soil and rock samples and analyze them for organic compounds and environmental conditions that could have supported microbial life now or in the past. MSL will be a long-duration (two years) roving science laboratory that will be twice as long and three times as heavy (800-850 kilograms) as the Mars Exploration Rovers, Spirit and Opportunity.

Key technologies developed for MSL include: throttle-controlled, high-thrust engines, required during Martian entry, descent, and landing (EDL); sample acquisition and processing equipment used to acquire and distribute samples to the analytic instrument suite; and long-life, high-reliability, thermal-cycle-resistant electronics for use in the rover.

The EDL system will accommodate a wide range of possible latitude and altitude locations on Mars in order to be discovery-responsive and to have the capability to reach very promising, but difficult-to-reach scientific sites. MSL will also carry a sample cache which will hold as many as 10 samples. Once filled, the cache may be later collected by a Mars Sample Return mission.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Commitments

The Mars Science Laboratory (MSL) will be ready to launch in September 2009 and will arrive at Mars after 12 months of flight time. MSL will operate for two Earth years on the surface of Mars and will travel approximately 20 kilometers.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Rover	JPL	Travel 20 kilometers over the Martian surface.	Same	Same
Stereoscopic and microscopic cameras	Malin Space Systems	Acquire color, stereo images with resolutions up to 0.2 mm/pixel at 2 m range.	Same	Deleted descent imager and camera zoom
Robotic arm tools	Honeybee Robotics	Acquire, process and deliver 75 rock and soil samples to analytic instruments.	Same	Changed the rock grinder to a brush, sample quantity unchanged
Chemistry camera (ChemCam)	Department of Energy/Los Alamos National Laboratory; France	Remotely measure elemental composition of rocks and soil up to 9m from rover.	Same	Same
Alpha Particle X-ray Spectrometer	JPL	Measure with high precision the elemental composition of in situ rocks and soil.	Same	Same
Rover Environmental Monitoring System (REMS)	JPL	Monitor key atmospheric measurements including temperature, pressure, wind speed/direction and humidity.	Same	Same
Dynamic Albedo of Neutrons (DAN)	JPL	Measure hydrogen content in subsurface deposits.	Same	Same
Cruise stage and entry system	Lockheed Martin	Transport rover to Martian surface and land with impact speed below 1 m/s	Same	Same
Mission operations and data archive	JPL	Conduct one-year cruise and two-year rover primary mission with remotely located science team.	Same	Same
Sample Analysis at Mars (SAM)	NASA/GSFC	Analysis of elemental and isotopic composition of Mars samples	Same	Same
Chemistry & Mineralogy Instrument (CheMin)	NASA/ARC	Analysis of mineral and chemical content of Mars samples	Same	Same
Sample cache	ARC	Hockey puck-sized container will collect sample of Martian soil for possible later collection by a Mars Sample Return mission	None	New Commitment

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Schedule Commitments

The Mars Science Laboratory Project entered formulation in November 2004 and proceeded into the development phase in August 2006.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
Critical Design Review	June 2007	No change	No change
System Integration Review (formerly ATLO)	February 2008	No change	No change
Launch Readiness Review	September 2009	No change	No change

Development Cost and Schedule Summary

The Base Year Development Cost Estimate for MSL of $1068.5 million has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table, since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2009 Mars Science Lab	2007	968.6	2008	1,035.0	7	Launch Readiness	9/30/2009	9/30/2009	0

Development Cost Details

The increased development cost was approved by SMD in September 2007 as a result of technical and schedule difficulties encountered during 2007.

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**968.6**	**1,035.0**	**66.4**
Spacecraft	424.8	490.8	66.0
Payloads	64.9	89.1	24.2
Systems I&T	46.5	49.8	3.3
Launch Vehicle/Services	182.6	177.5	-5.1
Ground Systems	45.5	46.4	0.9
Science/Technology	11.4	11.5	0.1
Other direct project cost	192.9	169.9	-23.0

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Management

2009 Mars Science Laboratory is a JPL-managed project. Instrument implementation has been assigned to JPL. The responsible official for this project is the Planetary Science Division Director.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Rover	JPL	JPL	None
Stereoscopic and microscopic cameras	JPL	None	None
Robotic arm tools	JPL	JPL	None
Chemistry camera (ChemCam)	JPL	None	Department of Energy and France
Alpha Particle X-ray Spectrometer	JPL	None	Canada
Rover Environmental Monitoring System (REMS)	JPL	None	Spain
Dynamic Albedo of Neutrons (DAN)	JPL	None	Russia
Cruise stage and entry system	JPL	JPL, AMES, LaRC	None
Spacecraft	JPL	JPL	None
Sample Analysis at Mars (SAM)	JPL	GSFC	CNES (France)
Chemistry & Mineralogy Instrument (CheMin)	JPL	ARC	None

Acquisition Strategy

All major acquisitions are in place. All major instruments were competitively selected.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO/IRT	06/2007	Assess maturity of MSL design. Design was deemed adequate to achieve mission science goals.	02/2008

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Heatshield development	Uncertain performance of heatshield material (SLA-561) for MSL entry conditions threatens the safety of the spacecraft during entry to Mars.	MSL has concluded that SLA-561 is not viable and has changed heatshield material (will now use PICA).
MSL mass margins	Significant additional mass growth has occurred during development. Increased rover mass results in the need for increased terminal descent propellant, and risks exceeding launch vehicle mass limit.	A complete review of rover mass has been conducted to validate changes and identify mass reduction opportunities. Mass changes are diminishing, and mass will be well understood as hardware deliveries are weighed.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Outer Planets

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**79.0**	**81.9**	**101.1**	**216.7**	**279.4**	**230.6**	**362.0**
Outer Planets	**79.0**	**81.9**	**101.1**	**216.7**	**279.4**	**230.6**	**362.0**
FY 2008 President's Budget Request	**94.7**	**97.2**	**95.8**	**95.3**	**81.6**	**47.3**	**0**
Operating Missions and Analysis	**94.7**	**97.2**	**95.8**	**95.3**	**81.6**	**47.3**	**0**
Changes from FY 2008 Request	**-15.6**	**-15.2**	**5.3**	**121.4**	**197.7**	**183.2**	**362.0**

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

The Outer Planets Program consists of two strategic missions, Cassini and a new Outer Planets Flagship mission. These missions conduct science investigations across a broader array of disciplines and in more detail than competed missions. The science discoveries made by these missions are not expected to be easily displaced with time and are expected to overthrow previous paradigms and create new ones in their place.

Program Relevance

Supports NASA's Mission "To pioneer the future in space exploration, scientific discovery, and aeronautics research," by enhancing our understanding of the solar system as it is today and of solar system's formation and evolution, and by protecting the public, our workforce, and our environment while achieving our science.

Supports NASA Strategic Goal 3: "Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration," by providing frequent flight opportunities for high-quality, high-value scientific investigations that can be accomplished under a not-to-exceed cost cap. More specifically, the program contributes to Outcomes through 3C.3.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Outer Planets

Plans For FY 2009

The Cassini prime science mission ends in July 2008 and starts the extend mission. Cassini FY 2009 major targets include several close flybys of Saturn's moon, Enceladus, as well as over a dozen flybys of the moon Titan. Cassini will also continue studies of Saturn and its rings.

SMD will select the destination for the Outer Planets Flagship in FY 2008 and begin Phase A formulation in FY 2009. Major FY 2009 milestones include release of the Announcement of Opportunity for the mission payload, conclusion of concept and technology definition, and completion of the mission definition review.

The 10 kilogram Pu-238 to be purchased (with funds to be released to Department of Energy in FY 2008 and FY 2009) will provide sufficient Pu238 to enable an Outer Planets Flagship Mission (OPF).

Project Descriptions and Explanation of Changes

Cassini

Cassini-Huygens is an Outer Planets Flagship mission to Saturn that is profoundly altering our understanding of that planet, its famous rings, magnetosphere, icy satellites, and particularly the moon Titan. Cassini-Huygens is an international collaborative effort, with a four year orbiter prime mission. Cassini is the first spacecraft to explore the Saturn system, including all its rings and moons. A major focus is Saturn's largest moon, Titan, with its dense atmosphere, methane-based meteorology, and geologically active surface. Launched in October 1997, Cassini arrived at Saturn in July 2004, and will continue to investigate Saturn and Titan through at least September 2012. The Huygens probe mission was completed successfully in January 2005.

Outer Planets Flagship Mission

The next Outer Planets Flagship mission will consist of a multi-national effort to explore Europa, the Jupiter system, or Titan. SMD plans to downselect to a single mission destination around October 2008. The mission will launch in 2016-2017, arrive at its destination in about 2021-2022, and spend at least three years conducting its primary mission.

Outer Planets Research Project

The Outer Planets Research Project provides for the Cassini Data Analysis Project (CDAP), which broadens the science community participation in the analysis of mission data, and allows scientists outside the selected flight team to look at the data from the mission, do research, and publish their findings. Without CDAP, the findings and publications would not come out until years after the mission, since the Cassini mission team members are very busy while the spacecraft is flying. The Cassini Announcement of Opportunity (AO) came out in 1989 and selection of the teams was in 1990. Without CDAP, researchers who were not selected 17 years ago would have little or no chance to participate. Furthermore, the CDAP project facilitates new ideas and approaches, getting young people started in science, and broadening participation to get a critical mass of scientific talent working on mission data at the critical time.

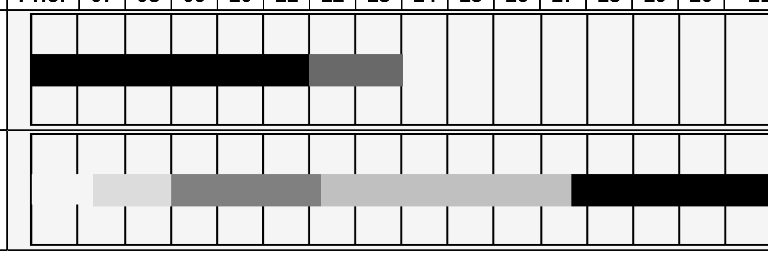
Mission Directorate:	Science
Theme:	Planetary Science
Program:	Outer Planets

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Deliver science data to Planetary Data Systems (PDS) consistent with science archive plan (in increments within 6 -9 months)	Cassini	Same - no changes
Deliver science data to PDS consistent with science objectives to be defined in the AO	Outer Planets Flagship	New

Implementation Schedule

Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21



Project	Phase	Beg	End
Cassini	Tech		
	Form		Sep-89
	Dev	Oct-89	Oct-97
	Ops	Oct-97	Sep-11
	Res	Aug-11	Sep-13
Outer Planets Flagship	Tech	Jan-07	Sep-08
	Form	Oct-08	Dec-11
	Dev	Jan-12	Jun-17
	Ops	Jun-17	Jul-25
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

Program management responsibility for both the Outer Planets Flagship Program and Cassini programs resides at JPL. Scientific mission priorities for OPF reside with SMD. The Planetary Science Director is the responsible official for this program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Cassini	JPL	JPL	The Italian Space Agency provided Cassini's high-gain communication antenna and the Huygens probe was built by the European Space Agency (ESA).
Outer Planets Flagship	JPL	JPL	Potential Partners: ESA and JAXA

Acquisition Strategy

All major acquisitions contracts for Cassini are in place. The acquisition strategy for the Outer Planets Flagship mission is expected to be similar to Cassini. The science payload will be competitively selected, and the nuclear power system will be provided by DOE.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	02/2007	Cassini senior review for an extended mission recommended approval of the extended mission science.	09/2012
Performance	Indepen TMC and Science Panels	11/2008	Independent science, technical, management, and cost review of concept studies. Results pending.	11/2009

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Plutonium availability	If the supply of plutonium remains limited, then the number and type of RPS available will be reduced, and enough units to meet the needs of the mission may not be available.	Reduce mission power requirements through descope of operational capabilities, mission redesign, or use of higher efficiency power system such as the Advanced Stirling Radioisotope Generator being developed by NASA.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	84.8	84.8	64.9	69.3	69.6	71.3	73.0
Technology	84.8	84.8	64.9	69.3	69.6	71.3	73.0
FY 2008 President's Budget Request	103.1	96.8	93.0	95.1	93.9	96.2	0
Technology	73.4	67.6	62.6	63.9	62.7	64.2	0
Advanced Multi-Mission Operation System	29.7	29.2	30.4	31.3	31.3	32.0	0
Changes from FY 2008 Request	-18.3	-12.0	-28.1	-25.8	-24.3	-24.9	73.0

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

Planetary Science is a challenging endeavor. Future Planetary Science missions will demand advances in both power and propulsion systems to enable successful trips to harsh environments, far from the Sun, with highly challenging trajectories. To meet these needs, the Planetary Science Technology Program includes the Radioisotope Power Systems (RPS), In-Space Propulsion (ISP), and Advanced Multi-Mission Operations System (AMMOS) Projects.

The ISP Project develops in-space propulsion technologies that can enable or benefit near- and mid-term NASA missions. These technologies will enhance the performance of planetary science missions by allowing increased science payload mass, minimized launch cost and decreased mission trip times. Furthermore, ISP will enable access to more challenging and interesting science destinations. The ISP Project is completing development in several propulsion technologies in support of future Flagship, Discovery, and New Frontiers missions. The high-temperature chemical thruster development task will be complete in FY 2008 and high-priority aerocapture ground activities will be completed by FY 2009. Electric propulsion development efforts for NASA's Evolutionary Xenon Thruster (NEXT) ion system development in FY 2008, and Hall thruster development and NEXT thruster wear testing are to continue through the planned project close-out in FY 2010.

The Radioisotope Power System (RPS) Project advances the capabilities of spacecraft power systems, thereby making it possible for missions to travel to more distant destinations. RPS activities focus on a technology portfolio that produces a proto-flight Advanced Stirling Radioisotope Generator (ASRG) by the 2012 to 2013 time frame and continues low-level investments in advanced thermoelectric conversion and thermal photovoltaic technologies as seeds to meet future needs late in the next decades. Funds will be needed to procure nuclear material to support missions in formulation.

The AMMOS Project provides planetary science missions with a set of navigation and design software tools and services for flight mission training, space communications resources allocation, and improved communication and navigation.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

Program Relevance

The Planetary Science Technology Program is designed to support the Outcomes 3C.1 to 3C.4.

Plans For FY 2009

The In-Space Propulsion (ISP) project will:
- Continue electric propulsion life validation testing and analysis of NASA's Evolutionary Xenon Thruster (NEXT);
- Complete high priority technology development activities (large scale aeroshell manufacturing, Guidance Navigation and Control system testing, and space environmental effects testing) for aerocapture; and
- Continue electric propulsion Hall thruster development task towards Technology Readiness Level 6 (TRL6).

Radioisotope Power Systems (RPS) Project will:
- Integrate the first-generation Stirling converters into an engineering model generator assembly, which will then undergo life-testing to provide reliability data;
- Demonstrate 1500-hour lifetime Radioisotope Thermoelectric Generator couples and validate four-couple module power output; and
- Begin development of one Advanced Stirling Radioisotope Generator (ASRG) proto-flight unit for delivery by the 2012 to 2013 time frame.

Advanced Multi-Mission Operations System (AMMOS) will continue to develop multi-mission software tools for spacecraft navigation and mission planning, efficient spacecraft communication, and data handling.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

Project Descriptions and Explanation of Changes

In-Space Propulsion (ISP)

The In-Space Propulsion (ISP) portfolio invests in high-priority technology areas such as Electric Propulsion (Next-Generation Electric Propulsion), Aerocapture Technology, and Advanced Chemical propulsion.

Radioisotope Power Systems (RPS)

The Radioisotope Power Systems (RPS) Project works toward the demonstration of an Advanced Stirling Radioisotope Generator (ASRG) and supports flight application of the Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) system. System and mission trade studies are performed to evaluate the benefits of advanced RPS technologies for future science missions and to define technology needs.

Technology Planning

Investments in technology planning allow for strategic studies of focused technology areas that are necessary for the achievement of Planetary Science Theme missions.

Advanced Multi-Mission Operations System (AMMOS)

Returning to Planetary Science in FY 2009 from the Heliophysics Deep Space Mission Systems (DSMS) Program, the AMMOS Project provides multi-mission navigation, design, and training tools to flight missions, and undertakes technology investments for improved communications and navigation technologies.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Next Generation Ion Thruster will demonstrate a >4,000-second specific impulse xenon thruster.	ISP	Completed in FY08
NEXT thruster long duration testing achieves greater than 80% of required qual-level throughput.	ISP	None
2.65m high temp aeroshell with ablative TPS will be fabricated.	ISP	None
Advanced Stirling convertor will work towards a qualified engineering model.	RPS	None
Radioisotope Thermoelectric Generator (RTG) will demonstrate an 8 Watts (electric)/kg system.	RPS	No longer supported
Provide standard interfaces in order to enable interoperability among missions.	AMMOS	None

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

Program Management

SMD provides overall oversight of the technology program. GRC is responsible for the ISP and RPS projects. JPL is responsible for the AMMOS project. The Planetary Science Division Director is the responsible official for this program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
ISP	GRC	GRC	None
RPS	Science Mission Directorate	JPL, GRC	Department of Energy
AMMOS	Science Mission Directorate	JPL	None

Acquisition Strategy

Technology activities are solicited using the NASA Research Opportunities in Space and Earth Sciences (ROSES) announcement, and selections are made using a competitive, peer-reviewed process. Lockheed Martin and Sunpower are providing support for the RPS Project.

Mission Directorate:	Science
Theme:	Astrophysics

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**1,365.0**	**1,337.5**	**1,162.5**	**1,122.4**	**1,057.1**	**1,067.7**	**1,116.0**
Astrophysics Research	98.9	102.2	152.3	170.4	181.0	203.0	198.9
Cosmic Origins	790.9	807.3	674.4	571.1	515.4	485.6	458.5
Physics of the Cosmos	201.3	159.0	157.0	219.8	249.0	271.1	326.0
Exoplanet Exploration	184.7	162.6	48.1	67.7	68.4	96.4	126.2
Astrophysics Explorer	89.2	106.4	130.6	93.3	43.3	11.7	6.4
FY 2008 President's Budget Request	**1,563.0**	**1,565.8**	**1,304.2**	**1,268.9**	**1,266.2**	**1,393.8**	**--**
Astrophysics Research	319.8	315.2	306.1	331.9	378.5	491.4	--
Astrophysics Explorer	69.4	99.1	88.8	28.2	11.7	5.7	--
James Webb Space Telescope	468.5	545.4	452.1	376.9	321.1	285.9	--
Beyond Einstein	22.1	32.3	51.5	147.6	170.6	222.1	--
Stratospheric Observatory for Infrared Astronomy (SOFIA)	--	77.3	89.1	88.6	89.9	92.1	--
Hubble Space Telescope	343.0	277.7	165.2	152.8	151.4	151.3	--
Gamma-ray Large Space Telescope (GLAST) Program	90.7	42.2	28.3	28.3	29.3	30.2	--
Navigator	124.7	57.1	58.4	59.5	61.0	62.5	--
International Space Science Collaboration	19.8	26.5	39.1	38.7	36.5	35.2	--
Discovery	105.0	93.0	25.7	16.3	16.2	17.6	--
Total Change from FY 2008 Request	**-198.0**	**-228.3**	**-141.8**	**-146.5**	**-209.1**	**-326.1**	**1,116.0**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Mission Directorate: Science
Theme: Astrophysics

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-198.0**	**-228.3**	**-141.8**	**-146.5**	**-209.1**	**-326.1**	**1,116.0**
Astrophysics Research	**-28.2**	**-17.9**	**27.2**	**47.4**	**39.8**	**54.3**	**198.9**
Programmatic Content	--	2.8	13.0	30.6	25.7	41.2	198.9
Programmatic Transfers	--	--	35.4	37.2	37.6	37.7	--
Institutional Adjustments	-28.2	-20.7	-21.2	-20.4	-23.5	-24.6	--
Cosmic Origins	**-102.2**	**-173.9**	**-108.9**	**-151.2**	**-189.0**	**-289.3**	**458.5**
Programmatic Content	--	-4.9	22.5	-29.9	-70.8	-158.9	458.5
Programmatic Transfers	--	-0.3	-0.1	-0.2	-0.2	-0.2	--
Institutional Adjustments	-102.2	-168.7	-131.3	-121.1	-118.0	-130.2	--
Physics of the Cosmos	**-18.4**	**-32.3**	**-52.4**	**-89.1**	**-82.5**	**-115.7**	**326.0**
Programmatic Content	--	-0.4	-19.2	-38.8	-28.4	-52.0	326.0
Institutional Adjustments	-18.4	-31.9	-33.2	-50.3	-54.1	-63.7	--
Exoplanet Exploration	**-43.5**	**14.7**	**-33.5**	**-5.5**	**-6.5**	**18.6**	**126.2**
Programmatic Content	--	32.4	-25.0	1.5	0.5	26.0	126.2
Institutional Adjustments	-43.5	-17.7	-8.5	-7.0	-7.0	-7.4	--
Astrophysics Explorer	**-5.7**	**-18.9**	**25.8**	**51.9**	**29.1**	**6.0**	**6.4**
Programmatic Content	--	-4.3	20.2	57.8	31.0	6.8	6.4
Programmatic Transfers	--	3.5	20.7	--	--	--	--
Institutional Adjustments	-5.7	-18.1	-15.1	-5.9	-1.9	-0.8	--

Note: The Astrophysics Theme was reorganized into 5 research areas and all projects were mapped into these areas.

Explanation of Program Changes

Astrophysics Research

Astrophysics Research and Analysis is increased to support more sounding rocket payloads, balloon payloads, detector technology, and theory.

Balloons Project augmentation will increase the number of balloons flights per year and advance the capability of the Ultra Long Duration Balloon (ULDB).

Cosmic Origins

Hubble Space Telescope Servicing Mission 4 is scheduled for August 2008. The launch date is set by the STS program. Their manifest is based upon the complex needs of the ISS Program and especially the desire to launch the International Partner Modules (one European and Two Japanese) in a timely fashion.

Physics of the Cosmos

Budget allocations to Joint Dark Energy Mission (JDEM), Laser Interferometer Infrared Antenna (LISA), and Constellation-X (Con-X) reflect the Beyond Einstein Program Advisory Committee (BEPAC) results. Funds Gamma'ray Large Area Space Telescope (GLAST) launch delay to May 2008.

Exoplanet Exploration

Redirect resources into mission concept studies and technology development for a new, executable, medium-class Exoplanet initiative.

Kepler was replanned due to contractor workforce and cost overruns. The replan was completed and Kepler is now scheduled for launch in February 2009.

Astrophysics Explorer

The Nuclear Spectroscopic Telescope Array (NuSTAR) Small Explorer has been restarted with a launch no earlier than 2011.

Mission Directorate:	Science
Theme:	Astrophysics

Theme Overview

How does the universe work? How did we get here? Are we alone? NASA searches for answers to these questions looking far away, towards the beginning of time, to see galaxies forming, and close to home, in search of planetary systems like Earth around nearby stars. The universe is a dynamic, evolving place, governed by cycles of matter and energy. In an intricate series of physical processes, chemical elements are formed and destroyed, passed between stars and diffuse clouds. Through the Astrophysics Theme, NASA seeks to understand these cycles and how they created the unique conditions that support life.

The Astrophysics portfolio has been re-structured into science-based programs that contain projects. The three new programs are: Cosmic Origins, Physics of the Cosmos, and Exoplanet Exploration. Science-based grouping of missions is especially useful for forward planning as the intellectual framework helps to justify new initiatives and maintain a scientifically balanced portfolio that will better serve upcoming strategic planning, as well as the next decadal survey.

The Astrophysics suite of operating missions includes three Great Observatories, which have helped astronomers unravel the mysteries of the cosmos by allowing contemporaneous observations of objects at different electromagnetic wavelengths. The best known is the Hubble Space Telescope, which has rewritten astronomy textbooks since its launch in 1990. Hubble was joined by the Chandra X-Ray Observatory in 1999 and the Spitzer Space Telescope in 2003. In the next few years Gamma'ray Large Area Space Telescope (GLAST) will begin to explore the high-energy world, Hubble Servicing Mission 4 will be performed, Kepler will begin the process to detect and characterize hundreds of planets in or near the habitable zone, and Wide-field Infrared Survey Explorer (WISE) will launch and begin its all-sky survey.

New technologies and more powerful instruments will allow the Astrophysics Theme to look deeper into the cosmos, to the edge of black holes and nearly to the beginning of time. In the search for origins, NASA will peer at tens of thousands of stars, inventory their planets, and search for solar systems resembling our own.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Astrophysics Theme encourages interdisciplinary research efforts on complex scientific frontiers to accelerate the progress of science. Astrophysics invests in cutting-edge research and the tools of science to produce unique and valuable discoveries that enable scientific advancement and innovation, and complements other facilities such as particle accelerators in making transformational scientific breakthroughs.

Knowing whether Earth alone supports life in the cosmos depends upon NASA's search for life-sustaining planets or moons, and researchers' understanding of the diversity of life here on Earth. Programs within the Astrophysics Theme are aimed at developing new technologies, building instruments to make crucial observations, and performing science that will bring answers to these questions.

The Astrophysics Theme seeks to answer questions that humankind has been pondering for centuries: How did the universe begin? How will it end? What are the limits of matter and energy, of space and time? How did the universe come to be, and what are the laws of nature that have permitted life to arise in the universe? Throughout history, these questions have served as cornerstones of mythology and philosophy: thought-provoking, but unanswerable. Now, with the aid of cutting-edge science and technology, the answers are within reach.

Relevance to the NASA Mission and Strategic Goals:

The Astrophysics Theme supports Strategic Subgoal 3D in the 2006 NASA Strategic Plan.

Relevance to education and public benefits:

Over the last decade, few scientific endeavors have contributed more to the rewriting of science textbooks, or generated more public interest and excitement, than the Astrophysics Theme's Great Observatories: the Hubble Space Telescope, the Chandra X-Ray Observatory, the Spitzer Space Telescope, and the Compton Gamma Ray Observatory (1991-1999). As more sophisticated instruments have been added through the years, the world has witnessed the birth of stars, begun to unravel the mysteries of black holes, and looked billions of years into the past. This flood of knowledge and questions has spread across the globe via front-page press, television, web sites, and school curricula at all levels.

In USA Today's list of "Top 25 Scientific Breakthroughs in the Past 25 Years" three Astrophysics achievements were in the top five: discovery of dark energy and the accelerating universe; the Hubble Space Telescope; and the Cosmic Background Explorer (COBE) fingerprint of the Big Bang. The Astrophysics Theme participates in science and mathematics education, and training the next generation of scientists and engineers.

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 3	**Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.**					
Sub Goal 3D	**Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.**					
Outcome 3D.1	**Progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity.**		**Green**	**Green**	**Green**	**Green**
APG 9AS1	Demonstrate progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9AS2	Develop missions in support of this Outcome, as demonstrated by releasing the Joint Dark Energy Mission (JDEM) Announcement of Opportunity (AO).	Physics of the Cosmos				None
Outcome 3D.2	**Progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects recognized in the present universe.**		**Blue**	**Green**	**Yellow**	**Green**
APG 9AS3	Demonstrate progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects we recognize in the present universe. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9AS4	Develop missions in support of this Outcome, as demonstrated by completing the James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Critical Design Review (CDR).	Cosmic Origins				Green
APG 9AS5	Develop missions in support of this Outcome, as demonstrated by beginning Stratospheric Observatory for Infrared Astronomy (SOFIA) open-door testing.	Cosmic Origins				None
Outcome 3D.3	**Progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems.**		**Green**	**Green**	**Yellow**	**Green**
APG 9AS4	Develop missions in support of this Outcome, as demonstrated by completing the James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Critical Design Review (CDR).	Cosmic Origins				Green
APG 9AS5	Develop missions in support of this Outcome, as demonstrated by beginning Stratospheric Observatory for Infrared Astronomy (SOFIA) open-door testing.	Cosmic Origins				None
APG 9AS6	Demonstrate progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems. Progress will be evaluated by external expert review.	Multiple Programs				Green

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome 3D.4	**Progress in creating a census of extra-solar planets and measuring their properties.**		**Green**	**Green**	**Yellow**	**Yellow**
APG 9AS7	Demonstrate progress in creating a census of extra-solar planets and measuring their properties. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9AS8	Develop missions in support of this Outcome, as demonstrated by completing Kepler Launch Readiness Review (LRR).	Exoplanet Exploration				Green

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Astrophysics Theme					
APG 9AS12	Complete all development projects within 110% of the cost and schedule baseline.				Red
APG 9AS13	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green
APG 9AS14	Peer-review and competitively award at least 95%, by budget, of research projects.				Green
APG 9AS15	Reduce time within which eighty percent of NRA research grants are awarded, from proposal due date to selection, by five percent per year, with a goal of 130 days.				Green

Performance Achievement Highlights:

Scientists using Hubble discovered that dark energy is not a new constituent of space, but rather has been present for most of the universe's history. Dark energy is a mysterious repulsive force that causes the universe to expand at an increasing rate. Scientists found that dark energy was already boosting the expansion rate of the universe as long ago as nine billion years. This picture of dark energy is consistent with Einstein's prediction that a repulsive form of gravity emanates from empty space. Data from Hubble provides supporting evidence into the nature of dark energy and helps scientists begin ruling out some competing explanations that predict that the strength of dark energy changes over time.

Astronomers, using data from Spitzer, laid down the cosmic equivalent of yellow "caution" tape around super-hot stars called O-stars, marking the zones where cooler stars are in danger of having their developing planets blasted away. These zones, inside of 1.6 light-years, or nearly 10 trillion miles, of an O-star, are where ultraviolet radiation from a super-hot star heats and evaporates the potentially planet-forming gas and dust within a debris disk, then winds from the star blow the material away. The findings are helping astronomers pinpoint the types of environments where planets--from massive gas giants to small terrestrial planets like Earth--are most likely to form.

Hubble's powerful vision allowed astronomers to study, for the first time, the layer-cake structure of the atmosphere of a Jupiter-sized extrasolar planet, called HD 209458b. HD 209458b orbits so close to its star and gets so hot that its upper layer of hot hydrogen gas is streaming into space, making the planet appear to have a comet-like tail. The Hubble data show how intense ultraviolet radiation from the parent star heats the gas in the upper atmosphere, inflating the atmosphere like a balloon. The gas is so hot that it moves very fast and escapes the planet's gravitational pull at a rate of 10,000 tons a second. Previous observations revealed oxygen, carbon, and sodium in the planet's atmosphere, as well as a huge hydrogen upper atmosphere.

For more information, see Sub-goal 3D in the FY 2007 Annual Performance Report, included in this budget.

Quality

Program Assessment Rating Tool (PART):

The Astrophysics Theme received a PART rating of "Adequate" in 2007. The assessment found that the program continues to return outstanding, groundbreaking scientific results in support of the community's scientific research priorities. However, significant concern regarding flight program cost and schedule performance was noted.

To address this, the Astrophysics Theme will:
- Continue detailed cost and schedule reporting for major missions;
- Improve flight project cost and schedule performance;
- Improve the cost and schedule performance of partners; and
- Establish the means to maximize return on available resources.

Life-cycle cost and schedule figures for projects in development are provided quarterly to OMB and annually to Congress as the Major Program Annual Report. NASA continues to work the process and policy to refine this reporting.

The Science Mission Directorate (SMD) has adopted a new management approach featuring control of cost through scope changes and other methods that allow missions to be managed within cost caps while maintaining risk at acceptable levels. A key to this approach is the focus on ensuring that project budget and scope are aligned early in the formulation phase. Budget and scope were also brought into alignment during the recent replan for the Kepler mission, currently in development. Additional efforts include the pursuit of new partnerships and expanded cost-sharing with existing partners for SOFIA and other programs.

To improve contract management, the Astrophysics Division has instituted Earned Value Management reporting for all contractors on major missions. Other methods have also been employed; these include reallocation of a portion of the Kepler prime contractor's fee to be awarded contingent on the achievement of specific performance measures.

The Astrophysics Division is strongly pursuing efforts to obtain greater returns on available resources. Examples include the addition of the Chandra X-ray Observatory and the Spitzer Space Telescope to the review process normally reserved for smaller missions in order to obtain the science community's assessment of the value associated with continuing flagship missions after their prime missions are completed. An emphasis has also been placed on maximizing near-term opportunities in the Explorer, Sounding Rockets, and Balloon Programs to strengthen the science community. SMD's new cost control ethic is part of this effort.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	National Research Council	09/2007	The Beyond Einstein Program Assessment Committee (BEPAC) recommended that JDEM proceed first among the former Beyond Einstein Program missions.	N/A
Relevance	National Research Council	05/2007	Mid-decadal NASA Astrophysics Performance Assessment report published.	N/A
Relevance	National Research Council	06/2007	Review of NASA Great Observatory Science Centers on lessons learned for future science centers report published.	N/A
Relevance	AAAC	N/A	Exo-planet task force of Astronomy and Astrophysics Advisory Committee (AAAC) convened to look at future of NASA and NSF planet-finding. Report due January 2008.	1/2008
Relevance	National Research Council	05/2001	Decadal Survey will start some time in the 2008 time frame. Last Decadal was published in 2001 which prioritized science objectives.	TBD

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Research

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	98.9	102.2	152.3	170.4	181.0	203.0	198.9
Astrophysics Research and Analysis	52.2	50.3	61.4	65.4	69.3	72.6	77.5
Balloon Project	22.2	22.8	24.6	26.7	28.8	32.4	33.2
Operating Missions and Data Analysis	24.5	29.1	66.3	78.4	82.9	97.9	88.2
FY 2008 President's Budget Request	127.1	120.1	125.0	123.1	141.2	148.7	0
Astrophysics Research and Analysis	59.6	57.4	58.9	55.3	57.6	59.6	0
Balloon Project	23.9	27.0	29.4	29.0	28.9	30.5	0
Operating Missions and Data Analysis	42.2	33.5	34.2	36.2	52.4	56.2	0
Other Navigator Projects	1.5	2.2	2.5	2.5	2.3	2.3	0
Changes from FY 2008 Request	-28.2	-17.9	27.3	47.4	39.8	54.3	198.9

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

For thousands of years, people have gazed at the stars, given them names, and observed their changes. Though NASA has only recently joined the ancient pursuit of knowledge of the cosmos, 40 years of space science has yielded such astronomical advances as full-sky mapping of the oldest light in the universe.

The Astrophysics Research Program translates missions into science advances by: collecting, processing, and storing mission data; making mission data available to scientists; and funding grants for basic research, technology development, and data analysis from past and current missions. All data collected by missions are archived in data centers located at universities and NASA Centers throughout the country and are readily available to all researchers and the general public. Suborbital efforts (balloons and sounding rockets) are significant contributors to meeting the following goals: conducting cutting-edge basic research; developing tools of science; maintaining U.S. leadership in science, engineering, and technology; and training the next generation of scientists and engineers to better compete in the 21st century.

For more information on current operating missions, visit: http://science.hq.nasa.gov/missions/universe.html.

Program Relevance

The Astrophysics Research Program supports Outcomes 3D.1 through 3D.4.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Research

Plans For FY 2009

The Astrophysics Research Program will continue to conduct and enable high-quality astrophysical research consistent with NASA's goals and science programs as described in the 2006 NASA Strategic Plan.

Project Descriptions and Explanation of Changes

Astrophysics Data Curation and Archival Research (ADCAR)

The Astrophysics Theme has established an archive structure beyond the scope of individual missions, to receive data and make them accessible by creating an ensemble of primarily wavelength-specific astrophysics archives. This is to ensure the availability of data and metadata (calibrations, instrument descriptions, etc.) to the broader science community, as well as to the taxpayer. This is generally the most cost-effective solution, and also helps ensure the integrity, completeness, and accessibility of the data. After the completion of a mission, all archive activities are taken over by the relevant active multi-mission archive.

Astrophysics Research and Analysis (R&A)

All Research and Analysis grants selected for funding by the Astrophysics Theme are broadly competed through NASA's Research Opportunities in Space and Earth Sciences (ROSES). Grant proposals must relate directly to both Agency and Theme goals and objectives, and all proposals are peer-reviewed by a mix of scientific disciplines and are selected based upon merit.

Balloons

Balloons have been used for decades to conduct scientific studies. While the basics of ballooning have not changed, balloon size and capabilities have increased, and their dependability has improved greatly. The Wallops Flight Facility manages the NASA Balloon Project. The project offers inexpensive, high-altitude flight opportunities for scientists to test new research technologies prior to spaceflight application. Eighteen flights are being planned for FY08 and a similar number is expected in FY09.

Astrophysics Senior Review

An Astrophysics Senior Review is conducted every two years. It is a comparative evaluation of all the Astrophysics operating missions. The science output for these missions is evaluated, and decisions are made as to which missions will receive funding for extended operations. Funding in this project line supports the missions recommended for extension via the Senior Review process.

Keck Single Aperture

This project provides funding for science operations and mission support at Keck Observatory.

Directorate Support - Space Science

This project covers Agency-wide Fee for Services for the Science Mission Directorate. These fees for services include Defense Contract Audit Service (DCAS) contract administration and Defense Contract Audit Agency (DCAA) audit services which are provided through contracts at Marshall Space Flight Center; various IT services including Ames Research Center and NASA Contract Assurance Services (NCAS) services provide through a contract at Glenn Research Center. This funding also supports related salaries at other Centers.

Education and Public Outreach

This project covers the Science Mission Directorate (SMD) small grants averaging $15,000 a year to research scientists to share the results of their NASA research with students, educators, and the public. It also covers the SMD educational forums and the mid-range awards.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Research

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Undertake an annual, peer-reviewed competition for research grants.	Astrophysics R&A	Same
Provide balloon flights for high-altitude science experiments.	Balloons	Same

Program Management

The Science Mission Directorate provides program management, with individual projects managed at Goddard Space Flight Center and the Jet Propulsion Laboratory.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Balloon working group	08/2007	Review the operations from a scientific standpoint	03/2008
Quality	Archival Senior Review Panel	04/2004	2004: Senior Review - Comparative review of archives efficiency and cost effectiveness.	05/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Out-dated Hardware	Potential loss of data and connectivity for the research community.	Conduct Senior Review to determine appropriate solutions for hardware upgrades and augmentations.

Mission Directorate:	Science	
Theme:	Astrophysics	
Program:	Cosmic Origins	

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	790.9	807.3	674.4	571.1	515.4	485.6	458.5
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James Webb Space Telescope	398.6	448.3	371.9	311.1	265.1	236.1	194.9
Stratospheric Observatory for Infrared Astronomy (SOFIA)	38.9	62.1	72.8	72.8	57.0	58.8	60.6
SIRTF/Spitzer	73.8	68.4	71.7	15.9	10.3	3.2	3.3
Astrophysics Future Missions	0	0	3.0	45.8	68.3	92.7	105.8
FY 2008 President's Budget Request	893.0	981.2	783.2	722.3	704.4	775.0	0
Hubble Space Telescope	343.0	277.7	165.2	152.8	151.4	151.3	0
James Webb Space Telescope	468.5	545.4	452.1	376.9	321.1	285.9	0
Stratospheric Observatory for Infrared Astronomy (SOFIA)	0	77.3	89.1	88.6	89.9	92.1	0
Operating Missions and Data Analysis	81.5	80.8	76.7	52.1	47.2	46.0	0
Astrophysics Future Missions	0	0	0.2	51.9	94.8	199.7	0
Changes from FY 2008 Request	-102.2	-173.9	-108.8	-151.2	-189.1	-289.3	458.5

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

How did we get here? This is the scientific context for human exploration of the origins of life and existence. Cosmic Origins Program investigates the history of the universe from the Big Bang to human existence.

How do stars and galaxies form and evolve? How did large-scale structure form and evolve? How were the elements in the periodic table formed? Astronomers search for answers to these questions by looking both far away towards the beginning of time to see galaxies forming, and close to home, exploring the formation of stars and planetary systems and the violent death of massive stars.

The missions that comprise the Cosmic Origins Program are: Hubble Space Telescope, James Webb Space Telescope, the Stratospheric Observatory for Infrared Astronomy and the Spitzer Space telescope. Both current and future projects use a wide range of the electromagnetic spectrum to observe the formation, evolution and ages of galaxies and stars, and the very elements from which we are made. For more information, please visit: http://science.hq.nasa.gov/missions/universe.html.

Program Relevance

The Cosmic Origins Program contributes to Outcomes 3D.2 and 3D.3.

Plans For FY 2009

Hubble Space Telescope will have completed Servicing Mission 4 and the in-orbit checkout of instruments will take place.

The James Webb Space Telescope Non-Advocate Review / Preliminary Design Review is scheduled for spring of 2008; if successful, the program will be allowed to proceed into development by 2009.

The Stratospheric Observatory for Infrared Astronomy will begin early science.

Spitzer Space Telescope will exhaust its cryogens and the baseline plan is to carry out a six month warm observatory phase.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

Project Descriptions and Explanation of Changes

Hubble Space Telescope (HST)

From the earliest days of astronomy, since the time of Galileo, astronomers have shared a single goal to see more, see farther, and see deeper.

The Hubble Space Telescope's launch in 1990 sped humanity to one of its greatest advances in that goal. Hubble orbits Earth, positioned above the atmosphere, which distorts and blocks the light from distant objects, giving it a view of the universe that typically far surpasses that of ground-based telescopes.

Hubble is one of NASA's most successful and long-lasting science missions. It has beamed hundreds of thousands of images back to Earth, shedding light on many of the great mysteries of astronomy. Its gaze has helped determine the age of the universe, the identity of quasars, and the existence of dark energy.

HST Service Mission-4 will be complete by FY 2009 and normal operations will resume. Extended mission operations will be subject to an independent review in which the Hubble budget will be scrutinized and evaluated against other current and/or future Astrophysics missions. The reductions in out-year operations still enable full operations but will reduce the capability to react to spacecraft anomalies.

James Web Space Telescope (JWST)

The James Web Space Telescope (JWST) will have a large mirror, 6.5 meters (21.3 feet) in diameter, and a sunshield the size of a tennis court. Neither the mirror nor the sunshade fit into the rocket fully open, so both will fold up and open only after JWST is in outer space. JWST will reside in an orbit about 1.5 million kilometers (one million miles) from the Earth. The telescope and instruments will operate at cryogenic temperature in order to achieve infrared performance. Launch is scheduled for 2013, on an European Space Agency-supplied Ariane-5 rocket to Sun-Earth L2 for a five-year science mission (10-year goal) to study the origin and evolution of galaxies, stars, and planetary systems.

Strategic Observatory for Infrared Astronomy (SOFIA)

Astronomical objects emit many forms of energy, which neither the human eye nor ordinary telescopes can detect. Infrared is one form of this invisible energy. The Strategic Observatory for Infrared Astronomy (SOFIA) is an airborne observatory that will study the universe in the infrared spectrum. Besides this contribution to science progress, SOFIA will be a major factor in the development of observational techniques, of new instrumentation and in the education of young scientists and teachers in the discipline of infrared astronomy.

NASA and the Deutches Zentrum für Luft- und Raumfahrt (DLR), Germany's Aerospace Research Center and Space Agency, are working together to construct SOFIA, a Boeing 747SP aircraft which was modified by L-3 Communications Integrated Systems to accommodate a 2.5 meter reflecting telescope. SOFIA will be the largest airborne observatory in the world, and will make observations that are impossible for even the largest and highest of ground-based telescopes.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

Spitzer Space Telescope

The Spitzer Space Telescope is an infrared cryogenic telescope equipped with three instruments to study--via spectroscopy, high-sensitivity photometry, and imaging-clouds of gas and dust--the characteristics of star-forming regions, centers of galaxies, and newly forming planetary systems. Spitzer will complete its cryogenic mission by mid-2009 and plans to operate a warm mission phase through the end of FY 2009. An extended warm mission phase opportunity will be subject to an independent review in which its budget will be scrutinized and evaluated against other current and/or future astrophysics missions.

Astrophysics Future Missions

This project line is dedicated to support the recommendations of the upcoming Astrophysics Decadal Study.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Extend HST science operations	HST	Same
Operate mid & near infrared cameras and a near infrared spectrograph using a 6m-mirror for 5 years	JWST	Same
Provide initial science operations with three available instruments	SOFIA	Beginning 2009

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

Implementation Schedule

Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

Project	Phase	Beg	End
HST	Tech		
	Form		
	Dev		
	Ops	Apr-90	Dec-13
	Res	Dec-13	Dec-16
JWST	Tech	Apr-96	Apr-99
	Form	Apr-99	Mar-08
	Dev	Mar-08	Jul-13
	Ops	Jul-13	Oct-23
	Res	Oct-23	Oct-24
SOFIA - Full Operational Capability was slipped from 2013 to 2014 in order to allow for early science to start in 2009, during the development phase.	Tech		
	Form		
	Dev	Dec-96	Sep-14
	Ops	Sep-14	Sep-34
	Res		
Spitzer	Tech		
	Form		
	Dev		
	Ops	Aug-03	Sep-09
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The following Centers are responsible for Cosmic Origins project management:

Goddard Space Flight Center: JWST and HST
Dryden Flight Research Center: SOFIA
Jet Propulsion Laboratory: Spitzer

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
HST	GSFC	GSFC	None
JWST	GSFC	None	European Space Agency (ESA) and Canadian Space Agency (CSA)
SOFIA	DFRC	DFRC & ARC	German Space Agency (DLR)
Spitzer	JPL	JPL	None

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

Acquisition Strategy

HST: All major acquisitions are in place for operations and servicing. Space Telescope Science Institute, Baltimore, MD and Ball Aerospace and Technologies Corp., Boulder, CO are providing support for SM4. For HST Operations, the Space Telescope Science institute coordinates with the Hubble European Space Agency Information Center.

JWST: JWST is being built by Northrop Grumman Space Technology (Redondo Beach, CA), teamed with Ball (Boulder, CO), ITT (Rochester, NY) and Alliant Techsystems (Edina, MN). Selections were made via a competitive NASA Request For Proposal.

SOFIA: L3 Communications (Waco,Texas), and MPC Products Corporation (Skokie,IL) are supporting the completion of the development, integration and test of the airborne platform system. L3 modified the SOFIA 747SP aircraft to install the telescope provided by Germany (DLR/DSI). MPC is developing the telescope cavity door drive system. CSC DynCorp (El Segundo, CA) is providing aircraft maintainence support.

University Space Research Association (Columbia, MD) will manage the science planning, ground science facilities, science instrument and technology development, and education and public outreach for SOFIA.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	HST SRB	N/A	SM4 Mission Readiness Review.	07/2008
Performance	JWST SRB	N/A	JWST Preliminary Design Review/Non-Advocate Review.	03/2008
Performance	SOFIA SRB	08/2007	Independent review of the entire mission to analyze progress since 2007 rebaseline.	08/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
HST Spacecraft Hardware	Degradation or failure of critical spacecraft hardware could result in loss of science program or mission.	Continue to identify and develop life-extension initiatives: One gyro science, zero gyro safemode and hybrid instrument operations; Battery management improvements, and; Forward looking science observations.
JWST Manufacturing, I&T	JWST has a long, complicated cryogenic integration and test which has never been performed at this scale.	JWST Standing Review Board regularly reviews the optical telescope element (OTE) testing and observatory-level integration and test planning.
SOFIA operations plan/costs are not fully understood	SOFIA does not yet have a comprehensive operations plan. Costs associated with the operations phase are not yet fully understood.	NASA is conducting a comprehensive independent operations review in the spring of 2008 in order to fully understand the cost and plan the budget accordingly.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Formulation:	James Webb Space Telescope

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	**398.6**	**448.3**	**371.9**
FY 2008 President's Budget Request	**468.5**	**545.4**	**452.1**
Total Change from 2008 President's Budget Request	**-69.9**	**-97.1**	**-80.2**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Project Purpose

The James Webb Space Telescope (JWST) was identified by the National Research Council as a top priority new initiative for astronomy and physics for the decade. JWST is a large, deployable, space-based infrared astronomical observatory, scheduled for launch no-earlier-than 2013. The mission is a logical successor to the Hubble Space Telescope (HST), extending beyond Hubble's discoveries by looking into the infrared spectrum, where the highly red-shifted early universe must be observed, where cool objects like protostars and protoplanetary disks emit strongly, and where dust obscures shorter wavelengths.

JWST will explore the mysterious epoch when the first luminous objects in the universe came into being after the Big Bang. The focus of scientific study will include first light, assembly of galaxies, origins of stars and planetary systems, and origins of the elements necessary for life.

For more information, please see: http://www.jwst.nasa.gov/.

Project Preliminary Parameters

JWST will be optimized for infrared astronomy, with some capability in the visible range. It will be sensitive to light from 0.6 to 27 micrometers in wavelength. JWST's instruments are: Near Infrared Camera (NIRCam); Mid Infrared Instrument (MIRI); Near Infrared Spectrograph (NIRSpec); and the Fine Guidance Sensor (FGS). The telescope is scheduled to launch in 2013 from Kourou, French Guiana, on an ESA-supplied Ariane 5 rocket. Its operational location is the L2 Lagrange point. The JWST Ground Operations, Science Support Center and archives will be at Space Telescope Science Institute (STScI) in Baltimore, MD.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Formulation:	James Webb Space Telescope

Estimated Project Deliverables

The James Webb Space Telescope is scheduled to launch in 2013 on a five year (10-year goal) mission. The four main science goals are:
- Search for the first galaxies or luminous objects formed after the Big Bang.
- Determine how galaxies evolved from their formation until now.
- Observe the formation of stars from the first stages to the formation of planetary systems.
- Measure the physical and chemical properties of planetary systems and investigate the potential for life in those systems.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Primary Mirror	Ball Aerospace; Tinsley Laboratories; Axsys Technologies; and Brush Wellman Inc.	Unobscured light collecting area of no less than 25 square meters.	Same	Same
Sunshield	Northrop Grumman Space Technology, Redondo Beach, California	Enable Zodiacal-light-background-limited observations over the wavelength range 1.7-10 micrometers.	Same	Same
Near-Infrared Camera (NIRCam) instrument	University of Arizona; Lockheed Martin	Optimized for finding first light sources, and operating over the wavelength range 0.6-5 microns.	Same	Same
Near-Infrared Spectrometer (NIRSpec)	European Space Agency (ESA)	Operating over the wavelength range 0.6-5 microns with three observing modes.	Same	Same
Mid-Infrared Instrument (MIRI)	ESA, University of Arizona, Jet Propulsion Lab	Operating over the wavelength range 5-27 microns, providing imaging, coronagraphy, and spectroscopy.	Same	Same
Fine Guidance Sensor	Canadian Space Agency (CSA)	Provides scientific target pointing information to the observatory's attitude control sub-system.	Same	Same

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Formulation:	James Webb Space Telescope

Estimated Project Schedule

The James Webb Space Telescope (JWST) is in late mission formulation, although some long-lead flight items are already in production per instructions from NASA Headquarters when the program entered Phase B, preliminary design. JWST was authorized to start formulation in March of 1999 and mission confirmation is scheduled to occur in mid-to-late FY 2008.

Milestone Name	Formulation Agreement Estimate	FY 2008 PB Request	FY 2009 PB Request
Formulation			
Technology Non-Advocate Review (T-NAR)		January 2007	Same
Non-Advocate Review/Preliminary Design Review		March 2008	Same
Critical Design Review		July 2009	Same
Launch		June 2013	Same

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Formulation:	James Webb Space Telescope

Project Management

Goddard Space Flight Center is responsible for James Webb Space Telescope project management.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Observatory	GSFC	GSFC	None
Mission management and System Engineering	GSFC	GSFC	None
Integrated Science Instrument Module (ISIM)	GSFC	GSFC	None
NIRCam	GSFC	GSFC	None
NIRSpec	ESA	None	ESA
MIRI	GSFC	JPL, ARC	ESA
Fine Guidance Sensor - Tunable Filter (FGS-TF)	CSA	None	CSA
Ariane 5 ESA launch vehicle and launch operations	ESA	None	ESA
Ground control systems and science operations and control center	GSFC	None	None

Acquisition Strategy

JWST is being built by Northrop Grumman Space Technology (Redondo Beach, CA), teamed with Ball (Boulder, CO), ITT (Rochester, NY) and Alliant Techsystems (Edina, MN). Selections were made via NASA Request For Proposal.

The Space Telescope Science Institute (STScI), in Baltimore, MD, is developing the Science and Operations Center and associated services.

The Integrated Science Instrument Module (ISIM) is being provided by GSFC.

The University of Arizona, Tucson, is providing the near-infrared science camera (NIRCam), along with Lockheed Martin. The selection was made via a NASA Announcement of Opportunity.

The European Space Agency is providing the Mid-Infrared Instrument, (MIRI) with management and technical participation by ARC and JPL, which was selected for this role after an internal NASA competition. The Europeans are also providing the Near-Infrared Spectrometer (NIRSpec) and an Ariane 5 launch vehicle.

The Canadian Space Agency is providing the Fine Guidance Sensor.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Formulation:	James Webb Space Telescope

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO & GSFC	01/2007	Technical Non-Advocate Review (T-NAR) completed successfully.	N/A
Performance	SRB	N/A	Non-Advocate Review (NAR)/Preliminary Design Review (PDR).	03/2008
Performance	SRB	N/A	Critical Design Review.	07/2009

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
JWST Manufacturing, I&T	JWST has a long, complicated cryogenic integration and test which has never been performed at this scale.	JWST Standing Review Board regularly reviews the optical telescope element (OTE) testing and observatory-level integration and test planning.
JWST Advanced Technology Development Risk	JWST requires advances in several technologies, which could present cost and schedule problems.	Successful Technology Non-Advocate Review (T-NAR) held in January 2007; risk retired.
JWST Partnership Risk	Because JWST is an international collaboration, NASA may incur schedule and cost impacts caused by challenges in Europe and Canada that are outside of NASA's control. Experience with similar collaborations indicates that this is likely to occur.	NASA has written clearly-defined interfaces and is actively managing and complying with export controls (ITAR).

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**556.7**	**38.9**	**62.1**	**72.8**	**72.8**	**57.0**	**58.8**	**60.6**	**1,599.4**	**2,579.0**
Formulation	35.0	--	--	--	--	--	--	--	--	35.0
Development / Implementation	521.7	38.9	62.1	72.8	72.8	57.0	58.8	60.6	--	944.7
Operations / Close-out	--	--	--	--	--	--	--	--	1,599.4	1,599.4
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
FY 2008 President's Budget Request	**556.7**	**--**	**77.3**	**89.1**	**88.6**	**89.9**	**92.1**	**--**	**2,425.4**	**3,419.0**
Formulation	35.0	--	--	--	--	--	--	--	--	35.0
Development / Implementation	521.7	--	63.1	72.9	72.9	74.1	75.9	--	--	880.6
Operations / Close-out	--	--	--	--	--	--	--	--	2,000.0	2,000.0
Other	0.0	--	14.2	16.2	15.7	15.8	16.2	--	425.4	503.4
Changes from FY 2008 Request	**--**	**38.9**	**-15.2**	**-16.2**	**-15.8**	**-33.0**	**-33.3**	**60.6**	**-826.0**	**-840.0**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	38.9	-1.0	-0.1	-0.1	-17.1	-17.1	60.6	--	64.1
Operations / Close-out	--	--	--	--	--	--	--	--	-400.6	-400.6
Other	--	0.0	-14.2	-16.1	-15.7	-15.9	-16.2	0.0	-425.4	-503.5

Note: FY 2009 P.B.R. is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY 2008.

Explanation of Project Changes

The Stratospheric Observatory for Infrared Astronomy (SOFIA) began flight testing in April, 2007. The SOFIA Project was rebaselined in July 2007 to reflect the fully restructured program and contracts, and to incorporate a new early science milestone to achieve science results earlier than previously planned. This resulted in a slight delay in full operational capability of SOFIA and a slight increase in development cost offset by operations costs, to reach full operational capability.

The funding profile shown assumes that a new major partner will join SOFIA by 2011. NASA is currently conducting a search for such a partner.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Project Purpose

Mission objectives for SOFIA include studying many different kinds of astronomical objects and phenomena, but some of the most significant are: star birth and death; formation of new solar systems; identification of complex molecules in space; planets, comets and asteroids in our solar system; nebulae and dust in galaxies (ecosystems of galaxies); and black holes at the center of galaxies.

Project Parameters

The Stratospheric Observatory for Infrared Astronomy (SOFIA) was designed as a highly-modified 747SP aircraft with a large open-port cavity aft of the wings, housing a 2.5 meter telescope optimized for infrared/sub-millimeter wavelength astronomy. SOFIA will operate in flight at 41,000 feet using seven U.S. instruments and two German instruments. SOFIA will ramp up to 960 science hours per year. Early science instruments will include: High-speed Imaging Photometer for Occultations (HIPO); First Light Infrared Test Experiment Camera (FLITECAM); and German Receiver for Astronomy at Terahertz frequencies (GREAT). These will be followed by six other instruments in the later phases.

Flights will last six to eight hours on average.

Project Commitments

SOFIA will initiate science observations in 2009. SOFIA will begin 20 years of operation as an airborne observatory in 2014.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Platform	DFRC/L3/MPC/DLR	747SP modified to carry an 18 ton, 2.5 meter telescope	Same	Same
Science Center	ARC/USRA	Science Center will schedule observations, and manage data acquisition and processing	Same	Same
Science Instruments	USRA/Universities	7 U.S. instruments ranging from Infrared to submillimeter	Same	Same
Flight Operations	DFRC/CSC DyneCorp	Flight crew, maintenance, and fuel	Same	Same

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Schedule Commitments

The development and test plan has been modified to enable earlier science observations by the science community to be concurrent with the late phases of aircraft flight testing. The modified plan provides for initial science observations with a subset of science instruments in 2009, followed by completion of the remaining science instruments and refinement of telescope performance, at which point Full Operational Capability (in FY 2014) is reached.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
First Flight	2000	2007	2007
First Science	N/A	2010	2009
Full Operational Capability (FOC)	N/A	2013	2014

Development Cost and Schedule Summary

The Base Year Development Cost Estimate for SOFIA of $1,005.5M has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Stratospheric Observatory for Infrared Astronomy (SOFIA)	2007	919.5	2008	946.4	3	Full Operation (FOC)	12/30/2013	9/15/2014	9

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**919.5**	**946.4**	**26.9**
Aircraft/Spacecraft	657.7	665.3	7.6
Other Costs	62.2	115.3	53.1
Science/Technology	199.6	165.8	-33.8

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Project Management

The overall Stratospheric Observatory for Infrared Astronomy (SOFIA) project, and the SOFIA airborne system is managed by Dryden Flight Research Center. The SOFIA science is managed by Ames Research Center.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Platform	DFRC	DFRC	Germany - DLR/DSI
Science	ARC	None	Germany - DLR/DSI
Mission Operations and Data Analysis	ARC	None	Germany - DLR/DSI
Instruments (9)	ARC	None	Germany - DLR/DSI

Acquisition Strategy

Drydent Flight Research Center (DFRC) handles the platform project (airframe and telescope). DFRC is working with L-3 Communications (Waco,Texas), and MPC Products Corporation (Skokie,IL) to support the completion of the development, integration and test of the airborne platform system. L-3 modified the SOFIA 747SP aircraft to install the telescope provided by Germany (DLR/DSI). MPC is developing the telescope cavity door drive system. DFRC is also working with CSC DynCorp (El Segundo, CA) which is providing aircraft maintainence support.

Ames Research Center (ARC) handles the science management. ARC is working with University Space Research Association (Columbia, MD) to manage the science planning, ground science facilities, science instrument and technology development, and education and public outreach for SOFIA.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SORT - Independent Team	05/2006	Assess the viability of the program.	N/A
Performance	SMOR - Independent Team	Ongoing	Assess the science operations.	06/08
Performance	Standing Review Board	New	Program Review.	TBD

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Operations plan/costs are not fully understood	SOFIA does not yet have a comprehensive operations plan. Costs associated with the operations phase are not yet fully understood.	NASA is conducting a comprehensive independent operations review in the spring of 2008 in order to fully understand the cost and plan the budget accordingly.
Mission Communication and Control System Development	If requirements are not established in a timely manner, the development of the system will be delayed.	Program is closely monitoring the requirement process so as to complete it in a timely manner.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	201.3	159.0	157.0	219.8	249.0	271.1	326.0
Gamma-ray Large Space Telescope (GLAST)	88.9	33.3	23.2	23.3	24.1	24.9	24.9
Joint Dark Energy Mission (JDEM)	0	3.7	8.5	63.0	83.0	109.0	125.0
Herschel	11.7	14.5	27.2	17.4	17.6	17.5	16.4
Planck	6.8	8.0	9.4	8.9	6.6	6.5	6.5
Other Missions and Data Analysis	93.9	99.5	88.8	107.2	117.7	113.2	153.2
FY 2008 President's Budget Request	219.7	191.3	209.5	308.8	331.5	386.8	0
Gamma-ray Large Space Telescope (GLAST) Program	90.7	42.2	28.3	28.3	29.3	30.2	0
Joint Dark Energy Mission (JDEM)	0	2.3	2.0	2.0	2.0	2.0	0
Herschel	12.5	17.1	29.0	29.3	29.5	29.3	0
Planck	7.3	9.5	10.1	9.4	7.0	5.9	0
Future Missions	22.1	30.0	49.5	145.6	168.6	220.1	0
Operating Missions and Data Analysis	87.2	90.4	90.6	94.2	95.2	99.4	0
Changes from FY 2008 Request	-18.4	-32.4	-52.4	-89.0	-82.5	-115.7	326.0

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

In attempting to understand and explain the universe, Albert Einstein devised several theories along with his theory of general relativity. Some fantastic predictions flow from these theories: the Big Bang, black holes, and existence of "dark energy." However, Einstein's theories only predict, they do not really explain the phenomena. To find answers, scientists must move beyond Einstein's theory. They must employ new techniques and launch missions to observe the universe in new and advanced ways. They must test and validate these new theories and enjoin heretofore separate fields like astronomy and particle physics.

NASA commissioned the National Research Council Beyond Einstein Program Assessment Committee (BEPAC) to conduct an independent study to examine the five proposed missions in the Beyond Einstein Program and recommend which of the missions should be developed and launched first.

For more information, please visit: http://science.hq.nasa.gov/missions/universe.html

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos

Program Relevance

Physics of the Cosmos will contribute to Outcomes 3D.1 and 3D.2.

Plans For FY 2009

NASA has received the results of the National Research Council's Beyond Einstein Program Advisory Committee (BEPAC). NASA is allocating resources to the program based upon the report to allow the Joint Dark Energy Mission to proceed forward while the Laser Interferometer Space Antenna and Constellation-X missions remain in technology development.

The Gamma-ray Large Area Space Telescope is scheduled to launch in May 2008. After two months of in-orbit checkout, research will begin in July 2008.

Herschel and Planck are scheduled to launch in October 2008. Operations will begin in 2009.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos

Project Descriptions and Explanation of Changes

Gamma-ray Large Space Telescope (GLAST)

The Gamma-ray Large Area Space Telescope (GLAST) mission will operate for five years (with a goal of 10 years) to measure the direction, energy, and arrival time of celestial gamma rays. Mission objectives include: understanding the mechanisms of particle acceleration in astrophysical environments such as active galactic nuclei; determining the high-energy behavior of gamma-ray bursts; resolving and identifying point sources with known objects; and probing dark matter and the extra-galactic background light in the early universe.

Herschel

Herschel will launch in October 2008 on a three-year prime mission (five-year goal) as a multipurpose observatory with data provided to the entire astronomical community. Mission objectives include: study the formation of galaxies in the early universe and their subsequent evolution; investigate the creation of stars and their interaction with the interstellar medium; observe the chemical composition of the atmospheres and surfaces of comets, planets and satellites; and examine the molecular chemistry of the universe.

Planck

Planck will launch in October 2008. The mission will collect and characterize radiation from the cosmic microwave background (CMB) using sensitive radio receivers operating at extremely low temperatures. These receivers will determine the black body equivalent temperature of the background radiation and will be capable of distinguishing temperature variations of about one micro-kelvin. These measurements will be used to produce the best-ever maps of aniosotopies in the CMB radiation field. Mission objectives include: mapping of CMB anisotropies with improved sensitivity and angular resolution; determination of Hubble constant; testing inflationary models of the early universe; and measuring amplitude of structures in the CMB.

Joint Dark Energy Mission (JDEM)

The Joint Dark Energy Mission (JDEM) will be an Einstein Probe to study the nature of dark energy that dominates the universe. More specifically, it will be a wide-field telescope in space to determine the expansion history of the universe and fully probe the nature of dark energy.

Laser Interferometer Infrared Antenna (LISA)

The Laser Interferometry Space Antenna (LISA) would be the first dedicated space-based gravitational wave observatory. LISA would use an advanced system of laser interferometry and the most delicate measuring instruments ever made to directly detect gravitational waves.

Constellation-X (CON-X)

The Constellation-X Observatory would be a combination of several X-ray telescopes working in unison to generate the observing power of one giant telescope. With the observatory, scientists will investigate black holes, Einstein's Theory of General Relativity, galaxy formation, the evolution of the universe on the largest scales, the recycling of matter and energy, and the nature of dark matter and dark energy.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos

Chandra

The Chandra X-ray Observatory explores the hot, turbulent regions in space in the X-ray part of the spectrum. Chandra's mirrors allow the sharpest X-ray imaging ever achieved, 25-times sharper than previous X-ray observations. Chandra will be subject to Senior Review in FY 2008.

Physics of the Cosmos Program Management

This mission line supports the program management office. The Program management office conducts the reviews and provides general oversight of the projects.

Physics of the Cosmos Future Missions

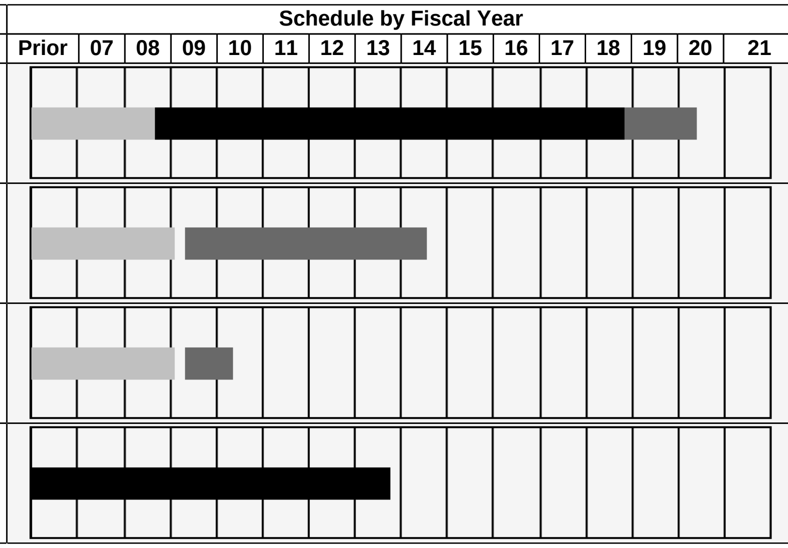
Physics of the Cosmos Future Missions supports concept studies and technology development for future missions.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Identify an initial Beyond Einstein mission to proceed to development	Physics of the Cosmos	Completed
Launch GLAST: Create an all-sky gamma-ray map; Complete 4 years of observing gamma-ray bursts	GLAST	Same
Provide 3 years of science data from NASA-provided instrumentation	Planck	Same
Provide roughly 7,000 hours of science data per year from NASA-provided instrumentation	Herschel	Same

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos

Implementation Schedule



Project	Phase	Beg	End
GLAST	Tech	Jun-98	Dec-99
	Form	Dec-99	Dec-03
	Dev	Dec-03	May-08
	Ops	May-08	Jul-18
	Res	Aug-18	Feb-20
Hershel	Tech		
	Form	Sep-97	Sep-01
	Dev	Oct-01	Oct-08
	Ops		
	Res	Feb-09	Apr-14
Planck	Tech		
	Form	Sep-97	Sep-01
	Dev	Oct-01	Oct-08
	Ops		
	Res	Feb-09	Feb-10
Chandra	Tech		
	Form		
	Dev		
	Ops	Jun-99	Jul-13
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

Goddard Space Flight Center has management responsibility for all projects, with the exception of Chandra (Marshall Space Flight Center) and the U.S. portion of Herschel and Planck (Jet Propulsion Laboratory).

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
GLAST	GSFC	GSFC	Japan, Italy, France, Sweden, and Germany
Herschel (Instrumentation)	JPL	JPL	ESA
Planck (Instrumentation)	JPL	JPL	ESA
JDEM	GSFC	TBD	DOE
LISA	GSFC	GSFC/JPL	ESA
CON-X	GSFC	GSFC	None
Chandra	MSFC	None	None

Acquisition Strategy

The acquisition strategies for JDEM, CON-X, and LISA are being worked. NASA will seek to maximize the amount of competition to ensure that the best concepts and science are supported.

JDEM: NASA expects to initiate a competitive process to select the dark energy science investigation in FY 2008.

GLAST: The spacecraft contract with General Dynamics/Spectrum Astro (Gilbert, AZ), was acquired via a blanket procurement through GSFC's Rapid Spacecraft Development Office. The acquisition of the primary instrument (LAT) at the Stanford Linear Accelerator Center, Stanford University, and the secondary instrument (GBM) at MSFC were selected through an Announcement of Opportunity competitive selection in 2000. Japan and Italy supplied a portion of LAT silicon strip detectors while Italy assembled the LAT tracker towers, which form the track imaging system, as well as additional hardware used in the towers. France supplied the Calorimeter structures and Sweden the Calorimeter detector crystals for the LAT. The Naval Research Laboratory (NRL), Washington, DC, assembled the Calorimeter for the LAT and environmentally tested the integrated instrument. Germany is providing the detectors and electronics for the GRB instrument. The GSFC Science Support Center will support Guest Observers (GO) and manage annual solicitation for GOs. GSFC Mission Operations Center personnel are provided by a contractor set-aside procurement. Japan, Italy, and France will all provide science support.

U.S. elements for the Herschel and Planck missions have been delivered to ESA.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NRC/BEPAC	09/2007	Assessed the five proposed missions in the (former) Beyond Einstein Program. Recommended which of those should be developed and launched first.	N/A
Performance	Standing Review Board	N/A	GLAST Launch Readiness Review.	5/2008
Performance	Independent Review Team (IRT)	09/2001	ISSC (Herschel and Planck): Critical Design Review. Completed successfully.	N/A

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
GLAST Integration & Test (I&T)	If further delays are experienced in bus completion and observatory I&T, then additional resources will be needed.	NASA HQ is closely monitoring General Dynamics cost, schedule and technical performance against their plan via regular senior management meetings.
System Configuration (Herschel and Planck)	International partnerships entail additional challenges in integrating components and system engineering.	Provide on-site integration and system engineering support as needed.
JDEM	Domestic and international partnerships not clearly defined.	Create effective MOUs that define roles and responsibilities.
LISA	Cost control,and international partnerships.	Work with the parties involved in order to scope the performance to the resources available.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Gamma-ray Large Space Telescope (GLAST) Project

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**404.2**	**88.9**	**33.3**	**23.2**	**23.3**	**24.1**	**24.9**	**24.9**	**123.6**	**770.3**
Formulation	98.8	--	--	--	--	--	--	--	--	98.8
Development / Implementation	305.4	88.9	24.5	--	--	--	--	--	--	418.8
Operations / Close-out	--	--	8.8	23.2	23.3	24.1	24.9	24.9	123.6	252.8
Other	0.0	0.0	0.0	0.0	0.0	0.0	--	--	--	-0.1
FY 2008 President's Budget Request	**426.1**	**90.7**	**42.2**	**28.3**	**28.3**	**29.3**	**30.2**	**--**	**180.1**	**855.0**
Formulation	98.8	--	--	--	--	--	--	--	--	98.8
Development / Implementation	327.3	75.2	--	--	--	--	--	--	--	402.5
Operations / Close-out	--	--	34.4	23.2	23.3	24.1	24.9	--	180.1	310.0
Other	0.0	15.5	7.8	5.1	5.0	5.2	5.3	--	0.0	43.7
Changes from FY 2008 Request	**-21.8**	**-1.8**	**-8.9**	**-5.1**	**-5.0**	**-5.2**	**-5.3**	**24.9**	**-56.5**	**-84.7**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	-21.9	13.7	24.5	--	--	--	--	--	--	16.3
Operations / Close-out	--	--	-25.6	--	--	--	--	24.9	-56.5	-57.2
Other	0.1	-15.5	-7.8	-5.1	-5.0	-5.2	-5.3	--	0.0	-43.8

Note: FY 2009 P.B.R. is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY 2008.

Explanation of Project Changes

The Gamma-ray Large Area Space Telescope (GLAST) launch has been delayed due to continued slips in the Command and Data Handling sub-system, schedule conflicts with DoD, and spacecraft contractor performance issues. Launch is currently scheduled for no earlier than May 2008.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Gamma-ray Large Space Telescope (GLAST) Project

Project Purpose

The Gamma-ray Large Area Space Telescope (GLAST) will study cosmic gamma-rays, the most energetic form of radiation. Billions of times more energetic than visible light and capable of generating prodigious amounts of energy, cosmic gamma rays are generated by distant objects such as supermassive black holes, merging neutron stars, and streams of hot gas moving close to the speed of light.

Mission objectives include: understanding the mechanisms of particle acceleration in astrophysical environments such as active galactic nuclei; determining the high-energy behavior of gamma-ray bursts; resolving and identifying point sources with known objects; and probing dark matter and the extra-galactic background light in the early universe.

Project Parameters

The Gamma'ray Large Area Space Telescope (GLAST) primary instrument is the Large Area Telescope (LAT), which will provide an all-sky gamma-ray map and provide follow-up observations of gamma-ray bursts. LAT is a high-energy pair conversion telescope with a mass of 3,000 kilograms. It utilizes a silicon strip detector to detect gamma rays in the energy range of 20 MeV to 300 GeV. LAT will achieve comparable sensitivity five-times faster than previous space-based instruments, monitor a region of the sky four-times larger, and locate objects with up to tenfold better precision.

The GLAST secondary instrument is the Gamma-ray Burst Monitor (GBM), which will detect and immediately transmit the data regarding gamma-ray bursts over the two-thirds of the sky that is unocculted by Earth. GBM includes a series of 12 low-energy Sodium Iodide (NaI) and two high-energy Bismuth Germanate detectors. GBM's mass is 70 kilograms and its energy range is 10 KeV to 25 MeV. GBM's energy range extends nearly three times as far as previous instruments, thereby permitting LAT burst detections to be tied to lower-energy measurements.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Gamma-ray Large Space Telescope (GLAST) Project

Project Commitments

The Gamma'ray Large Area Space Telescope (GLAST) will launch in 2008 and complete five years of mission operations (with a goal of 10 years of operations) to: measure the direction, energy, and arrival time of celestial gamma-rays; create an all-sky gamma-ray map during the first year of operations; and detect and provide follow-up observations of gamma-ray bursts.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Large Area Telescope	Stanfor Linear Accelerator Center	GLAST will identify gamma rays in 20 MeV to 300 GeV energy range with a sensitivity 50 times that of EGRET at 100 MeV. GLAST will have a positional accuracy of 30 arcsec to 5 arcmin.	Same	Same
GLAST Burst Monitor	MSFC	GLAST will detect gamma-ray bursts at 10 keV to 25 MeV energy range, with a positional accuracy of 15 degress for burst alerts, 3 degrees after final processing.	Same	Same
Launch Vehicle	Boeing	Delta 2920 (H).	Same	Same
Missions Ops	Goldbelt Orca/Omitron	Mission operations development.	Same	Same
Data Management	GSFC	Science Support Center/Archive at GSFC. Science data production at Stanford Linear Accelerator Center (LAT) and MSFC (GBM).	Same	Same

Schedule Commitments

GLAST entered implementation in December 2003. By the end of fiscal year 2007, the entire observatory integration was complete. Thermal vacuum testing will be conducted in FY 2008, with launch currently scheduled for no earlier than May 2008.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
Flight/Operational Readiness Review	February 2007	April 2007	April 2008
Launch Readiness	May 2007	November 2007	May 2008

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Gamma-ray Large Space Telescope (GLAST) Project

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Gamma-ray Large Space Telescope (GLAST) Project	2006	403.3	2008	423.1	5	Launch Readiness	9/30/2007	5/30/2008	8

Development Cost Details

The Base Year Development Cost Estimate for Gamma¿ray Large Area Space Telescope (GLAST) of $414.0 million has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**403.3**	**423.1**	**19.8**
Science/Technology	10.0	11.9	1.9
Payload	113.0	118.7	5.7
Aircraft/Spacecraft	97.0	104.7	7.7
Launch Vehicle/Services	87.0	64.1	-22.9
Ground Systems	14.0	17.6	3.6
Other (in-house labor and overhead are reflected in this element)	82.3	104.7	22.4
I & T	0.0	1.5	1.5

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Gamma-ray Large Space Telescope (GLAST) Project

Project Management

Goddard Space Flight Center is responsible for Gamma'ray Large Area Space Telescope project management.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	GSFC	N/A	None.
LAT	GSFC	N/A	DOE, Italy, Japan, France and Sweden
GBM	GSFC	MSFC	Germany
Mission Operations and Data Analysis	GSFC	MSFC Mission Operations Center	DOE, Italy, Japan, France, and Germany
Launch Vehicle	GSFC	KSC	None.
Science	GSFC	GSFC Science Support Center	DOE, Italy, Japan and France will provide science support.

Acquisition Strategy

The spacecraft contractor, General Dynamics/Spectrum Astro (Gilbert, AZ), was chosen via a blanket procurement through GSFC's Rapid Spacecraft Development Office.

The primary instrument (LAT) at the Stanford Linear Accelerator Center, Stanford University, and the secondary instrument (GBM) at Marsall Space Flight Center were selected through a competitive Announcement of Opportunity selection in 2000.

Italy assembled the LAT tracker towers, which form the track imaging system, as well as additional hardware used in the towers. Japan and Italy supplied a portion of the LAT silicon strip detectors. France supplied calorimeter structures and Sweden provided the calorimeter detector crystals. Germany supplied the detectors and electronics for GBM.

The Naval Research Laboratory (NRL), Washington, DC, assembled the calorimeter for the LAT and environmentally tested the integrated instrument.

The GSFC Science Support Center will support guest observers (GO) and manage annual solicitation for GOs. Goldbelt Orca/Omitron will provide the ground system via a mission operations development contract. Mission Operations Center personnel will be provided by a contractor set-aside procurement.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Gamma-ray Large Space Telescope (GLAST) Project

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Standing Review Board	04/2007	Integration & Test schedule & performance review / Pre-Environmental Review was successful.	N/A
Performance	Standing Review Board	New	Flight/Operations Readiness Review	04/2008
Performance	Standing Review Board	New	Launch Readiness Review	05/2008

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Integration & Test (I&T)	If further delays are experienced in bus completion and observatory I&T, then additional resources will be needed.	NASA HQ is closely monitoring General Dynamics cost, schedule and technical performance against their plan via regular senior management meetings.
Contractor Personnel Attrition	If attrition continues, then schedule and cost increases will occur due to inefficiencies in re-establishing the mission-unique technical knowledge base.	GLAST Project and General Dynamics expeditiously replace lost personnel and incentivize retention.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Herschel

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**115.7**	**11.7**	**14.5**	**27.2**	**17.4**	**17.6**	**17.5**	**16.4**	**27.9**	**266.0**
Formulation	10.4	--	--	--	--	--	--	--	--	10.4
Development / Implementation	105.3	11.7	14.5	--	--	--	--	--	--	131.5
Operations / Close-out	--	--	--	27.2	17.4	17.6	17.5	16.4	27.9	124.0
Other	0.0	0.0	0.0	0.0	0.0	0.0	--	--	--	0.1
FY 2008 President's Budget Request	**115.7**	**12.5**	**17.1**	**29.0**	**29.3**	**29.5**	**29.3**	**--**	**79.2**	**341.5**
Formulation	10.4	--	--	--	--	--	--	--	--	10.4
Development / Implementation	105.3	11.7	15.9	--	--	--	--	--	--	132.9
Operations / Close-out	--	--	--	27.2	27.4	27.6	27.5	--	74.3	184.0
Other	0.0	0.8	1.2	1.8	1.9	1.9	1.8	--	4.9	14.2
Changes from FY 2008 Request	**--**	**-0.8**	**-2.5**	**-1.9**	**-11.8**	**-11.8**	**-11.8**	**16.4**	**-51.3**	**-75.5**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	--	-1.4	--	--	--	--	--	--	-1.4
Operations / Close-out	--	--	--	--	-10.0	-10.0	-10.0	16.4	-46.4	-60.0
Other	--	-0.8	-1.1	-1.9	-1.8	-1.8	-1.8	--	-4.9	-14.1

Note: FY 2009 P.B.R. is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the five-year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY 2008.

Explanation of Project Changes

All instruments have been delivered to the European Space Agency for integration. Operations management efficiency improvements and redirection of science funding to other mission priorities implemented beginning in FY 2010.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Herschel

Project Purpose

The mission objectives of Herschel are to: study the formation of galaxies in the early universe and their subsequent evolution; investigate the creation of stars and their interaction with the interstellar medium; observe the chemical composition of the atmospheres and surfaces of comets, planets and satellites; and examine the molecular chemistry of the universe.

The Herschel project supports Outcomes 3D.1 - 3D.3.

Project Parameters

The Herschel Space observatory is a collaboration between NASA and the European Space Agency (ESA). It will be the first space observatory covering the full far-infrared and sub-millimeter waveband, and its telescope will have the largest mirror deployed in space to date.

The observatory will operate for 7000 hours a year at the second Lagrange point of the Earth-Sun system. Herschel will perform high spatial and spectral resolution imaging in the 85-900 micron wavelength region with superb sensitivity for both photometry and spectroscopy. Herschel's 3.5 meter mirror will collect the light from distant and poorly known objects, such as newborn galaxies thousands of millions of light-years away, and will focus that light onto three instruments whose detectors will be kept at temperatures close to absolute zero.

ESA is the lead agency for the mission. NASA is providing the first two of the following three science instruments, as well as mission and science operations:

Heterodyne Instrument for the Far Infrared (HIFI) is a very high-resolution heterodyne spectrometer;

Spectral and Photometric Imaging Receiver (SPIRE) is an imaging photometer and an imaging Fourier transform spectrometer; and

Photodetector Array Camera and Spectrometer (PACS) is an imaging photometer and medium resolution grating spectrometer.

Herschel will launch aboard an Ariane-5.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Herschel

Project Commitments

Herschel will launch in October 2008 on a three-year prime mission (five-year goal) as a multipurpose observatory with data provided to the entire astronomical community. Mission objectives include: study the formation of galaxies in the early universe and their subsequent evolution; investigate the creation of stars and their interaction with the interstellar medium; observe the chemical composition of the atmospheres and surfaces of comets, planets and satellites; and examine the molecular chemistry of the universe.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
HIFI	JPL	A very high-resolution heterodyne spectrometer operating continuously in seven bands from 480 to 1250 GHz and portions of 1410 - 1910 GHz range.	Same	Same
SPIRE	JPL	The photometer images the sky in three bands simultaneously. Provides broadband photometry and medium resolution spectroscopy in wavelengths from 200 to 670 microns.	Same	Same
Science Operations	JPL	Jet Propulsion Laboratory manages the U.S. portion of the science operations.	Same	Same

Schedule Commitments

Herschel entered implementation in October 2001. NASA delivered all instrument hardware in fiscal year 2006. Herschel is scheduled to launch in October 2008.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
Launch Readiness	N/A European Launch	July 2008	October 2008

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Herschel

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Herschel	2006	117.0	2008	131.7	13	Launch Readiness	8/30/2007	10/30/2008	14

Development Cost Details

The Base Year Development Cost Estimate for Herschel of $117.0 million has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**117.0**	**131.7**	**14.7**
Other	38.6	39.6	1.0
Payload	56.7	58.7	2.0
Science/Technology	19.3	30.9	11.6
Systems Integration & Test	2.4	2.5	0.1

Project Management

The Jet Propulsion Laboratory has management of the U.S. portion of the mission, including mission and science operations.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Herschel HIFI	JPL	None	ESA
Herschel SPIRE	JPL	None	ESA

Acquisition Strategy

Completed major acquisitions.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Herschel

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	JPL IRT	09/2001	Critical Design Review was successful	N/A

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Potential performance anomalies	Unexpected performance issues that only arise in system configuration.	NASA has personnel on-site during integration and testing.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Planck

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**64.2**	**6.8**	**8.0**	**9.4**	**8.9**	**6.6**	**6.5**	**6.5**	**--**	**117.0**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	64.2	6.8	8.0	--	--	--	--	--	--	79.0
Operations / Close-out	--	--	--	9.4	8.9	6.6	6.5	6.5	--	37.9
Other	0.0	0.0	0.0	0.0	0.0	0.0	--	--	--	0.1
FY 2008 President's Budget Request	**64.2**	**7.3**	**9.5**	**10.1**	**9.4**	**7.0**	**5.9**	**--**	**5.5**	**118.9**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	64.2	6.8	8.0	--	--	--	--	--	--	79.0
Operations / Close-out	--	--	--	9.4	8.9	6.5	5.4	--	5.0	35.2
Other	0.0	0.5	1.5	0.7	0.5	0.5	0.5	--	0.5	4.7
Changes from FY 2008 Request	**--**	**-0.5**	**-1.4**	**-0.7**	**-0.6**	**-0.4**	**0.6**	**6.5**	**-5.5**	**-1.9**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	--	--	--	--	--	--	--	--	--
Operations / Close-out	--	--	--	--	--	0.1	1.1	6.5	-5.0	2.7
Other	--	-0.5	-1.4	-0.7	-0.6	-0.5	-0.5	--	-0.5	-4.6

Note: FY 2009 P.B.R. is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY 2008.

Explanation of Project Changes

All instruments have been delivered to the European Space Agency for integration. Operations management efficiency improvements and redirection of science funding to other mission priorities implemented beginning in FY 2010.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Planck

Project Purpose

The Planck spacecraft will help provide answers to one of the most important sets of questions asked in modern science: how did the universe begin, how did it evolve to the state we observe today, and how will it continue to evolve in the future? Planck's objective is to analyze, with the highest accuracy ever achieved, the remnants of the radiation that filled the universe immediately after the Big Bang, which researchers observe today as the cosmic microwave background (CMB). Planck will study the global characteristics of the universe (age, composition, topology, etc.) by its precision all-sky measurement of the CMB. Planck is designed to image tiny flucuations in CMB temperature and polarization over the whole sky, with unprecedented sensitivity and angular resolution. The Planck mission is led by the European Space Agency. NASA participates on the two project instruments, the Low Frequency Instrument (LFI), and the High Frequency Instrument (HFI).

NASA is providing a high-electron-mobility transistor radio receiver array for the LFI, and a bolometric detector array for the HFI. In addition, NASA is providing two sorption cryo-coolers to the Planck science payload.

Project Parameters

Planck will collect and characterize radiation from the CMB using sensitive radio receivers operating at extremely low temperatures. The receivers will determine the blackbody equivalent temperature of the background radiation and be capable of distinguishing temperature variations of about one microkelvin. LFI and HFI will be the most sensitive instruments ever built for their respective frequency ranges. Their measurements will produce the best-ever maps of anisotropies in the CMB radiation field, enabling researchers to construct a "cosmic fingerprint" of the Universe.

Project Commitments

NASA has delivered all the hardware components for Planck to the principal investigator.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
High Frequency Instrument	JPL/CalTech	A micro-fabicrated bolometric microwave receiver array operating at 6 frequency bands from 100 GHz to 857 GHz.	Same	Same
Low Frequency Instrument	JPL	A coherent microwave receiver array based on high-electron-mobility transistor amplification, operating at 30, 44, and 70 GHz.	Same	Same
Sorption Cryocooler	JPL	Cools the payload from its thermal-shield temperature down to ~20 degrees Kelvin at the instruments, acting as the major pre-cooler for the mission.	Same	Same

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Planck

Schedule Commitments

Planck entered implementation in October 2001. NASA delivered all instrument hardware in fiscal year 2006. Planck is scheduled to launch in October 2008. (Please note that Herschel and Planck are launched on the same launch vehicle.)

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
Launch Readiness	N/A European	July 2008	October 2008

Project Management

JPL is responsible for Planck project management. NASA and JPL Program Management Councils have program oversight responsibility.

Planck is a European Space Agency mission and NASA has provided critical components and technologies to this mission.

Acquisition Strategy

Completed major acquisitions.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos
Project In Development:	Planck

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Instrument ship Readiness Rev.	05/2007	Established by ESA to confirm readiness of Planck payload for shipping. Payload delivered to ESA.	N/A
Performance	Planck data analysis review.	05/2007	The review emphasized that Planck will make a superb and unprecedented database of all-sky intensity and polarization maps; and the important role the US team has played in ensuring the success of the Planck mission to date.	N/A

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Potential performance	Unexpected performance issues that only arise in system configuration.	NASA has personnel on-site during integration and testing.

Mission Directorate:	Science	
Theme:	Astrophysics	
Program:	Exoplanet Exploration	

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**184.7**	**162.6**	**48.1**	**67.7**	**68.4**	**96.4**	**126.2**
Space Interferometer (SIM)	30.4	54.1	0	0	0	0	0
Kepler	121.8	78.9	25.2	14.9	13.9	12.6	8.8
Other Missions and Data Analysis	32.5	29.6	22.9	52.9	54.5	83.7	117.4
FY 2008 President's Budget Request	**228.2**	**147.9**	**81.7**	**73.3**	**74.9**	**77.8**	**0**
Space Interferometer (SIM) - PlanetQuest	100.6	21.6	22.1	23.4	23.8	24.0	0
Kepler	105.0	93.0	25.7	16.3	16.2	17.6	0
Other Navigator Projects	22.6	33.2	33.8	33.6	35.0	36.2	0
Changes from FY 2008 Request	**-43.5**	**14.7**	**-33.6**	**-5.6**	**-6.5**	**18.6**	**126.2**

Note: The Exoplanet Exploration Program (formerly Navigator) has been reconfigured to focus on a medium-class exo-planet mission and technology development.

In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration

Program Overview

Are humans alone? For centuries, humankind has pondered this question. Within the past few decades, advances in science and technology have brought humans to the threshold of finding an answer to this timeless question.

Recent discovery of planets around stars other than the Sun confirms that the solar system is not unique. Indeed, these extra-solar planets appear to be common in the galactic neighborhood. Although the giant, Jupiter-like planets discovered thus far are unlikely to support life, some may be in systems that also contain smaller, terrestrial planets like Mars and Earth.

As called for in the Vision for Space Exploration, the Exoplanet Exploration program supports the goal to explore the solar system and beyond, and addresses the following science objectives:
- Learn how stars and planets form, interact, and evolve by focusing on observing the formation of planetary systems and characterizing their properties.
- Look for signs of life in other planetary systems by focusing on: discovering planetary systems of other stars and their physical characteristics; and searching for worlds that could, or, do harbor life.

The Exoplanet Exloration Program will consist of a coherent series of increasingly challenging projects, each complementary to the others, and all missions building on the results and capabilities of those that preceded them as NASA searches for habitable planets outside of the solar system. Each mission will measure unique properties of exoplanets. Together the missions build a synergistic picture of exoplanets that no single mission can do.

The understanding of planetary systems has undergone a profound shift since 1995 when the first exoplanets were discovered. The field has been transformed from one in which extrapolation from the solar system has been replaced by the empirical wealth of data for over 200 exoplanets. The sheer variety of giant planets and planetary systems--including planets orbiting very close to stars or on highly elliptical orbits, and resonance-locked pairs of planets--has come as a surprise. Yet these discoveries just reveal the "tip of the iceberg." If the solar system is typical, then these giant planets may be accompanied by many sibling terrestrial planets.

Until a website is developed for the Exoplanet Exploration Program, for more information, please visit: http://science.hq.nasa.gov/missions/universe.html.

Program Relevance

The Exoplanet Exploration Program is the focus of NASA's efforts to enable advanced telescope searches for Earth-like planets, as called for by the Vision for Space Exploration. The objectives of the program are to:
- Search for and detect terrestrial planets that might exist in the habitable zones of nearby stars;
- Characterize the atmospheres of all detected planets;
- Search for indicators of the presence of life on terrestrial planets; and
- Study each planetary system (planets plus zodiacal dust) as a whole.

The Exoplanet Exploration Program contributes to Outcome 3D.4.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration

Plans For FY 2009

Resources in the Exoplanet Exploration Program will be used to assess different techniques and mission concepts for detecting and characterizing extrasolar planets, including space-based astrometric, coronagraphic, and statistical concepts.

A new medium-class Exoplanet mission, managed by the Jet Propulsion Laboratory, will begin formulation in 2010, for which a re-scoped version of Space Interferometry Mission (SIM) is being evaluated as a potential candidate. $271.8M is available within Other Missions and Data Analysis for this mission ($6.6M in FY09, $41.7M in FY10, $44.0M in FY 11, $72.0M in FY12 and $107.5M in FY13).

The Keck Interferometer has been delivered for community use, and NASA's partnership in the Keck Observatory is being renewed.

The Large Binocular Telescope Interferometer (LBTI) will be reviewed during FY 2009 to ensure satisfactory progress and support from the appropriate agency.

Kepler is scheduled to launch in February 2009.

The program maintains a technology line as Terrestrial Planet Finder (TPF) funds now reside in a new "Exoplanet Exploration Technology" line.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration

Project Descriptions and Explanation of Changes

Kepler

The Kepler Mission is specifically designed to survey our region of the Milky Way galaxy to detect and characterize hundreds of Earth-size and smaller planets in or near the "habitable zone." The habitable zone encompasses the distances from a star where liquid water can exist on a planet's surface

Keck Interferometer (KI)

Keck Interferometer will deliver instrumentation for community use and will be phased out to support new initiatives.

Keck Operations

Keck Operations is the NASA portion of the Keck Observatory partnership. NASA uses its share of observing time for technology development and testing (Keck Interferometry), and support of Exoplanet-related science. Observation time is competed time, organized through the Michelson Science Center.

Large Binocular Telescope Interferometer (LBTI)

The Large Binocular Telescope Interferometer project will deliver instrumentation for community use, then it will be phased out to support new initiatives.

Terrestrial Planet Finder (TPF) /Exoplanet Exploration Technology

Terrestrial Planet Finder funds now reside in the "Exoplanet Exploration Technology" line, which will continue to support technology development for an eventual terrestrial planet-finding mission.

Exoplanet Exploration Future Missions

This project is an Exoplanet initiative for new, medium-class missions.

Exoplanet Exploration Program Management

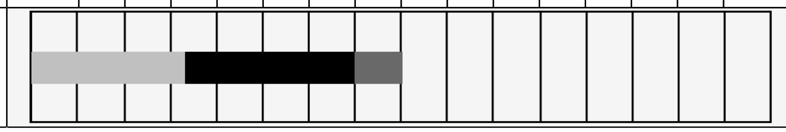
This mission line supports programmantic, technical, and business management, as well as program science leadership and coordination for education and public outreach products and services.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Over 3 1/2 years, determine the frequency of terrestrial and larger planets in the habitable zone.	Kepler	Launch February 2009

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration

Implementation Schedule

Project	Schedule by Fiscal Year	Phase Dates		
	Prior 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21		Beg	End
Kepler		Tech		
		Form	Dec-01	May-05
		Dev	May-05	Feb-09
		Ops	Feb-09	Oct-12
		Res	Oct-12	Oct-13

- Tech & Adv Concepts (Tech)
- Formulation (Form)
- Development (Dev)
- Operations (Ops)
- Research (Res)
- Represents a period of no activity for the Project

Program Management

Center responsibility for program management is currently in work and TBD.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Kepler	JPL (Development) & ARC (MO&DA)	JPL (Development) & ARC (MO&DA)	None.

Acquisition Strategy

All major acquisitions are in place. Ames Research Center and Ball Aerospace & Technologies (Boulder, CO) were selected as the Kepler development and operations team via a competative NASA Discovery Program Announcement of Opportunity. The Laboratory for Atmospheric and Space Physics (Boulder, CO) was chosen as a subcontractor for mission operations.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Exoplanet Task Force	New	Determine planet-finding research and technology approach & prioritization leading up to the next decadal survey. Report scheduled to go to AAAC January 2008.	01/2008
Performance	SRB	New	Kepler Launch Readiness	2/2009

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Exo-planet Science Capability	Extended technology and formulation phases may make it difficult to retain expertise on exoplanet science.	An exoplanet task force has been formed to assess current planet-finding research and technology, and suggest a research strategy leading up to the next decadal survey. Plan for a new, medium class exo-planet mission to begin formulation in 2010.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration
Project In Development:	Kepler

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**309.5**	**121.8**	**78.9**	**25.2**	**14.9**	**13.9**	**12.6**	**8.8**	**--**	**585.6**
Formulation	142.8	--	--	--	--	--	--	--	--	142.8
Development / Implementation	166.7	121.8	78.9	16.2	--	--	--	--	--	383.6
Operations / Close-out	--	--	--	9.0	14.9	13.9	12.6	8.8	--	59.2
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0
FY 2008 President's Budget Request	**314.6**	**105.0**	**93.0**	**25.7**	**16.3**	**16.2**	**17.6**	**--**	**24.2**	**612.6**
Formulation	147.2	--	--	--	--	--	--	--	--	147.2
Development / Implementation	167.4	89.2	79.5	--	--	--	--	--	--	336.1
Operations / Close-out	--	--	--	21.4	13.4	13.3	14.5	--	20.0	82.6
Other	0.0	15.8	13.5	4.3	2.9	2.9	3.1	--	4.2	46.7
Changes from FY 2008 Request	**-5.1**	**16.9**	**-14.1**	**-0.5**	**-1.4**	**-2.3**	**-4.9**	**8.8**	**-24.2**	**-27.0**
Formulation	-4.4	--	--	--	--	--	--	--	--	-4.4
Development / Implementation	-0.7	32.6	-0.6	16.2	--	--	--	--	--	47.5
Operations / Close-out	--	--	--	-12.4	1.5	0.6	-1.9	8.8	-20.0	-23.4
Other	0.0	-15.7	-13.5	-4.3	-2.9	-2.9	-3.0	0.0	-4.2	-46.7

Note: FY 2009 P.B.R. is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY 2008.

Explanation of Project Changes

Due to contractor workforce and cost overruns, Kepler underwent a major restructuring and replan during FY 2007. A new management team is in place, the organizational structure has been changed, and the new cost and schedule plans are complete. Project mission life has been decreased by six months, and the launch is now scheduled for February 2009.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration
Project In Development:	Kepler

Project Purpose

The centuries-old search for other Earth-like worlds has been re-energized by the intense excitement and popular interest surrounding the discovery of Jupiter-like, gas-giant planets orbiting stars beyond our solar system. With the exception of the pulsar planets, a large majority of the extrasolar planets detected thus far are gas giants.

The Kepler mission is designed to survey a portion of the extended solar neighborhood. The goal is to detect and characterize hundreds of potentially habitable planets that are up to 600 times less massive than Jupiter. Transits by planets produce a fractional change in stellar brightness. From measurements of the period, change in brightness and known stellar type, the planetary size, orbital size and characteristic temperature are determined. From these properties, the question of whether or not the planet might be habitable (not necessarily inhabited) can be answered.

Kepler's specific objectives include: determine the frequency of terrestrial and larger planets in or near the habitable zones of a wide variety of spectral types of stars; determine the distribution of planet sizes and their orbital semi-major axes (half the longest diameter of the orbit); estimate the frequency and orbital distribution of planets in multiple-stellar systems; and determine the distributions of semi-major axis, albedo, size, mass, and density of short-period giant planets.

For more information please see http://www.kepler.nasa.gov.

Project Parameters

Flight System Characteristics:
- Spacebased Photometer: 0.95-meter aperture
- Primary mirror: 1.4 meter diameter, 85 percent weighted
- Detectors: 95 mega pixels (42 charge coupled devices (CCDs) with 2200x1024 pixels)
- Fine guidance sensors: four charge coupled devices (CCDs) located on science focal plane
- Uplink X-band; Downlink Ka-band
- Spacecraft and instrument mass: 1039 kilogram, maximum expected
- Spacecraft and instrument power: 651 Watt, maximum expected

Mission Characteristics:
- Continuously point at a single star field in Cygnus-Lyra region except during Ka-band downlink
- Roll the spacecraft 90 degrees about the line-of-sight every three months to maintain the sun on the solar arrays and the radiator pointed to deep space
- Monitor 100,000 solar class and cooler stars for planets
- Mission lifetime of 3 1/2 years
- D2925-10L (Delta II) launch into an Earth-trailing helio-centric orbit
- Scientific Operations Center at NASA Ames Research Center
- Mission Operations Center at University of Colorado Laboratory for Atmospheric and Space Physics
- Data Management Center at Space Telescope Science Institute
- Deep Space Network for telemetry
- Routine contact: X-band contact twice a week for commanding, health and status, and Ka-band contact once a month for science data downlink

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration
Project In Development:	Kepler

Project Commitments

Following a 30-day characterization period, Kepler will begin acquiring its scientific data by continuously and simultaneously observing over 100,000 target stars. During the first year, terrestrial planets with orbital periods shorter than that of Mercury, as well as a wide range of larger planets with similar periods, should be detected. Finally, the anticipated identification of Earth-size planets in the habitable zones of other star systems will begin during the third year.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Flight System	Ball Aerospace Technologies, Boulder, Colorado	Provides on-orbit capability to detect Earth-sized planet transits in the habitable zone.	Same	Same
Launch Vehicle	Boeing	D2925-10L (Delta II) .	Same	Same
Mission Operations	University of Colorado Laboratory for Atmospheric and Space Physics	Use of existing facility to operate the mission .	Same	Same
Data Management	Space Telescope Science Institute	Use of existing facility to pre-process data and manage the archives.	Same	Same
Mission Science	ARC Science Operations Center	Use of existing facility for data reduction and analysis.	Same	Same

Schedule Commitments

Kepler was selected as a Discovery class mission in January 2001 and entered implementation in May of 2005. The project underwent a replan in 2007 and has since successfully integrated all charge-coupled devices (CCDs) and completed all primary mirror coating. Launch is now scheduled for February 2009, and mission operations are scheduled to be complete in the fall of 2012, with an additional year of funded research.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
Critical Design Review	March 2006	October 2006	Same
Assemby, Test, and Launch Operations (ATLO) start	December 2006	July 2007	September 2007
Launch Readiness	June 2008	November 2008	February 2009

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration
Project In Development:	Kepler

Development Cost and Schedule Summary

The Base Year Development Cost Estimate for Kepler of $322.0 million has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Kepler	2006	312.7	2008	390.2	25	Launch Readiness	6/30/2008	2/28/2009	8

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**312.7**	**390.2**	**77.5**
Science/Technology	16.0	4.8	-11.2
Payload	65.0	152.3	87.3
Aircraft/Spacecraft	52.0	70.4	18.4
Launch Vehicle Services	82.0	82.6	0.6
Ground Systems	29.0	15.5	-13.5
Systems Integration & Testing	7.0	14.8	7.8
Other	61.7	49.8	-11.9

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration
Project In Development:	Kepler

Project Management

Jet Propulsion Laboratory (JPL) is responsible for Kepler development project management.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Flight System	JPL	None	None
ELV	KSC	None	None
Mission Operations & Data Analysis	ARC	ARC	None

Acquisition Strategy

All major acquisitions are in place. Ames Research Center and Ball Aerospace & Technologies (Boulder, CO) were selected as the Kepler development and operations team via a competative NASA Discovery Program Announcement of Opportunity. The Laboratory for Atmospheric and Space Physics (LASP, Boulder, CO) was chosen as a subcontractor for mission operations.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB, JPL & ARC	10/2006	Critical Design Review (CDR) was completed successfully.	N/A
Performance	SRB, JPL & ARC	08/2007	Assembly, Test & Launch Operations (ATLO) Readiness Review.	N/A
Performance	SRB, JPL & ARC	N/A	Operational Readiness Review.	01/2009
Performance	SRB, JP	N/A	Launch Readiness Review.	02/2009

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Contractor Performance	Ball Aerospace and Technology Corp. and many of its sub-contractors have not been able to execute planned activities within the cost and schedule they proposed. This has put the overall schedule and total cost for the project at risk.	New management personnel and structures have been put in place at BATC. Contract negotiations provide greater incentives for BATC to take direct responsibility for any further cost and schedule growth.
Focal Plane Array Integration	The Focal plane on Kepler, with 42 large CCDs, is the largest ever flown in space and has stringent requirements on science performance. That together with the high density of elements and electrical and thermal attachments makes the assembly and test of this element a key challenge for the project.	Management attention to this element continues to extend to the NASA HQ level. CCDs are now all integrated and early testing has proven successful.
Launch Conflicts	Early calendar year 2009 launch manifest is currently quite crowded; changing Kepler's launch will result in negative cost impacts to the new plan.	Monitor the manifest schedule and adjust as required.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**89.2**	**106.4**	**130.6**	**93.3**	**43.3**	**11.7**	**6.4**
Wide - Field Infrared Survey Explorer	54.1	71.8	65.2	13.0	5.2	1.6	0
NuStar	0	0	41.5	57.8	31.0	6.8	6.4
Operating Missions and Data Analysis	35.1	34.6	23.9	22.5	7.1	3.2	0
FY 2008 President's Budget Request	**94.9**	**125.2**	**104.9**	**41.4**	**14.1**	**5.7**	**0**
Wide-Field Infrared Survey Explorer	58.4	83.0	74.9	14.0	5.5	1.7	0
Operating Missions and Data Analysis	36.5	42.2	30.0	27.4	8.6	3.9	0
Changes from FY 2008 Request	**-5.7**	**-18.9**	**25.8**	**51.9**	**29.1**	**6.0**	**6.4**

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

The Explorer Program provides frequent flight opportunities for world-class astrophysics and space physics investigations, using an innovative and efficient approach to spacecraft development and operations. The program is composed of a series of independent space science missions that share a common funding and management structure. The program emphasizes missions that can be accomplished under the control of the scientific research community within specified life cycle cost requirements. The program provides access to space and launch vehicle funding. These funds are part of the total cost cap for each mission. For each mission class, launch will take place within the following number of months after implementation starts: Small Explorer (SMEX), 33 months; Medium-class Explorer (MIDEX), 40 months.

The Wide-field Infrared Survey Explorer (WISE) is the only Explorer project in development currently supporting the Astrophysics Theme. The Nuclear Spectroscopic Telescope Array (NuSTAR) Small Explorer has been restarted with a launch no earlier than 2011. Please refer to the Heliophysics Theme for information on additional Explorer projects. For more information, visit: http://explorers.gsfc.nasa.gov.

Program Relevance

Wide-field Infrared Survey Explorer (WISE) will contribute to Outcomes 3D.2 and 3D.3.

Plans For FY 2009

The WISE spacecraft and payload integration and testing will begin.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

Project Descriptions and Explanation of Changes

Wide-field Infrared Survey Explorer (WISE)

Currently in development and planned for launch in 2009, the Wide-field Infrared Survey Explorer (WISE) will provide a storehouse of knowledge about the solar system, the Milky Way, and the universe. During its six-month mission, WISE will map the sky in infrared light, searching for the nearest and coolest stars, the origins of stellar and planetary systems, and the most luminous galaxies in the universe. WISE's infrared survey will provide an essential catalog for the James Webb Space Telescope. (Solar panels will provide WISE with electricity as it orbits several hundred miles above the dividing line between night and day on Earth, looking out at right angles to the Sun and always pointing away from the planet.) As the telescope orbits from the North Pole to the South Pole and then back up to the North Pole, it will sweep out a circle in the sky. As Earth moves around the Sun, this circle will shift, until WISE has observed the entire sky.

Nuclear Spectroscopic Telescope Array (NuSTAR)

The Nuclear Spectroscopic Telescope Array (NuSTAR) was approved for restart in September 2007, into an extended Phase A study effective January 1, 2008. Assuming a successful review, it will be authorized to proceed into Phase B by February, 2008. NuSTAR will provide a greater capability for using high-energy X-rays to detect black holes than any currently existing instrument.

NuSTAR has been designed to answer fundamental questions about the universe, such as: How are black holes distributed through the cosmos? How were the elements of the universe created? What powers the most extreme active galaxies? This mission will expand our ability to understand the origins and to predict the destinies of stars and galaxies.

Suzaku

Suzaku is Japan's fifth X-ray astronomy mission, and was developed at the Institute of Space and Astronautical Science of Japan Aerospace Exploration Agency (ISAS/JAXA) in collaboration with the United States (NASA/GSFC, MIT) and Japanese institutions. NASA provided the five X-ray mirrors for Suzaku, as well as one instument: the micro-calorimeter spectrometer. Suzaku studies black holes, neutron stars, and quasars, to unravel the physics of high-energy processes and the behavior of matter under extreme conditions. Suzaku was formerly known as Astro-E2.

Swift

Swift, a NASA mission with international participation, studies the position, brightness, and physical properties of gamma-ray bursts. With Swift, scientists now have a tool dedicated to answering fundamental questions about gamma-ray bursts and solving the gamma-ray burst mystery. Its three instruments give scientists the ability to scrutinize gamma-ray bursts like never before. Within seconds of detecting a burst, Swift relays a burst's location to ground stations, allowing both ground-based and space-based telescopes around the world the opportunity to observe the burst's afterglow. Swift has achieved its Level 1 requirements.

Galaxy Evolution Explorer (GALEX)

The Galaxy Evolution Explorer (GALEX) is exploring the origin and evolution of galaxies and the origins of stars and heavy elements, and is also conducting an all-sky ultraviolet survey. GALEX has achieved its Level 1 requirements.

Wilkinson Microwave Anisotropy Probe (WMAP)

The Wilkinson Microwave Anisotropy Probe (WMAP) studies the early universe by measuring the cosmic microwave background radiation over the full sky. WMAP produced the earliest "baby picture" of the universe, showing temperature variation of microwave light 379,000 years after the Big Bang, over 13 billion years ago. WMAP has completed its Level 1 requirements.

Far Ultraviolet Spectroscopic Explorer (FUSE)

The Far Ultraviolet Spectroscopic Explorer (FUSE) studies the wavelength range of 90 to 120 nanometers from high orbit. This range provides an opportunity to answer important questions about many types of astrophysical objects, such as the nuclear regions of active galaxies and quasars, massive stars, supernovae, planetary nebulae, and the outer atmospheres of cool stars and planets. FUSE enables study of the physical processes governing the evolution of galaxies, as well as the origin and evolution of stars and planetary systems. FUSE was in extended operations and ceased scientific observations in August 2007 due to a spacecraft anomaly. Final critical instrument calibration tasks, mission closeout, data reprocessing and archiving will be complete by September 2008. FUSE achieved its Level 1 requirements.

Rossi X-Ray Timing Explorer (RXTE)

Rossi X-Ray Timing Explorer (RXTE) observes the high-energy worlds of black holes, neutron stars, and X-ray pulsars. RXTE studies variability over time in the emission of X-ray sources, with moderate spectral resolution. This time behavior is a source of important information about processes and structures in white-dwarf stars, X-ray binaries, neutron stars, pulsars, and black holes. RXTE has achieved its Level 1 requirements.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Begin a 6 month survey of the infrared sky.	WISE	Same
Duration 25 months for both checkout and Science data collection	NuSTAR	Approved restart of project

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

Implementation Schedule

Project	Phase	Beg	End
WISE	Tech		
	Form	Apr-02	Oct-06
	Dev	Oct-06	Nov-09
	Ops	Nov-09	May-10
	Res	May-10	May-12
Swift	Tech		
	Form		
	Dev		
	Ops	Apr-04	Sep-10
	Res		
Suzaku	Tech		
	Form		
	Dev		
	Ops	May-05	Sep-10
	Res		
WMAP	Tech		
	Form		
	Dev		
	Ops	Jun-01	Sep-10
	Res		
GALEX	Tech		
	Form		
	Dev		
	Ops	Apr-03	Sep-10
	Res		
RXTE	Tech		
	Form		
	Dev		
	Ops	Dec-95	Sep-09
	Res		
FUSE	Tech		
	Form		
	Dev		
	Ops	Jun-99	Sep-08
	Res		
NuSTAR	Tech		
	Form	Feb-08	Nov-09
	Dev	Nov-09	Aug-11
	Ops	Aug-11	Sep-13
	Res		

Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

- Tech & Adv Concepts (Tech)
- Formulation (Form)
- Development (Dev)
- Operations (Ops)
- Research (Res)
- Represents a period of no activity for the Project

Program Management

The Explorer Program is a multiple-project program with program responsibility assigned to Goddard Space Flight Center (GSFC).

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
WISE	GSFC	JPL	None.
FUSE	GSFC	N/A	Johns Hopkins University
GALEX	GSFC	N/A	None.
NuSTAR	GSFC	JPL	None.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

Acquisition Strategy

Explorer projects are selected through competitive Announcements of Opportunity, from which multiple investigations are selected for initial concept studies, followed by a competitive down-select to proceed to the next stage of formulation. Investigations are selected to proceed from one phase to the next through execution of contract options, based on successful technical, cost, and schedule performance in the previous phases.

The Wide-field Infrared Survey Explorer (WISE) acquisitions are in place.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	WISE IIRT	N/A	Assembly, Test, Launch, and Operations (ATLO) Readiness Review	03/2009
Quality	Senior Review Panel	04/2006	2006: Senior Review - Comparative review of operating missions/Ranked missions in terms of science return.	04/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Cost cap	The Explorer Program funds smaller projects which, in order to keep projects within their cost caps, have less risk mitigation built into the project design. Rising launch vehicle costs increase the cost-pressure on mission design.	Technical, management, & cost risks for each investigation are carefully examined as part of the selection process; acceptable risks are documented in individual project appendices to the Explorer Program plan. All technical & programmatic risks are further reviewed as part of the preliminary design review (PDR) and project confirmation review to ensure risks have been mitigated.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Wide-Field Infrared Survey Explorer

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**99.6**	**54.1**	**71.8**	**65.2**	**13.0**	**5.2**	**1.6**	**--**	**--**	**310.5**
Formulation	99.6	--	--	--	--	--	--	--	--	99.6
Development / Implementation	--	54.1	71.8	65.2	--	--	--	--	--	191.1
Operations / Close-out	--	--	--	--	13.0	5.2	1.6	--	--	19.8
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0
FY 2008 President's Budget Request	**99.6**	**58.4**	**83.0**	**74.9**	**14.0**	**5.5**	**1.7**	**--**	**--**	**337.1**
Formulation	99.6	--	--	--	--	--	--	--	--	99.6
Development / Implementation	--	52.7	72.7	65.2	--	--	--	--	--	190.6
Operations / Close-out	--	--	--	--	13.0	5.2	1.6	--	--	19.8
Other	0.0	5.7	10.3	9.7	1.0	0.3	0.1	--	--	27.1
Changes from FY 2008 Request	**--**	**-4.3**	**-11.2**	**-9.7**	**-1.0**	**-0.3**	**-0.1**	**--**	**--**	**-26.6**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	1.4	-0.9	--	--	--	--	--	--	0.5
Operations / Close-out	--	--	--	--	--	--	--	--	--	--
Other	--	-5.7	-10.3	-9.7	-1.0	-0.3	-0.1	--	--	-27.1

Note: FY 2009 P.B.R. is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY 2008.

Explanation of Project Changes

No changes.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Wide-Field Infrared Survey Explorer

Project Purpose

The Wide-Field Infrared Survey Explorer (WISE) mission has six objectives: finding the most luminous galaxies in the universe; finding the closest stars to the Sun; detecting most main-belt asteroids larger than three kilometers; extending the 2MASS Project survey into the thermal infrared; enabling a wide variety of studies ranging from the evolution of protoplanetary debris disks to the history of star formation in normal galaxies; and providing a catalog for the James Webb Space Telescope.

Project Parameters

The single WISE instrument is a four-channel imager that will take overlapping snapshots of the sky. WISE includes: a two-stage, solid-hydrogen cryostat to cool detectors and optics; a 40-centimeter telescope and reimaging optics; and a scan mirror to stabilize the line-of-sight while the spacecraft scans the sky.

Project Commitments

WISE will launch in November 2009 on a six-month mission (with a one-month checkout) to provide an all-sky survey in the wavelengths from 3.5 to 23 microns--up to 1000 times more sensitive than the Infrared Astronomical Satellite (IRAS) survey.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Spacecraft	Ball Aerospace & Technologies Corporation	40-centimeter telescope	Same	Same
Launch Vehicle	Boeing	Delta 2	Same	Same
Science Payload	Space Dynamics Laboratory	Instrument integration and launch support	Same	Same
Mission Operations and Data Management	UCLA	N/A	Same	Same

Schedule Commitments

WISE entered development in October 2006 after an extended formulation phase. WISE is scheduled to launch in November 2009.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
Begin Development	October 2006	October 2006	Same
Assembly, Test & Launch Operations	April 2008	April 2008	Same
Launch Readiness	November 2009	November 2009	Same

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Wide-Field Infrared Survey Explorer

Development Cost and Schedule Summary

The Base Year Development Cost Estimate for WISE of $217.9.0 million has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Wide-Field Infrared Survey Explorer	2007	192.1	2008	190.9	-1	Launch Readiness	11/30/2009	11/30/2009	0

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**192.1**	**190.9**	**-1.2**
I & T Systems	5.3	4.7	-0.6
Technology Development	3.4	3.0	-0.4
Aircraft/Spacecraft	37.8	33.4	-4.4
Ground Systems	13.6	11.9	-1.7
Launch Vehicle	87.5	76.9	-10.6
Other	16.5	36.2	19.7
Payload	23.0	20.4	-2.6
Science/Technology	5.0	4.4	-0.6

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Wide-Field Infrared Survey Explorer

Project Management

The Jet Propulsion Laboratory is responsible for the Wide-field Infrared Survey Explorer project management. The Goddard Space Flight Center Program Management Council has program oversight responsibility.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	JPL	None	None
Mission operations and data analysis	JPL	JPL	None
Payload	JPL	None	None

Acquisition Strategy

The Wide-field Infrared Survey Explorer was selected competitively as part of the Explorer Announcement of Opportunity in 2002. All elements of the project were included in the competitive proposal. The cryogenic instrument is being built by Space Dynamics Laboratory; Ball Aerospace and Technologies Corporation in Colorado is building the spacecraft.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IIRT	N/A	Assembly, Test, Launch, and Operations (ATLO) Readiness Review.	03/2009
Performance	IIRT	01/2006	Review the progress and status of the WISE mission / Integrated Independent Review Team (IIRT) recommended confirmation.	N/A
Quality	IRT - Critical Design Review	08/2007	Assess the quality/viability of the the mission design.	N/A

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Inadvertent Cover Deployment	If the cover deploys other than when commanded, or doesn't deploy when commanded, the mission will not be operable.	Use of flight-proven actuators and pyro firing circuitry. Utilize the lessons learned from SPIRIT III and WIRE anomalies.

Mission Directorate: Science
Theme: Heliophysics

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**830.8**	**840.9**	**577.3**	**598.9**	**689.4**	**741.2**	**746.6**
Heliophysics Research	208.0	181.2	184.8	180.3	175.3	179.8	187.5
Living with a Star	188.6	217.1	223.8	212.0	216.6	232.8	237.5
Solar Terrestrial Probes	71.8	105.9	123.1	137.5	171.4	172.6	161.5
Heliophysics Explorer Program	74.4	61.0	41.3	66.8	125.1	156.0	160.1
New Millennium	40.8	25.8	4.3	2.2	1.1	--	--
Near Earth Networks	43.8	39.5	--	--	--	--	--
Deep Space Mission Systems (DSMS)	203.3	210.5	--	--	--	--	--
FY 2008 President's Budget Request	**1,028.1**	**1,057.2**	**1,028.4**	**1,091.3**	**1,241.2**	**1,307.5**	**--**
Heliophysics Research	221.2	206.1	188.0	201.5	192.8	207.5	--
Living with a Star	232.5	253.0	269.2	261.4	266.1	286.7	--
Solar Terrestrial Probes	88.7	126.8	125.3	114.4	181.3	181.5	--
Heliophysics Explorer Program	78.3	76.1	75.6	133.1	166.8	186.5	--
New Millennium	89.6	66.2	33.0	36.0	92.1	95.9	--
Near Earth Networks	63.7	66.0	65.2	67.2	65.6	66.9	--
Deep Space Mission Systems (DSMS)	254.2	263.0	272.1	277.7	276.5	282.4	--
Total Change from FY 2008 Request	**-197.3**	**-216.3**	**-451.1**	**-492.4**	**-551.8**	**-566.3**	**746.6**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-197.3**	**-216.3**	**-451.1**	**-492.4**	**-551.8**	**-566.3**	**746.6**
Heliophysics Research	**-20.8**	**-24.9**	**-3.1**	**-21.2**	**-17.4**	**-27.7**	**187.5**
Programmatic Content	14.5	12.2	30.3	14.1	16.1	8.2	187.5
Institutional Adjustments	-35.3	-37.1	-33.4	-35.3	-33.5	-35.9	--
Living with a Star	**-36.8**	**-36.0**	**-45.4**	**-49.4**	**-49.5**	**-54.0**	**237.5**
Programmatic Content	-1.2	10.7	3.3	-3.0	-2.7	-3.7	237.5
Programmatic Transfers	--	-0.1	--	--	--	--	--
Institutional Adjustments	-35.6	-46.6	-48.7	-46.4	-46.8	-50.3	--
Solar Terrestrial Probes	**-17.2**	**-21.0**	**-2.2**	**23.2**	**-9.9**	**-8.8**	**161.5**
Programmatic Content	-3.2	2.4	20.5	43.5	22.0	23.0	161.5
Programmatic Transfers	--	-0.1	--	--	--	--	--
Institutional Adjustments	-14.0	-23.3	-22.7	-20.3	-31.9	-31.8	--
Heliophysics Explorer Program	**-15.4**	**-15.2**	**-34.3**	**-66.2**	**-41.8**	**-30.5**	**160.1**
Programmatic Content	-1.3	2.4	2.1	15.2	18.6	9.0	160.1
Programmatic Transfers	--	-3.6	-22.7	-57.8	-31.0	-6.8	--
Institutional Adjustments	-14.2	-14.0	-13.7	-23.6	-29.4	-32.7	--
New Millennium	**-5.5**	**-40.3**	**-28.8**	**-33.8**	**-91.1**	**-95.9**	**--**
Programmatic Content	-0.7	-32.5	-25.1	-28.6	-75.8	-80.7	--
Institutional Adjustments	-4.8	-7.8	-3.7	-5.2	-15.3	-15.2	--
Near Earth Networks	**-30.3**	**-26.5**	**-65.2**	**-67.2**	**-65.6**	**-66.9**	**--**
Programmatic Content	-18.5	-14.3	-13.8	-12.7	-12.1	-12.1	--
Programmatic Transfers	--	--	-39.6	-42.6	-42.0	-43.1	--
Institutional Adjustments	-11.8	-12.2	-11.8	-11.9	-11.5	-11.7	--
Deep Space Mission Systems (DSMS)	**-71.3**	**-52.4**	**-272.1**	**-277.8**	**-276.5**	**-282.5**	**--**
Programmatic Content	--	0.2	--	--	--	--	--
Programmatic Transfers	-27.5	-29.4	-247.2	-252.6	-253.0	-259.0	--
Institutional Adjustments	-43.8	-23.2	-24.9	-25.2	-23.5	-23.5	--

Explanation of Program Changes

Heliophysics Research

Increased budgets for Sounding Rockets, Research Range and Research and Analysis to achieve a more robust level of small payload opportunities. Reduced funding for Guest Investigator program. Research Range has been transferred from Near Earth Network program to Heliophysics Research.

Living with a Star

Added funding during reprioritization of missions within Heliophysics Division, initiated study of Solar Orbiter Collaboration project, delayed formulation of Solar Sentinels, and removed funding for Space Environment Testbed (SET) activities beyond the SET-1 mission. Reinstated Geospace Mission of Opportunity with a downselect for a balloon research project called Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL). NASA is examining a cost-constrained Solar Probe mission (Solar Probe Lite) during FY 2008, FY 2009 activities will be determined as a result of these analyses. Reduced LWS Management to accommodate SMD budget priorities. Increased funding for future missions line and SDO. SDO launch delay from August 2008 to December 2008 has been approved.

Solar Terrestrial Probes

STEREO and Solar-B (Hinode) successfully launched and are in prime mission operations. Magnetospheric Multiscale (MMS) has been approved to proceed into Phase B.

Heliophysics Explorer Program

THEMIS and AIM launched successfully and are in prime mission operations. AIM has achieved minimum required mission success. SMEX Announcement of Opportunity was released in September 2007. NuSTAR (Small Explorer) and WISE were transferred to the Astrophysics Theme.

New Millennium

Launched ST-6 successfully from Wallops Flight Facility. ST-7 is completing rework after experiencing environmental test anomalies. Schedule delay has not been approved. Program Management Council decision is expected in February 2008. ST-8 was redirected to reduce scope and complete ground demonstration in FY 2008. Reduced New Millennium Program's (NMP) budget to accommodate reprioritization of programs within the Heliophysics Division.

Near Earth Networks

Transfer management and budget to Space Operations Mission Directorate.

Deep Space Mission Systems (DSMS)

Transfer management and budget to Space Operations Mission Directorate.

Mission Directorate:	Science
Theme:	Heliophysics

Theme Overview

The Sun is a magnetic star at the center of our solar system with daily-to-several day variations in magnetic activity that occur together within a 22-year cycle of activity. The short-term variations are called space weather and the long-term variability is analogous to the Earth's climate. Products from its activity--particles, radiation, and magnetic fields--extend throughout the volume of space known as the heliosphere. They can interact with planetary atmospheres and magnetic fields such as those found on the Earth and Mars and change the solar activity products inside the atmospheres. They also affect human technology including spacecraft and humans in space. The science that addresses the production and propagation of solar activity and its interactions with planets in our solar system. Compared to Earth science, Heliophysics Theme is in its infancy.

Just as we depend upon a terrestrial weather reports and knowledge of the Earth's climate to plan our days on Earth, we use space weather reports to safely and successfully explore beyond Earth and use increasingly complex technology. The Heliophysics Division strives to increase the scientific foundation of heliophysics that will lead to a reliable space weather predictive capability. It has three science and exploration objectives: understand the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium; understand how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields; and, maximize the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space.

The Heliophysics Theme makes progress on achieving its objectives as follows: collects and analyzes data from a network of heliophysics spacecraft in prime or extended operations; conducts prime operations for the Solar Terrestrial Relations Observatory and Hinode missions from the Solar Terrestrial Probes program to obtain new information about the physical processes of the Sun; develops new missions such as Magnetospheric Multiscale, Solar Dynamics Observatory, and Interstellar Boundary Explorer that will improve the data detail in areas of heliophysics that surfaced as important in prior investigations/missions; and conducts future mission pre-concept studies

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The capability for space weather prediction and knowledge of space weather effects on humans and microelectronics improves the ability to maintain telecommunications containing satellite links, to operate intelligence-gathering spacecraft, and to retain the safety of airplanes and airline crews.

Relevance to the NASA Mission and Strategic Goals:

Success in future exploration missions can only be achieved when we understand and either accommodate or mitigate the effects of space weather on the health and safety of astronauts and technological systems in the heliosphere and planetary environments.

Heliophysics programs support NASA's achievement of Sub-goal 3B.

Relevance to education and public benefits:

The ability to predict and then accommodate or mitigate space weather effects on increasingly more complex technological systems will facilitate their use for health, safety, and leisure applications.

Mission Directorate:	Science
Theme:	Heliophysics

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 3	**Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.**					
Sub Goal 3B	**Understand the Sun and its effects on Earth and the solar system.**					
Outcome 3B.1	**Progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.**		**Green**	**Green**	**Green**	**Green**
APG 9HE1	Demonstrate progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9HE2	Develop missions in support of this Outcome, as demonstrated by completing the Magnetospheric Multiscale (MMS) Spacecraft Preliminary Design Review (PDR).	Solar Terrestrial Probes				Red
APG 9HE3	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	Living with a Star				Green
APG 9HE4	Develop missions in support of this Outcome, as demonstrated by completing the Explorer down-select.	Heliophysics Explorer Program				Green
APG 9HE5	Conduct flight program in support of this outcome, as demonstrated by achieving mission success criteria for STEREO, AIM, THEMIS and IBEX.	Multiple Programs				None
Outcome 3B.2	**Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields.**		**Green**	**Green**	**Green**	**Green**
APG 9HE2	Develop missions in support of this Outcome, as demonstrated by completing the Magnetospheric Multiscale (MMS) Spacecraft Preliminary Design Review (PDR).	Solar Terrestrial Probes				Red
APG 9HE3	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	Living with a Star				Green
APG 9HE4	Develop missions in support of this Outcome, as demonstrated by completing the Explorer down-select.	Heliophysics Explorer Program				Green
APG 9HE6	Demonstrate progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9HE7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for AIM and THEMIS.	Multiple Programs				None

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome 3B.3	**Progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers.**		**None**	**None**	**Green**	**Green**
APG 9HE3	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	Living with a Star				Green
APG 9HE8	Demonstrate progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers. Progress will be evaluated by external expert review.	Multiple Programs				Green
APG 9HE9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for STEREO.	Multiple Programs				None

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Heliophysics Theme					
APG 9HE10	Complete all development projects within 110% of the cost and schedule baseline.				Yellow
APG 9HE11	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green
APG 9HE12	Peer-review and competitively award at least 95%, by budget, of research projects.				Green
APG 9HE13	Reduce time within which eighty percent of NRA research grants are awarded, from proposal due date to selection, by five percent per year, with a goal of 130 days.				Red

Performance Achievement Highlights:

NASA scientists revealed new information on the source and generation mechanisms for the electromagnetic waves responsible for the acceleration of particles to high energies near Earth. The waves are radio signals with narrow-band tones that rise in frequency over a period of a few seconds. Called the "dawn chorus," the wave signal resembles that of birds heard at a distance. Although the signals had been detected for several decades, scientists knew very little about the actual source of the dawn chorus and how the waves themselves were created. For example, a "chorus" is most often detected on Earth's morning side, but it was not clear why. By measuring tiny differences in the arrival time of chorus signals at multiple spacecraft, scientists were able to deduce that the source region is quite compact and located near the magnetic equator at distances beyond 15,000 miles. Furthermore, this region is very likely to be the source for a large class of other, but similar, wave phenomena that propagate downward to be observed as aurorae. These studies enable scientists to learn more about how radio waves propagate in an electrified gas, which will be helpful to future applications of radio technology.

A new space weather forecast method, based on data from the Solar and Heliospheric Observatory (SOHO) spacecraft, permits for the first time up to an hour of warning prior to the arrival of the most dangerous particles of a solar storm at Earth. According to radiation safety experts at Johnson Space Center, once verified, the technique may help NASA reduce the exposure to radiation by more than 20 percent compared to current methods and may allow astronauts to venture farther from shelter. Solar storms consist of electrons and ions, the latter of which pose a grave danger to space-borne electronics and to humans outside Earth's protective magnetic field. Electrons arrive first, signaling the later arrival and intensity of the ions. Previously, there was no adequate method to predict when and at what intensities the ions arrive.

For more information, see Sub-goal 3B in the FY 2007 Annual Performance Report, included in this budget.

Quality

Program Assessment Rating Tool (PART):

The Earth-Sun System Theme, which included both Heliophysics and Earth Science, was subject to a PART review in 2005 and received an "Effective" rating. The assessment found that this program is well-defined, with a clear purpose and direct ties to NASA's Mission. The Earth-Sun System is now two distinct Themes: Earth Science, which will undergo a PART review during FY 2008, and Heliophysics, which will be reviewed at a later date.

An area identified for performance improvement was the achievement of program goals within budgeted costs and established schedules. To address this, the theme will continue to report for major missions on: estimated mission life-cycle cost upon entering development; key schedule milestones associated with each mission phase for those missions formally approved for formulation; mission cost and schedule progress achieved in each phase before entering the next; and any plans to re-baseline life-cycle cost and schedule.

The life-cycle cost and schedule figures for projects in development are provided quarterly to the Office of Management and Budget and annually to the Congress as the Major Program Annual Report. NASA continues to work the process and policy to refine this reporting.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NASA Advisory Council (NAC)	10/2007	Reviews of science and program implementation strategies and relevance to the NASA strategies and goals, and program effectiveness.	TBD
Relevance	HPS	10/2007	Reviews of science and program implementation strategies and relevance to the NASA Strategies and goals, and program effectiveness. The Heliophysics Subcommittee (HPS) is part of the NAC.	TBD
Relevance	National Research Council	12/2003	Decadal review of science content and programmatic effectiveness.	2008

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**208.0**	**181.2**	**184.8**	**180.3**	**175.3**	**179.8**	**187.5**
Heliophysics Research and Analysis	**32.5**	**30.9**	**33.9**	**35.9**	**38.9**	**39.6**	**40.5**
Sounding Rockets	**31.9**	**30.2**	**45.1**	**47.3**	**48.9**	**49.7**	**51.8**
ACE	**4.6**	**5.7**	**4.0**	**3.8**	**4.0**	**4.1**	**4.2**
Operating Missions and Data Analysis	**91.5**	**81.6**	**71.5**	**62.1**	**65.0**	**67.3**	**71.4**
Research Range	**17.5**	**12.8**	**18.3**	**19.2**	**18.6**	**19.2**	**19.6**
GSFC Building Support	**30.0**	**20.0**	**12.0**	**12.0**	**0**	**0**	**0**
FY 2008 President's Budget Request	**246.1**	**221.9**	**204.8**	**216.9**	**207.4**	**222.1**	**0**
Heliophysics Research & Analysis	**36.5**	**36.8**	**37.8**	**36.3**	**36.2**	**37.1**	**0**
Sounding Rockets	**39.0**	**37.0**	**34.9**	**32.9**	**32.0**	**32.7**	**0**
Operating Missions and Data Analysis	**109.5**	**107.8**	**100.7**	**117.6**	**124.5**	**137.8**	**0**
Research Range	**24.9**	**15.8**	**16.8**	**15.4**	**14.6**	**14.6**	**0**
GSFC Building Support	**36.2**	**24.5**	**14.7**	**14.6**	**0**	**0**	**0**
Changes from FY 2008 Request	**-38.0**	**-40.8**	**-20.0**	**-36.6**	**-32.1**	**-42.3**	**187.5**

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Program Overview

The Heliophysics Research Program undertakes scientific investigations using operational space-based and suborbital platforms (surface, balloon, aircraft, and rocket). The program also funds basic research and modeling utilizing the results of the full array of NASA's missions. The program has four major components: Research and Analysis (R&A), Heliophysics Operating Missions, Sounding Rockets and Research Range, and Science Data and Computing Technology.

Research and Analysis solicits basic and applied research in support of the Heliophysics Division's objectives. The Heliophysics Operating Missions are a fleet of satellites that are making systematic measurements of the solar structure and phenomena, the solar wind and solar energetic particles, and the Sun's extensive electromagnetic fields. Sounding Rockets provide low-cost platforms that have direct access to Earth's mesosphere and lower thermosphere, so the researchers can observe the Sun's impact on those regions. The Research Range provides instrumentation for communications and metrics needed for operations of suborbital campaigns. The Science Data and Computing Technology component supports the Science Mission Directorate (SMD) endeavors in two ways, first by assuring the permanent archiving and preservation of space science data obtained from past missions, and secondly by soliciting applications of advance information science and technology to enhance science productivity.

Following the commissioning and checkout phase of the spacecraft, Headquarters management responsibility for the operational phase (Phase E) transitions to the Heliophysics Research Program.

For more information, please see http://sec.gsfc.nasa.gov/.

Program Relevance

The Heliophysics Research Program supports three main objectives of Heliophysics Science:
- Open the Frontier to Space Environment Prediction: Understand the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.
- Understand the Nature of Our Home in Space: Understand how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields.
- Safeguard the Journey of Exploration: Develop the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers.

Research into the nature of solar activity and its effects on the solar system will help safeguard the journeys of robotic and human explorers. NASA's objective is to understand and predict the causes of space weather by studying the Sun, the heliosphere, and planetary environments as a single, connected system.

The Heliophysics Research Program supports Outcomes 3B.1 through 3B.3.

Plans For FY 2009

The Research and Analysis Program will hold its annual competition for new research awards: approximately $15 million will be available for the competition resulting in approximately 90 new awards.

NASA will continue to execute space-based solar and space physics investigations and will hold its annual guest investigator competition. After ceasing operations in the spring 2008, Polar will complete the research phase of its mission in FY 2009. Ulysses will cease operations after the conclusion of its 3rd solar pass in March 2008. After an appropriate overlap with the Solar Dynamics Observatory (SDO) Project, the Transition Region and Coronal Explorer (TRACE) Project will cease operations early in FY 2009. All other missions will participate in a Senior Review in April 2008 to determine their status and funding profiles in FY 2009 and beyond.

The Sounding Rockets Program will launch approximately 20 missions, from domestic and international locations. The Research Range will provide launch instrumentation for NASA suborbital programs and projects at both local and remote locations, and upgrade the mission operations communications handsets to be compatible with Mission Operations Voice Enhancement, the new Agency standard.

Science Data and Computing Technology will continue to sustain the National Space Science Data Center and hold its annual competition for the Applied Information Systems Research where approximately $4 million will be available for new research awards.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Project Descriptions and Explanation of Changes

Research and Analysis

Research and Analysis comprises an ever-evolving suite of individual Principal Investigator-proposed investigations that cover the complete range of science disciplines and techniques essential to achieve the Heliophysics Theme's objectives.

Research and Analysis covers four elements: Geospace Science; Low-Cost Access to Space; Solar and Heliospheric Physics; and the Heliophysics Theory. Geospace Science studies the physics of magnetospheres, including their formation and fundamental interactions with plasmas, fields, and particles (Earth's magnetosphere is emphasized, but studies of the magnetospheres of planets, comets, and other primordial bodies are also supported). Geospace Science also deals with the physics of the mesosphere, thermosphere, ionosphere, and aurorae of Earth, including the coupling of these phenomena to the lower atmosphere and magnetosphere.

Low-Cost Access to Space funds science investigations that may be completed through suborbital rocket or balloon flight of experimental instrumentation, as well as proof-tests of new concepts in experimental techniques that may ultimately find application in free-flying Heliophysics space missions.

Solar and Heliospheric Physics treats the Sun as a typical star, as the dominant, time-varying source of energy, plasma, and energetic particles in the solar system (especially concerning its influence on Earth). This project investigates the origin and behavior of the solar wind, energetic particles, and magnetic fields in the heliosphere and their interaction with the interstellar medium.

The Heliophysics Theory Program supports efforts to attack problems concerning phenomena relating to the Heliophysics program using relatively large "critical mass" groups of investigators that are beyond the scope of the nominally smaller Supporting Research and Technology Programs.

Heliophysics Operating Missions

Following the commissioning and checkout phase of the spacecraft, Headquarters management responsibility for the operational phase (Phase E) transitions to the Heliophysics Research Program.

The evolving Heliophysics Operating Missions have impressive capabilities for studying the solar structure and phenomena (the SOHO, Hinode, SDO, and RHESSI missions), the resulting solar energetic particles and solar wind at 1 AU (Wind, ACE, SOHO, and STEREO missions) and in outer regions of the heliosphere (Voyager and IBEX), the terrestrial magnetospheric which responds to solar drivers (Cluster, Geotail, FAST, THEMIS, and TWINS), and the upper terrestrial atmosphere (TIMED, AIM, C/NOFS and CINDI). It is this collective asset that provides the data, expertise, and research results that contribute directly to the national goals of real time space weather predictions as well as contributing to fundamental research on solar and space plasma physics. The Guest Investigator (GI) program is a critical component of the Heliophysics Operating Missions. The GI program enables the broadest community of researchers in universities and institutions across the country to use data from the operating missions in innovative scientific research.

Sounding Rockets

The Sounding Rockets effort funds all suborbital mission activities (payload integration, launch, and mission operation) that support science investigations funded in other parts of the research program, such as the Heliophysics and Astrophysics Research and Analysis programs, as well as other NASA research benefiting from low-cost or periodic access to space such as exploration technology test and demonstration programs.

Sounding Rockets present unique low-cost platforms that provide direct access to Earth's mesosphere and lower thermosphere (40-120 kilometers) and precipitation regions of Earth's magnetosphere. Because of their short duration and access to Earth's upper atmosphere and the space environment, sounding rocket suborbital missions also enable calibration under-flights of orbital missions, repeated proof-of-concept technology demonstration missions, and valuable end-to-end space mission experience for scientists and engineers learning to develop and execute discovery-oriented orbital missions.

Science Data and Computing

Science Data and Computing includes two elements, the National Space Science Data Center (NSSDC) and administration of the Applied Information Systems Research (AISR) investigations selected under the Research Opportunities in Space and Earth Science (ROSES) NASA Research Announcements (NRA). Both are SMD-wide support activities. The NSSDC is responsible for assuring the permanent archiving and preservation of space science data from past missions, and works in federation with other distributed science data centers to provide multidiscipline data and information services to the science community. The AISR Program exploits advances in information science and technology to enhance the science productivity from SMD-sponsored missions.

GSFC Building Support

The Exploration Sciences building, currently under construction at the Goddard Space Flight Center, is a 262,500 square-foot laboratory and office building. The facility will provide state-of-the-art laboratory, support, and office space for 750 scientists. By consolidating science work groups, it is expected to increase work efficiency and scientific collaboration. The new facility will replace the 44-year old Research Projects Laboratory building and the 37-year old Space Science Data Center building, in which electrical and mechanical systems have become unreliable, impacting science functions. The buildings require extensive repairs and have high energy and operating costs. The new Exploration Sciences building will incorporate energy reducing and environmentally friendly features that will reduce overall operating costs and generate a cost savings over the life of the facility.

Research Range

The Research Range effort funds NASA's only test range, located at Wallops Flight Facility, for launch of suborbital and orbital vehicles, supporting launch operations, tracking, telemetry and command (TT&C) capabilities. The Wallops Research Range also supports a mobile TT&C capability to support launches safely from a number of launch sites worldwide, many of which have limited capabilities of their own. The NASA Research Range is one of the few ranges in the Nation to offer a mobile capability. The Range maintains it own airspace and supports a wide variety of small launch vehicles, suborbital missions, and airborne missions utilizing non-FAA-certified vehicles such as unmanned aircraft systems.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Complete planned research and analysis activities and disseminate results.	Research and Analysis, Science Data and Computing	None
Continue ops & science delivery through end of prime mission & any approved extended mission.	Operational Missions	None
Provide Sounding Rockets flights and Research Range for science experiments and communications	Sounding Rockets and Research Range	None

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Implementation Schedule

Project	Phase	Beg	End
Voyager	Tech		
	Form		
	Dev		
	Ops	Aug-77	Aug-13
	Res		Aug-14
Ulysses	Tech		
	Form		
	Dev		
	Ops	Oct-90	Mar-08
	Res		Mar-09
Geotail	Tech		
	Form		
	Dev		
	Ops	Jul-92	Jul-08
	Res		Jul-09
Wind	Tech		
	Form		
	Dev		
	Ops	Nov-94	Nov-13
	Res		Nov-14
Solar and Heliospheric Observatory (SOHO)	Tech		
	Form		
	Dev		
	Ops	Dec-95	Dec-13
	Res		Dec-14
Polar	Tech		
	Form		
	Dev		
	Ops	Feb-96	Apr-08
	Res		Dec-08
Fast Auroral Snapshot Explorer	Tech		
	Form		
	Dev		
	Ops	Aug-96	Jul-08
	Res		Mar-09
Advanced Composition Explorer (ACE)	Tech		
	Form		
	Dev		
	Ops	Aug-97	Aug-13
	Res		Aug-14
Transition Region and Coronal Explorer (TRACE)	Tech		
	Form		
	Dev		
	Ops	Apr-98	Feb-09
	Res		Jun-09
Cluster-II	Tech		
	Form		
	Dev		
	Ops	Jul-00	Jul-10
	Res		Jul-11
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED)	Tech		
	Form		
	Dev		
	Ops	Dec-01	Dec-13
	Res		Dec-14
RHESSI	Tech		
	Form		
	Dev		
	Ops	Feb-02	Feb-13
	Res		Feb-14

Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Program Management

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research and Analysis	SMD	All NASA Centers	None
Heliophysics Operating Missions	SMD	GSFC and JPL	ESA and JAXA
Sounding Rockets and Research Range	SMD	GSFC	None
Science Data and Computing	SMD	GSFC and other NASA Centers	None

Acquisition Strategy

The acquisition in the Heliophysics Research and Analysis (R&A) component are based on full and open competition. Proposals are peer reviewed and selected based on the NASA research announcement, Research Opportunities in Space and Earth Sciences (ROSES). Universities, government research labs, and industry throughout the U.S. participate in R&A research projects.

The Heliophysics Operating Missions and instrument teams were previously selected from NASA Announcements of Opportunity. The distribution of priority within the operating missions are reviewed bi-annually. This project sponsors two annual competitions in ROSES: Heliophysics Guest Investigators and Virtual Observatories for Heliophysics Data.

The prime contract for the Sounding Rockets is being re-competed during 2009. The prime contract for the Research Range is being re-competed during 2008, and the new contract will be in place at the beginning of 2009.

The Science Data and Computing component holds a competition where proposals are peer reviewed and selected based on ROSES research announcement. Universities, government research labs, and industry throughout the United States participate in Science Data and Computing Technology research projects.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	01/2001	The Research and Analysis project and the Applied Information Systems Research element of Scientific Data and Computing were reviewed in a special Senior Review of the Space Science Research Programs in 2001. SMD is in the early steps of organizing the next Senior Review for these research elements. All projects received satisfactory remarks to proceed with planned activities.	TBD
Quality	Senior Review Panel	11/2005	The missions of the Heliophysics Operating Missions had their last Senior Review in November 2005. The next Senior Review is scheduled for April 2008. The Heliophysics data centers along with the NSSDC went before a Senior Review panel in May 2006. All projects received satisfactory or excellent remarks to proceed with planned activities.	04/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Heliophysics Research Program	There is no significant risk at this time.	No mitigation is necessary.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	188.6	217.1	223.8	212.0	216.6	232.8	237.5
Solar Dynamics Observatory	144.0	90.0	24.1	14.2	14.0	14.9	14.1
Radiation Belt Storm Probes	12.9	77.7	154.4	154.7	113.4	57.9	15.8
Solar Probe	0	13.9	0	3.4	40.1	74.2	106.3
Balloon Array for Radiation - Belt Relativ	0	0	0.9	3.9	2.4	2.0	2.1
Other Missions and Data Analysis	31.7	35.5	44.4	35.8	46.8	83.8	99.2
FY 2008 President's Budget Request	232.5	253.0	269.2	261.4	266.1	286.7	0
Solar Dynamics Observatory	182.9	110.4	25.6	16.7	15.3	20.5	0
Radiation Belt Storm Probes	4.9	95.3	188.6	174.7	123.1	28.9	0
Other Missions and Data Analysis	44.6	47.3	55.0	70.0	127.7	237.3	0
Changes from FY 2008 Request	-43.9	-36.0	-45.4	-49.4	-49.5	-53.9	237.5

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Program Overview

The Living with a Star (LWS) Program seeks to improve our understanding of how and why the Sun varies, how the Earth and solar system respond, and how the variability and response affect humanity. This improved understanding of solar variability (i.e., space weather) and its effects will lead to a reliable predictive capability for space weather. This capability is essential to safe and successful future space exploration and increased use of complex technological systems to improve the safety and quality of life on the ground. LWS accomplishes its goals with a combination of new science missions and yearly science research grant opportunities to improve scientific understanding. Its first mission, the Solar Dynamics Observatory, will replace and improve upon the science of the Solar and Heliospheric Observatory (SOHO).

If approved for development, the second mission, the Radiation Belt Storm Probes (RBSP), will address the processes that accelerate and transport radiation particles by having two spacecraft make identical measurements as they transit through Earth's radiation belts in elliptical orbits on a two -year mission. The RBSP results will enable the development of models for Earth's radiation belts and for under-sampled planetary environments, such as Mars. Spacecraft and aeronautics engineers will use the models to reduce the design margins for radiation effects and to alert operators or pilots of predicted storms and ionizing radiation that could impact crew health or vehicle operations. Two missions are starting pre-formulation studies, Solar Probe and Solar Orbiter Collaboration (SPC) with the European Space Agency. Solar Probe will explore the Sun from very close range, from two to 10 solar radii, to improve our understanding of the generation and flow of the solar wind that links the Sun to the Earth and the solar system. The Solar Orbiter Collaboration will investigate the links between the solar surface, corona, and inner heliosphere from as close as 45 solar radii and image the side of the Sun not visible from Earth.

For more information, please see http://lws.gsfc.nasa.gov/.

Program Relevance

Understanding and either accommodating or mitigating the effects of space weather on the health and safety of astronauts and technological systems in the heliosphere and planetary environments will enhance opportunities for human exploration. LWS provides the capability for space weather prediction and knowledge of space weather effects on humans and microelectronics. It also improves the ability to maintain telecommunications containing satellite links, operate intelligence-gathering spacecraft, and retain the safety of aircraft.

The Living with a Star Program supports Outcomes 3B.1, 3B.2, and 3B.3.

Plans For FY 2009

1. Launch Solar Dynamics Observatory and commission spacecraft.
2. Complete Phase B for the Radiation Belt Storm Probes mission.
3. Complete Phase B for Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL), a Geospace Mission of Opportunity.
4. Select instruments for start of Phase A for the Solar Probe mission.
5. Select instruments for start of Phase A for the Solar Orbiter Collaboration.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Project Descriptions and Explanation of Changes

Solar Dynamics Observatory (SDO)

The Solar Dynamics Observatory (SDO) will investigate how the Sun's magnetic field is structured and how its energy is converted and released into the heliosphere in the forms of solar wind, energetic particles, and variations in solar irradiance. The SDO will launch in December 2008, a delay of four months, due to underestimating development time for high-performance electronic parts.

Radiation Belt Storm Probes (RBSP)

The Radiation Belt Storm Probes (RBSP) will improve the understanding of how solar storms interact with and change particles, fields, and radiation in Earth's Van Allen radiation belts and atmosphere. This knowledge could be applied to any planet in our solar system that has a magnetic core, such as Mars.

Space Environment Testbeds (SET)

The Space Environment Testbeds (SET) will improve the engineering approach to accommodate and/or mitigate the effects of solar variability on spacecraft design and operations. It has a space flight mission comprised of a testbed that will be delivered for a piggyback ride on the U.S. Air Force Deployable Structures Experiment (DSX) mission and had funded one data mining component that analyzed existing data to improve the engineering design and operations models. SET funding beyond the flight mission has been reprogrammed to other parts of the LWS Program.

Geospace Mission of Opportunity (G-MOO)

Three Geospace Mission of Opportunity selections were made for a competitive Phase A study. The proposals are from the same Announcement of Opportunity used to select the science investigations for Radiation Belt Storm Probes. This down-select, made December 5, 2007, is for a series of science instruments that will ride on a balloon-based mission, the Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL).

LWS Science

LWS science funds competitively-selected proposals that improve the understanding of the physics of the integrated system that links the Sun and its activity to the heliosphere and planetary atmospheres. This improved understanding will be achieved through data analysis to support the development of new or revised theories and models and is the precursor to a predictive space weather capability.

Solar Orbiter Collaboration (SOC)

The Solar Orbiter Collaboration (SOC) with the European Space Agency (ESA) is a cost-constrained mission wherein ESA provides the spacecraft, the ESA member states provide all but one instrument/science investigation, and the LWS Program provides the launch vehicle and one instrument/science investigation. Selection of the NASA-contributed investigation(s) will be from a focused opportunity for measurements that were prioritized by the Solar Orbiter/Solar Sentinels Joint Science and Technology Definition Team Report. Partnering opportunities with ESA Principal Investigators will also be provided through the Small Explorers Announcement of Opportunity.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

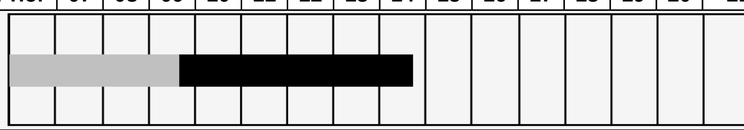
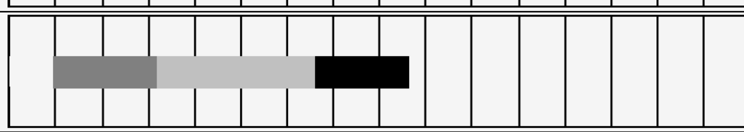
Solar Probe

NASA is examining a cost-constrained Solar Probe mission (Solar Probe Lite) that will perform the first in-situ measurements very close to the Sun, from four to ten solar radii, to improve our understanding of the generation and flow of the solar wind that links the Sun to the Earth and the solar system. The results of analyses undertaken in FY 2008 will determine FY 2009 activities.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Launch SDO for a five-year mission and commission observatory	SDO	LRD: +5 months; 5-year mission changed to TBD; cost changed by TBD
Begin implementation (Phase C/D) for RBSP	RBSP	
Complete Phase B for the Geospace-Mission of Opportunity	G-MOO	Down-selected BARREL in December 2007
Select instruments for the Solar Orbiter Collaboration	SOC	New

Implementation Schedule

Project	Schedule by Fiscal Year (Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21)	Phase	Beg	End
SDO		Tech		
		Form	Aug-02	Jul-04
		Dev	Jul-04	May-09
		Ops	Jun-09	May-14
		Res		
RBSP		Tech		
		Form	Sep-06	Dec-08
		Dev	Jan-09	May-12
		Ops	Jun-12	May-14
		Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Program Management

The Agency Program Management Council has oversight for the LWS program. GSFC is the managing center for the program. Missions are implemented by GSFC or Johns Hopkins University-Applied Physics Laboratory (JHU-APL).

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
SDO	GSFC	GSFC	
RBSP	JHU/APL		National Reconnaissance Office (NRO)
G-MOO (BARREL)	GSFC	GSFC	TBD
Solar Probe	TBD	TBD	TBD
SOC	TBD	TBD	TBD

Acquisition Strategy

LWS missions will be managed either by Goddard Space Flight Center (GSFC) or by Johns Hopkins University - Applied Physics Laboratory (JHU-APL). All missions will report to GSFC as the managing center for the program. The Science Mission Directorate Associate Administrator will determine which organization will manage each mission, and whether the spacecraft will be procured or built in-house at the managing organization for the mission. The Solar Dynamics Observatory launch vehicle and two instruments were selected through full and open competition, and one instrument is being provided sole-source from Lockheed-Martin. The spacecraft is an in-house build at GSFC.

Four instruments for the Radiation Belt Storm Probes (RBSP) were selected through full and open competition, and one instrument was obtained by partnering with the National Reconnaissance Office. The launch vehicle will be selected through full and open competition, and the spacecraft is an in-house build at JHU/APL.

The G-MOO was selected through full and open competition through the same solicitation as the RBSP instruments.
Solar Probe will continue being studied in preparation for the selection of science investigations. NASA-led Solar Orbiter Collaboration (SOC) instruments are to be selected using full and open competition as will the Solar Probe Lite (SPL) and SOC launch vehicles. No decision has been made regarding the acquisition of the Solar Probe spacecraft.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	LWS Independent Review Team	09/2006	Assess program status/acceptability to proceed	09/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Launch vehicle cost and availability	Availability and increased cost for launch vehicles may reduce content of science missions.	Maintain knowledge of launch vehicle availability and costs; use knowledge in any rebaselining or planning of follow-on missions.
Uncertainty in mission environments	Uncertainties in the definitions of the mission environments introduce uncertainties in the mission lifetimes and reliabilities.	Add design margin, redundancy, testing, and error detection and correction techniques to reduce uncertainties in lifetime and increase reliability.
Uncertainty in partner funding and readiness	Uncertainty in the availability of funding and resources to have contribution available as agreed to may change the cost and schedule for NASA contribution.	Monitor changes to partner schedule and resources and communicate frequently to minimize impacts to the NASA contribution.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**474.8**	**144.0**	**90.0**	**24.1**	**14.2**	**14.0**	**14.9**	**14.1**	**8.6**	**798.5**
Formulation	85.8	--	--	--	--	--	--	--	--	85.8
Development / Implementation	389.0	144.0	90.0	--	--	--	--	--	--	623.0
Operations / Close-out	--	--	--	24.1	14.2	14.0	14.9	14.1	8.6	89.9
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.2
FY 2008 President's Budget Request	**474.8**	**182.9**	**110.4**	**25.6**	**16.7**	**15.3**	**20.5**	**--**	**30.7**	**876.9**
Formulation	85.8	--	--	--	--	--	--	--	--	85.8
Development / Implementation	389.0	151.8	90.1	--	--	--	--	--	--	630.9
Operations / Close-out	--	--	--	20.9	13.7	12.5	16.9	--	25.3	89.3
Other	0.0	31.1	20.3	4.7	3.0	2.8	3.6	--	5.4	70.9
Changes from FY 2008 Request	**--**	**-39.0**	**-20.4**	**-1.6**	**-2.4**	**-1.3**	**-5.6**	**14.1**	**-22.2**	**-78.3**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	-7.8	-0.1	--	--	--	--	--	--	-7.9
Operations / Close-out	--	--	--	3.2	0.5	1.5	-2.0	14.1	-16.7	0.6
Other	--	-31.2	-20.3	-4.8	-2.9	-2.8	-3.6	0.0	-5.5	-71.0

Note: FY 2009 President's Budget Review is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY2008.

Explanation of Project Changes

SDO encountered technical problems in the development of high performance parts. Due to these problems, SDO was rebaselined in October 2007 with a cost increase of $18.1 million and a delay in the launch readiness date of four months.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Project Purpose

The Solar Dynamics Observatory (SDO) is the first mission for the Living With a Star (LWS) Program. It will investigate how the Sun's magnetic field is structured and how its energy is converted and released into the heliosphere in the forms of solar wind, energetic particles, and variations in solar irradiance. Scientists will analyze SDO data to improve the science needed to enable space weather predictions. The five-year prime life is designed to provide measurements over a substantial portion of the solar cycle.

Project Parameters

The SDO satellite will be placed into an inclined geosynchronous orbit to allow for a nearly-continuous observation of the Sun, a high-science data downlink rate, and contact with a single, dedicated, ground station. The combined data from the satellite and the three science instruments--the Helioseismic and Magnetic Imager (HMI), the Extreme Ultraviolet Variability Experiment (EVE), and the Atmospheric Imaging Assembly (AIA)--will require a downlink rate of 1.4 terrabytes per day.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Project Commitments

SDO will launch in December 2008 to begin a five-year prime mission in geosynchronous Earth orbit. The mission received approval to delay the launch date from August 2008 to December 2008.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Helioseismic and Magnetic Imager (HMI)	Stanford University	Resolution of 1 arc-second, with noise level <= 40 meters per second and 25 Gauss respectively: obtain full-disk photospheric velocity and longitudinal magnetic field measurements every 60 seconds.	Same	Same
Atlas V Evolved Expendable Launch Vehicle (EELV)Vehicle	KSC and Lockheed Martin	Deliver a 3,200 kg spacecraft to geosynchronous transfer orbit at about 2,500 km altitude.	Same	Same
Spacecraft	GSFC	Deliver high-rate data from instrument to ground station with a high accuracy for 5 years.	Same	Same
Atmospheric Imaging Assembly (AIA)	Lockheed Martin Solar Astrophysics Laboratory	Field-of-view of 40 arc-minutes in 1 chromospheric, 3 coronal wavelength bands with 1.2 arc-second resolution, and a cadence of 4 images every 10s: obtain full-disk images of the solar atmosphere.	Same	Same
Extreme Ultraviolet Variability Experiment (EVE)	University of Colorado	Make hourly solar spectral irradiance measurements in 6 emission lines at resolution of 0.2 nanometers, and measure Helium II emission line with resolution of 5 nanometers.	Same	Same
Ground System	GSFC	Transmit 1.3 MB/sec of Ka-band science data to the scientists and have 30-day backup ground storage.	Same	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Schedule Commitments

The Solar Dynamics Observatory (SDO) Project was authorized to begin Formulation in August 2002. It was initially confirmed to begin Phase B in October 2003. After an independent review coincident with the project's Preliminary Design Review, the NASA Program Management Council confirmed the SDO Project to begin development in July 2004.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
Begin Implementation	July 2004	Same	Same
Critical Design Review	February 2005	April 2005	Same
Complete Spacecraft Structure	January 2006	March 2006	Same
Deliver Science Instruments to Spacecraft	February 2007	Same	November 2007
Launch Readiness	April 2008	August 2008	December 2008

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Development Cost and Schedule Summary

The Base Year Development Cost Estimate for SDO of $652.7M has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Solar Dynamics Observatory (SDO)	2006	623.7	2008	641.4	3	Launch Readiness	8/30/2008	12/30/2008	4

Development Cost Details

The Base Year Development Cost Estimate for Solar Dynamics Observatory (SDO) of $652.7M has been adjusted in the following two tables to reflect the change in this document to Direct Dollars for Fiscal Year 2007 forward in order to provide an accurate comparison to the Current Year Development Cost Estimate. The Current Year Development Cost Estimate may differ from the Budget Request table since these estimates were developed prior to passage of the 2008 Omnibus Appropriations Act.

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**623.7**	**641.4**	**17.7**
Spacecraft	234.1	151.4	-82.7
Payload	181.8	155.9	-25.9
I & T	0.0	5.4	5.4
Launch Vehicle	120.6	108.7	-11.9
Ground System	69.7	45.2	-24.5
Science / Technology	0.0	0.0	0.0
Other	17.5	174.8	157.3
Reserve	0.0	0.0	0.0

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Project Management

The spacecraft will be built in-house at Goddard Space Flight Center (GSFC). GSFC is also responsible for management, design, integration, test, and operations. The Heliophysics Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Helioseimic and Magnetic Imager (HMI)	n/a	None	None
EELV	KSC	KSC	None
Spacecraft design, integration, and test	GSFC	GSFC	None
Atmospheric Imaging Assembly (AIA)	GSFC	None	None
Extreme Ultraviolet Variability Experiment (EVE)	GSFC	None	None
Mission Operations	GSFC	GSFC	None

Acquisition Strategy

The SDO spacecraft and ground system are being designed, developed, and tested in-house at GSFC using a combination of GSFC civil servants and local task contractors. The acquisition of sub-contracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the SDO Procurement Office. The ground system components include a dedicated ground station antenna/facility and science data distribution system at White Sands, New Mexico, and a mission operations center at GSFC. The EVE and HMI science investigations were procured through the Announcement of Opportunity (AO) process. The AIA was obtained through a Justification for Other Than Full and Open Competition using unusual and compelling urgency after one investigation that was initially selected from the AO was not confirmed to begin Phase B.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	LWS Independent Review Team	07/2007	Assess project status/recommend revised LRD and $18.1M increase	07/2008

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Operations in Radiation Environment	Mission lifetime and reliability may be limited due to the severe ionizing radiation environment in geosynchronous Earth orbit (GEO).	Develop and verify requirements for operation in GEO that begin at the materials and component levels and continue through the level of the entire observatory.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Radiation Belt Storm Probes (RBSP)

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	**12.9**	**77.7**	**154.4**
FY 2008 President's Budget Request	**4.9**	**95.3**	**188.6**
Total Change from 2008 President's Budget Request	**8.0**	**-17.6**	**-34.2**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Project Purpose

The Radiation Belt Storm Probes (RBSP) mission will improve our understanding of how solar storms interact with and change the particles, fields, and radiation in the Earth's Van Allen radiation belts and atmosphere. The mission results will be applicable to any planet in our solar system, with a magnetic core, such as Mars.

The solar wind, produced by the Sun's activity, transports heat, electric and magnetic fields, and high energy ions and electrons throughout the solar system; the energy is high enough to be categorized as ionizing radiation. The heat, fields, ions, and electrons in the solar wind are drawn into the Earth's magnetic field at the Earth's poles, and interact with the Earth's magnetosphere. When a solar flare or storm occurs, i.e., space weather, the solar wind and hence the magnetosphere can change very quickly if the flare is directed toward the Earth. This space weather can affect the operations of technological systems with sensitive microelectronics (such as telecommunications with satellite links, spacecraft, and aircraft) and humans in space. Understanding the science associated with the solar wind and the planet's fields and atmosphere is a necessary precursor to developing a predictive space weather capability.

Project Preliminary Parameters

The RBSP mission is comprised of two identical spacecraft in elliptical, low-inclination orbits that travel independently through the Earth's radiation belts to distinguish time and space variations in the measured ions, electrons, and fields. The mission design lifetime of two years is a design challenge due to the high-radiation environment approximately of 100 kilorads behind 220 mils of aluminum. The two spacecraft are in close proximity at times and are operated separately.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Radiation Belt Storm Probes (RBSP)

Estimated Project Deliverables

The Radiation Belt Storm Probes (RBSP) project will launch two identical spacecraft in 2012 to begin a two-year prime mission in geosynchronous transfer Earth orbit.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
EELV	KSC	Deliver a spacecraft to operational orbit	New	Same
Energetic Particle, Composition and Thermal Plasma (ECT)	Boston University	Measure the electron & ion spectra & composition to understand the electron & ion changes	New	Same
Radiation Belt Science of Protons, Ion Composition and Electrons (RBSPICE)	New Jersey Institute of Technology	Measure the ring current in the magnetosphere during geomagnetic storms	New	Same
Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS)	University of Iowa	Measure the magnetic fields & plasma waves	New	Same
Electric Field and Search Coil (EFASC)	University of Minnesota	Measure the electric fields for particles in the radiation belts	New	Same
Relativistic Proton Spectrometer (RPS)	National Reconnaissance Office	Measure the inner Van Allen belt protons	New	Same
Spacecraft	JHU-APL	Operate science instruments in high radiation; transmit science data to ground	New	Same
Ground System	JHU-APL	Receive science data from two spacecraft; distribute to investigators	New	Same

Estimated Project Schedule

The RBSP project was authorized to begin formulation in September 2006 when the selections for science investigations were announced. It is scheduled to be initially confirmed to begin Phase B in FY 2008. The Authority to Proceed (ATP) Baseline will be established when the Science Mission Directorate's Program Management Council reviews the findings from the Non-Advocate Review (NAR) and approves the project to begin development.

Milestone Name	Formulation Agreement Estimate	FY 2008 PB Request	FY 2009 PB Request
Formulation			
Begin Formulation	Sept. 2006	Same	June 2005
Initial Confirmation Review	Jan. 2008	Same	December 2007
Begin Implementation	Jan. 2009 (Preliminary)	Same	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Radiation Belt Storm Probes (RBSP)

Project Management

GSFC will provide oversight and the science management of data analysis through Phase E.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Ground Systems	GSFC	None	None
Data Analysis	GSFC	GSFC	National Reconnaissance Office, various international participants
Instrument Development	GSFC	None	National Reconnaissance Office
Spacecraft design, integration with instrument, and test	GSFC	None	National Reconnaissance Office
Mission Operations	GSFC	None	None
Expendable Launch Vehicle	KSC	TBD	None

Acquisition Strategy

The RBSP spacecraft and ground system is being designed, developed, and tested at the JHU-APL. The acquisition of sub-contracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the JHU-APL Procurement Office.

Instrument development participants include the University of Iowa, University of Minnesota, New Jersey Institute of Technology, and Boston University, as well as contributions from the National Reconnaissance Office and the Czech Republic.

The ground system components will be defined during the definition phases (Phases A and B) and will include a mission operations center at the JHU-APL.

The Energetic Particle, Composition and Thermal Plasma (ECT), Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS), Electric Field and Search Coil (EFASC), and Radiation Belt Science of Protons, Ions, Composition, and Electrons (RBSPICE) science investigations were procured through the Announcement of Opportunity process, and the operations phase (Phase E) contracts will be managed by GSFC. The Radioisotope Power System (RPS) instrument is being obtained through an agreement with the National Reconnaissance Office.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	LWS Standing Review Board	10/2007	Assess project status. Ready to enter into Phase B	11/2008

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Radiation Belt Storm Probes (RBSP)

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Operations in Radiation Environment	Mission lifetime and reliability may be limited due to the severe ionizing radiation environment through which the spacecraft will operate	Develop and verify requirements for operation in the radiation environment that start at the materials and component levels and continue through the level of the entire spacecraft observatories.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**71.8**	**105.9**	**123.1**	**137.5**	**171.4**	**172.6**	**161.5**
Magnetospheric Multiscale	**31.1**	**73.2**	**94.6**	**116.0**	**149.3**	**148.8**	**137.5**
Other Missions and Data Analysis	**40.7**	**32.7**	**28.5**	**21.5**	**22.0**	**23.9**	**24.1**
FY 2008 President's Budget Request	**88.7**	**126.8**	**125.3**	**114.4**	**181.3**	**181.5**	**0**
Magnetospheric Multiscale	**45.2**	**84.5**	**91.1**	**100.9**	**176.4**	**172.0**	**0**
Other Missions and Data Analysis	**43.5**	**42.3**	**34.2**	**13.5**	**4.9**	**9.5**	**0**
Changes from FY 2008 Request	**-16.9**	**-20.9**	**-2.2**	**23.1**	**-10.0**	**-8.9**	**161.5**

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

The primary goal of the Solar Terrestrial Probes (STP) Program is to explore the Sun-solar system connection to understand the sun and its effects on Earth, the solar system, and on the space environment conditions that will be experienced by explorers. To accomplish this overarching goal, STP investigations focus on specific scientific areas required to advance our fundamental understanding of the Sun-solar system connection. Successive STP missions target the "weakest links" in the chain of understanding how plasma processes operate from the Sun to the Earth's space environment. STP missions will address processes such as the variability of the Sun, the responses of the planets to these variations, and the interaction of the Sun and solar system. STP missions are strategically defined and investigations are competitively selected. Strategic mission lines afford the space physics community the opportunity to plan specific missions to address research focus areas and thus make significant progress in elucidating the fundamental processes of the coupled Sun-solar system connection. Following the commissioning and checkout phase of the spacecraft, Headquarters management responsibility for the operational phase (Phase E) transitions to the Heliophysics Research Program.

For more information please see Solar Terrestrial Probes Program at: http://stp.gsfc.nasa.gov/.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

Program Relevance

The Solar Terrestrial Probes missions study the Sun, the heliosphere, and planetary environments as elements of a single interconnected system. Each STP mission responds to at least one of the three Heliophysics Division science and exploration objectives:

- Understand the fundamental physical processes of the space environment;
- Understand how humans, technology, and habitability of planetary exploration are affected by solar variability; and
- Maximize the safety and productivity of explorers by developing the capability to predict space weather.

Understanding our space environment to the point of prediction also contributes to developing future operational systems that support the needs of our increasingly technological society.

The program supports Strategic Plan Subgoal 3B: Understand the Sun and its effects on Earth and the solar system, and, more specifically, Outcomes 3B.1, 3B.2, and 3B.3, which correspond to the objectives above.

Plans For FY 2009

Magnetospheric Multiscale to complete spacecraft Preliminary Design Review (PDR).

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

Project Descriptions and Explanation of Changes

Solar TErrestrial RElations Observatory (STEREO)

Launched on October 25, 2006, the Solar TErrestrial RElations Observatory (STEREO) is a two-year mission employing two nearly identical observatories to provide three-dimensional measurements of the Sun to study the nature of coronal mass ejections. These powerful eruptions are a major source of the magnetic disruptions on Earth and a key component of space weather, which can greatly affect satellite operations, communications, power systems, the lives of humans in space, and global climate.

Magnetospheric Multiscale (MMS)

A four-spacecraft mission launch planned for no earlier than 2014 with a two-year mission life, Magnetospheric Multiscale (MMS) is designed to study magnetic reconnection in key boundary regions of the Earth's magnetosphere. Reconnection is a fundamental process that occurs throughout the universe. The best laboratory for understanding it is the Earth's magnetosphere where reconnection powers storms and substorms. The spacecraft will probe the regions of geospace most critical to measuring reconnection. Additional detail can be found in the Magnetospheric Multiscale Project section of this document.

Solar B (Hinode)

Hinode launched on September 22, 2006, from Japan's Uchinoura Space Center to begin its three-year mission is to explore the magnetic fields of the Sun. A follow-on to the highly successful Japan/US/UK Yohkoh (Solar-A) satellite that operated between 1991 and 2001, Hinode consists of a coordinated set of optical, Extreme-Ultraviolet (EUV), and X-ray instruments that will investigate the interaction between the Sun's magnetic field and its corona. The result will be an improved understanding of the mechanisms that power the solar atmosphere and drive solar eruptions. NASA developed three science instrument components: the Focal Plane Package (FPP), the X-Ray Telescope (XRT), and the Extreme Ultraviolet Imaging Spectrometer (EIS) and will share operations support for science planning and instrument command generation activities.

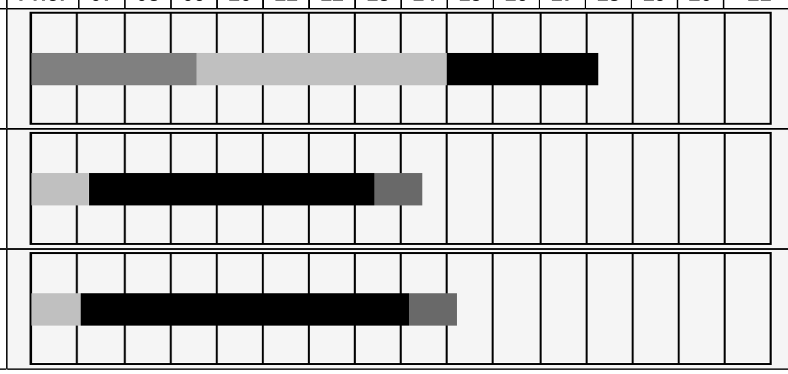
Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Observe ~ 50 Coronal Mass Ejections (CMEs) and 24 inter-planetary events over a 2 year period.	STEREO	Same
Complete MMS Spacecraft PDR	MMS	New
Measure Sun's magnetic field and ultraviolet/x-ray radiation over a 3 year period.	Solar B (Hinode)	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

Implementation Schedule

Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21



Project	Phase	Beg	End
Magnetospheric Multiscale (MMS)	Tech		
	Form	May-02	Apr-09
	Dev	Apr-09	Oct-14
	Ops	Oct-14	Dec-17
	Res		
STEREO	Tech		
	Form	May-01	Mar-02
	Dev	Mar-02	Jan-07
	Ops	Jan-07	Feb-13
	Res		Feb-14
Solar-B (Hinode)	Tech		
	Form	Dec-98	Nov-00
	Dev	Nov-00	Nov-06
	Ops	Nov-06	Nov-13
	Res		Nov-14

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

Program management responsibility for the STP Program is assigned to GSFC.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
STEREO	GSFC		United Kingdom
MMS	GSFC	GSFC	
Solar B (Hinode)	MSFC	MSFC	JAXA

Acquisition Strategy

The STP uses full and open competitions to the greatest extent possible for the acquisition of scientific instruments, spacecraft, and science investigations, including research and analysis. Certain instruments, missions or mission systems may be acquired without competitions, e.g., through international partnerships, provided there is a clear scientific or technological benefit to NASA. Missions may be implemented in the "out-of-house" or "PI-mode" where the entire mission is acquired through full and open competition. This strategy varies by project.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	07/2006	Overall assessment of life cycle cost, schedule and deliverables of the STP Program. Outcome was favorable and no programmatic changes were recommended.	07/2008

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Formulation:	Magnetospheric Multiscale (MMS)

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	**31.1**	**73.2**	**94.6**
FY 2008 President's Budget Request	**45.2**	**84.5**	**91.1**
Total Change from 2008 President's Budget Request	**-14.0**	**-11.3**	**3.5**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Project Purpose

The Magnetospheric Multiscale (MMS) Project will use four identically instrumented spacecraft to perform the first definitive study of magnetic reconnection in space. Reconnection occurs in all astrophysical plasma systems but can be studied efficiently only in the Earth's magnetosphere. It is thought to be of great importance for energy transfer throughout the universe and is an efficient and fast acceleration mechanism. Reconnection is the primary process by which energy is transferred from the solar wind to Earth's magnetosphere and is the critical physical process determining the size of a space weather geomagnetic storm. MMS will determine why magnetic reconnection occurs, where it occurs, how it varies, how magnetic energy is coupled into heat and particle kinetic energy, and how this energy is coupled into the surrounding plasma. For more information see: http://stp.gsfc.nasa.gov/missions/mms/mms.htm.

Project Preliminary Parameters

The MMS instrument payload will measure electric and magnetic fields and plasmas within the small-scale diffusion regions where magnetic reconnection occurs. High-temporal and -spatial resolution measurements will permit direct observation of the microphysical processes that allow it to proceed. The four spacecraft and instrument suites have identical design requirements. A two-phase, low-inclination orbit will probe both the dayside magnetopause and the magnetotail neutral sheet where reconnection is known to frequently occur. The primary target of Phase 1 is the dayside magnetopause reconnection region. Phase 2 will focus on the near-Earth neutral line in the magnetotail. The four spacecraft will fly in a tetrahedron formation and the separation between the observatories will be adjustable over a range of 10 to 400 kilometers during science operations and within the area of interest. The mission design life is two years after spacecraft checkout and full commissioning of the instruments.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Formulation:	Magnetospheric Multiscale (MMS)

Estimated Project Deliverables

NASA plans to launch four identically-instrumented spacecraft on an Evolved Expendable Launch Vehicle (EELV) into a highly elliptical Earth orbit in October 2014 and begin two years of scientific measurements that will enable an understanding of fundamental plasma physics processes associated with magnetic reconnection.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
EELV	TBD	Deliver ~4,000-kg payload consisting of 4 observatories to a highly elliptical Earth orbit.	Same	Same
Ground Systems	GSFC	Provide during operations minimum science data payback of ~4 Gbits of data per observatory each day.	Same	Same
Spacecraft	GSFC	Deliver high-rate data from instruments to ground station with a high accuracy for 2 years	Same	Same
Electric Field Instruments	Southwest Research Institute	Provide measurements of electric fields (time resolution 1 ms).	Same	Same
Plasma Wave Instruments	Southwest Research Institute	Provide plasma wave measurements (electric vector to 100 KHz).	Same	Same
Energetic Particle Instruments	Southwest Research Institute	Provide high-resolution measurement of energetic particles	Same	Same
Electron and Ion Plasma Spectrometer Instruments	Southwest Research Institute	Three-dimensional measurements of hot plasma composition (time resolution 10s).	Same	Same
Magnetic Field Instruments	Southwest Research Institute	Provide measurements of magnetic fields (time resolution 10 ms)	Same	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Formulation:	Magnetospheric Multiscale (MMS)

Estimated Project Schedule

Magnetospheric Multiscale (MMS) began formulation in 2002 and the project's Initial Confirmation Review was held in November 2007 and approved. The Non-Advocate and Confirmation Reviews are planned for 2009.

Milestone Name	Formulation Agreement Estimate	FY 2008 PB Request	FY 2009 PB Request
Formulation			
Mission Definition Review	September 2007	Same	Same
Initial Confirmation Review	November 2007	Same	November 2007
Confirmation Review (Preliminary Date)	April 2009	Same	Same
Launch (Preliminary Date)	October 2014	Same	Same

Project Management

The Goddard Space Flight Center (GSFC) has program management responsibility for the Solar Terrestrial Probes Program and Project Management responsibility for the MMS project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Four Instrument Suites	GSFC	None	Austrian Space Agency, Sweden (SNSB), and France (CNES), and Japan (JAXA)
EELV	KSC	TBD	None
Four Spacecraft	GSFC	GSFC	None
Mission Operations	GSFC	GSFC	None

Acquisition Strategy

The instrument suite was acquired via a competitive Announcement of Opportunity process. A cost plus-fixed fee contract was awarded to the instrument suite team led by the Principal Investigator at Southwest Research Institute (SWRI) to work with GSFC in mission formulation. GSFC is building the four spacecraft in-house. GSFC is also responsible for operating the MMS observatories and managing the Mission Operations Center. SWRI is also responsible for the Science Operations Center at LASP, Colorado. The Evolved Expendable Launch Vehicle (EELVO), Atlas V or Delta IV, will be acquired via competitive process by the Kennedy Space Center (KSC).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	IPAO	09/2007	To assess MMS readiness to proceed into Phase B	02/2009

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	74.4	61.0	41.3	66.8	125.1	156.0	160.1
Interstellar Boundary Explorer	45.1	30.8	9.5	6.9	1.0	0	0
Other Missions and Data Analysis	29.3	30.2	31.8	60.0	124.1	156.0	160.1
FY 2008 President's Budget Request	78.3	76.1	75.6	133.1	166.8	186.5	0
Interstellar Boundary Explorer	48.3	37.8	11.6	8.3	1.2	0	0
Other Missions and Data Analysis	30.0	38.3	64.0	124.7	165.7	186.5	0
Changes from FY 2008 Request	-3.8	-15.1	-34.3	-66.2	-41.7	-30.5	160.1

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

The mission of the Heliophysics Explorer Program is designed to provide frequent flight opportunities for world-class astrophysics and space physics investigations, using innovative, streamlined and efficient management approaches to spacecraft development and operations. The Heliophysics Explorer Program is composed of an on-going series of space science missions that are independent, but share a common funding and management structure. The program emphasizes missions that can be accomplished under the control of the scientific research community and seeks to control total mission life-cycle costs. The program also seeks to enhance public awareness of, and appreciation for, space science and to incorporate educational and public outreach activities. The Medium-Class Explorers (MIDEX) project provides flight opportunities for focused science missions. The Small Explorer (SMEX) project provides frequent flight opportunities for highly focused and relatively inexpensive missions. Mission of Opportunity (MO) space science investigations are flown as part of a non-NASA space mission. MOs are conducted on a no-exchange-of-funds basis with the organization sponsoring the mission.

Following the commissioning and checkout phase of the spacecraft, HQ management responsibility for the operational phase (Phase E) transitions to the Heliophysics Research Program.

The Heliophysics Explorer Program currently has Interstellar Boundary Explorer, Coupled Ion Neutral Dynamics Investigation, and Two Wide-angle Imaging Neutral-atom Spectrometers B in development within the Heliophysics Division. Two Explorer missions, Widefield Infrared Survey Explorer and the Nuclear Spectroscopic Telescope Array, are incorporated into the Astrophysics Division budget and details can be found there.

For information is http://explorers.gsfc.nasa.gov/missions.html.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Program Relevance

Numerous U.S. and cooperative international scientific space Explorer missions have made impressive discoveries ranging from Earth's magnetosphere and the shape of its gravity field to gamma ray astronomy. Some Explorer spacecraft have even traveled to other planets, and some have monitored the Sun.

The Heliophysics Explorer Program supports Outcomes 3B.1 and 3B.2.

The program also works to incorporate education and public outreach activities as an integral part of its space science investigations to enhance public awareness of, and appreciation for, space science.

Plans For FY 2009

The Heliophysics Explorer Program developed a Small Explorer Announcement of Opportunity (AO) in FY 2007. The mission down-select from this AO will be conducted FY 2009.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Project Descriptions and Explanation of Changes

Aeronomy of Ice in Mesophere (AIM)

The primary objective of the Aeronomy of Ice in Mesophere (AIM) mission is to understand why polar mesospheric clouds (PMCs) form and why they vary. AIM will study the microphysics of polar mesospheric clouds, as well as the environment in which they form. AIM will also determine the causes of Earth's highest-altitude clouds, which form in the coldest part of the atmosphere about 50 miles above the polar regions every summer. AIM launched on April 25, 2007, on board a Pegasus XL from Vanderberg Air Force Base into a Sun-synchronous orbit at 600 kilometers. Hampton University will maintain operations for two years. This mission is supplying spectacular data which is leading to new science discoveries. The discoveries were reported at the American Geophysical Union 2007 Fall Meeting.

Interstellar Boundary Explorer (IBEX)

The Interstellar Boundary Explorer (IBEX) will detect for the first time the edge of the solar system, study galactic cosmic rays, and energetic particles from beyond the solar system that pose health and safety hazards for humans exploring beyond Earth's orbit. As the solar wind from the Sun flows out beyond Pluto, it collides with the material between the stars, forming a shock front. IBEX contains two neutral atom imagers that are designed to detect particles from the termination shock at the boundary between the solar system and interstellar space. IBEX will make these observations from a highly elliptical orbit that takes it beyond the interference of Earth's magnetosphere. IBEX will be launched on a Pegasus XL from Kwajalein in June 2008. Southwest Research Institute will maintain operations for two years.

Time History of Events and Macroscale Interactions during Substorms (THEMIS)

The Time History of Events and Macroscale Interactions during Substorms (THEMIS) Project will lead to the understanding of the onset and evolution of magnetospheric substorms. NASA's THEMIS mission will use five identical micro-spacecraft (probes) to answer fundamental outstanding questions regarding magnetospheric substorm instability, a dominant mechanism of transport and explosive release of solar wind energy within geospace. THEMIS will also employ a dense network of ground observatories to time known plasma particles and fields signatures in Earth's magnetotail, relative to substorm onset. In addition to addressing its primary objective, THEMIS answers critical questions in radiation belt physics and solar wind-magnetosphere energy coupling. THEMIS is a Medium-Class Explorers (MIDEX) mission that launched on February 17, 2007, from Cape Canaveral, Florida, on board a Delta II rocket. The University of California, Berkeley will maintain operations of the five satellites for two years. The mission is supplying spectacular data which is leading to new science discoveries. The discoveries were reported at the American Geophysical Union 2007 Fall Meeting.

Coupled Ion-Neutral Dynamics Investigation (CINDI)

The Coupled Ion-Neutral Dynamics Investigation (CINDI) is a NASA-sponsored Mission of Opportunity (MO) conducted by the University of Texas at Dallas (UTD). CINDI will discover the role of ion-neutral interactions in the generation of small- and large-scale electric fields in Earth's upper atmosphere. Ion-neutral interactions are a key process in controlling the dynamics of all planetary atmospheres and their understanding is important to describing the electrodynamic connections between the Sun and the upper atmosphere. CINDI is carried out as an enhancement to the science objectives of the Communication/Navigation Outage Forecast System (C/NOFS) undertaken by the Air Force Research Laboratory (AFRL) and the Space and Missile Command Test and Evaluation Directorate (SMC/TEL). In addition, the CINDI instruments will provide measurements of the three-dimensional neutral winds and ion drifts. CINDI will operate for at least two years, and during this time its science investigations will provide essential input to real-time specification and prediction models being developed by C/NOFS. This synergistic relationship optimizes the productivity and resources for the CINDI mission. This mission is scheduled to launch in June 2008.

Two Wide-angle Imaging Neutral-atom Spectrometers (TWINS-B)

The Two Wide-angle Imaging Neutral-atom Spectrometers (TWINS-B) will provide the second half of the stereo imaging capability of Earth's magnetosphere. This region surrounding the planet is controlled by its magnetic field and contains the Van Allen radiation belts and other energetic charged particles. TWINS-B will enable three-dimensional global visualization of this region, which will lead to a greatly enhanced understanding of the connections between different regions of the magnetosphere and their relation to the solar wind. TWINS-B will fly as a NASA-sponsored Mission of Opportunity in the first quarter of 2008.

Explorer Program Management and Future Missions

Explorer Program Management and Future Missions funds the project selections for future Medium-Class Explorers (MIDEX), Small Explorers (SMEX), and Missions of Opportunity (MO).

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Conduct down-select of SMEX AO	Up to three SMEX missions: SMEX -12, -13, -14	New

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Implementation Schedule

Project	Phase	Beg	End
AIM	Tech		
	Form	Jul-02	Apr-04
	Dev	Apr-04	May-07
	Ops	May-07	May-13
	Res		May-14
IBEX	Tech		
	Form	Jan-05	Mar-06
	Dev	Mar-06	Jul-08
	Ops	Jul-08	Jul-10
	Res		
THEMIS	Tech		
	Form	Oct-02	Apr-04
	Dev	Apr-04	Aug-07
	Ops	Aug-07	Aug-13
	Res		Aug-14
CINDI	Tech		
	Form	Sep-00	Nov-01
	Dev	Nov-01	Jul-08
	Ops	Jul-08	Jul-10
	Res		
TWINS-B	Tech		
	Form		
	Dev	Apr-99	Dec-07
	Ops	Dec-07	Dec-09
	Res		

Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

Goddard Space Flight Center (GSFC) has Program Management responsibility for all Heliophysics Explorer Programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
AIM	GSFC		N/A
IBEX	GSFC		N/A
THEMIS	GSFC		N/A
CINDI	GSFC		N/A
TWINS-B	GSFC		N/A

Acquisition Strategy

The Heliophysics Explorer Program has established an acquisition strategy that contracts for the whole mission (concept through delivery of science data/analysis), with emphasis on performance incentives and a cost cap for each mission.

Investigations are selected through the AO process, where multiple investigations are selected competitively for initial concept studies with a competitive down-select to proceed to the next stage of formulation. The investigations are selected to proceed from one phase to the next through execution of contract options, based on successful technical, cost, and schedule performance in the previous phases.

The following awards have been made for development and mission operations:

AIM: Laboratory for Atmospheric and Space Physics (LASP), Orbital Science Corporation, Hampton University (mission operations);

IBEX: Orbital Science Corporation, Los Alamos National Laboratory, Lockheed Martin Advance Technology Center, Southwest Research Institute (mission operations);

THEMIS: ATK (formally Swales Aerospace), France, Germany, and Canada, University of California Berkeley (mission operations);

CINDI: U.S. Air Force, University of Texas at Dallas (mission operations); and

TWINS-B: Los Alamos National Laboratory, Aerospace Corporation, Southwest Research Institute (mission operations).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	03/2003	Review and make recommendations on Announcements of Opportunity selections. Selected Interstellar Boundary Explorer (IBEX) and Nuclear Spectroscopic Telescope Array (NuSTAR).	06/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Increased cost of launch vehicle	The increasing cost of the Delta launch vehicle threatens the maintainability and viability of the Explorer Program and future missions.	SMD management initiated a Small Explorer (SMEX) Announcement of Opportunity to increase the number of science missions for the Explorer future line.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program
Project In Development:	Interstellar Boundary Explorer (IBEX)

FY 2009 Budget Request

Budget Authority ($ millions)	**Prior**	**FY 2007 Actual**	**FY 2008 Enacted**	**FY 2009**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**BTC**	**LCC TOTAL**
FY 2009 President's Budget Request	**70.0**	**45.1**	**30.8**	**9.5**	**6.9**	**1.0**	**--**	**--**	**--**	**163.3**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	70.0	45.1	30.8	--	--	--	--	--	--	145.9
Operations / Close-out	--	--	--	9.5	6.9	1.0	--	--	--	17.4
Other	0.0	0.0	0.0	0.0	0.0	0.0	--	--	--	0.0
FY 2008 President's Budget Request	**70.0**	**48.3**	**37.8**	**11.6**	**8.3**	**1.2**	**--**	**--**	**--**	**129.0**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	70.0	--	30.8	--	--	--	--	--	--	100.8
Operations / Close-out	--	--	--	9.5	6.9	1.0	--	--	--	17.4
Other	0.0	48.3	7.0	2.1	1.4	0.2	--	--	--	10.8
Changes from FY 2008 Request	**--**	**-3.2**	**-7.0**	**-2.1**	**-1.5**	**-0.2**	**--**	**--**	**--**	**34.3**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	45.1	--	--	--	--	--	--	--	45.1
Operations / Close-out	--	--	--	--	--	--	--	--	--	--
Other	--	-48.3	-7.0	-2.1	-1.5	-0.2	--	--	--	-10.8

Note: FY 2009 President's Budget Request is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5 year Proposed Budget Estimates for 2009 through 2013. FY 2008 P.B.R. is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book, the "Other" line captures indirect costs as budgeted for in FY2008

Explanation of Project Changes

No sigificant changes.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program
Project In Development:	Interstellar Boundary Explorer (IBEX)

Project Purpose

IBEX will investigate the global interation between the solar wind and the Interstellar Medium (ISM)- the local part of the Milky Way Galaxy that our Solar System is moving through. The ISM, built up from material released from the stars of our galaxy through stellar winds, novae, and supernovae, has considerable structure. IBEX images will reveal global properties of the boundaries that separate our heliosphere from the local ISM and answer these important science questions: What is the global strength and structure of the termination shock? How are energetic protons accelerated at the termination shock? What are the global properties of the solar wind flow beyond the termination shock and in the heliotail? How does the interstellar flow interact with the heliosphere beyond the heliopause? IBEX will achieve these objectives with a set of global energetic neutral atom (ENA) images.

The IBEX mission will have the first global look at the interaction between the Solar System and the Galaxy.

Project Parameters

IBEX is designed for a 2 year mission lifetime, with a highly elliptical orbit - 236,000 km (37 Re-Radius of Earth) apogee x 7000 km perigee.

Science data accumulates at 205 bps during primary science operations.

Project Commitments

IBEX is a SMEX-class mission that will be launched from Kwajalein on a Pegasus XL launch vehicle. The IBEX- Hi and IBEX- Lo are single pixel sensors that measure ENAs from the outer heliosphere. The Combined Electronics Unit (CEU) commands and stores data from the IBEX-Hi and Lo sensors, provides the low and high voltages and other electronics support needed for the IBEX-Hi and Lo sensors to capture energetic neutral atoms from the galactic frontier and is the payload interface to the spacecraft bus.

Schedule Commitments

Project authority to proceed into implementation was granted on May 24, 2006, and re-baselined on September 6, 2006. The mission will launch in the third quarter of 2008. The exact date will be based on pad availability and favorable moon geometry.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program
Project In Development:	Interstellar Boundary Explorer (IBEX)

Project Management

Goddard Space Flight Center has project management responsibility for the IBEX Small Explorer spacecraft.

Acquisition Strategy

IBEX is a Principle Investigator (PI) led mission. The PI, at Southwest Research Institute, leads the science, instrument and spacecraft teams.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	New Millennium

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**40.8**	**25.8**	**4.3**	**2.2**	**1.1**	**0**	**0**
New Millennium	40.8	25.8	4.3	2.2	1.1	0	0
FY 2008 President's Budget Request	**89.6**	**66.2**	**33.0**	**36.0**	**92.1**	**95.9**	**0**
New Millennium	89.6	66.2	33.0	36.0	92.1	95.9	0
Changes from FY 2008 Request	**-48.8**	**-40.4**	**-28.7**	**-33.8**	**-91.0**	**-95.9**	**0.0**

Note: In addition to programmatic changes which resulted in budget changes, the Agency's decision to reallocate institutional overhead (Corporate G&A, CM&O, and Institutional Investments) also impacted budgets for FY 2009 through FY 2013. Therefore, the changes shown in the above budget tables consist of both programmatic and institutional adjustments.

Program Overview

Due to SMD reprioritization of programs, the NMP Future Missions budget line is being realigned into other cross-theme areas within SMD. A small amount of funding remains to cover unknowns and closeout costs.

The New Millennium Program (NMP) is a technology flight validation program designed to retire risk of key emerging and breakthrough technologies to enable future NASA science missions. The objectives of the program are to capitalize on investments being made in U.S. technological capabilities and accelerate the incorporation of payoff, advanced technologies into future NASA Science Missions by conducting in-space validation missions, when the technologies must be tested in space in order to be validated. NMP allows NASA to conduct technology maturation and validation in low cost NMP projects, rather than during science mission development.

For more information, please see: http://nmp.jpl.nasa.gov.

Program Relevance

The goal of the New Millennium Program (NMP) is to reduce the risks to, as well as the costs of, future NASA science missions. In that capacity, NMP supports NASA Strategic Goal 3: develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human space flight program to focus on exploration. NMP contributes to the following Sub-goals through the demonstration of technologies that enable or enhance missions in each science Theme:

3A: Study Earth from space to advance scientific understanding and meet societal needs.
3B: Understand the Sun and its Effects on the Earth and the Solar System.
3C: Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere and the hazards and resources present as humans explore space.
3D: Discover the origin, structure, evolution and destiny of the universe, and search for Earth-like planets.

NMP also contributes to NASA Strategic Goal 5: Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	New Millennium

Plans For FY 2009

Plans for FY 2009 include continued development for Space Technology 7, which will be Integrated and Testing on the ESA spacecraft. Due to SMD reprioritization of programs, the NMP Future mission budget line is being realigned into other cross-Theme areas within the SMD. A small amount of funding remains to cover closeout and other unknown costs.

Project Descriptions and Explanation of Changes

Space Technology 7 -- Disturbance Reduction System

Space Technology 7's Disturbance Reduction System (DRS) incorporates enhanced micro-Newton thruster technology, which works with enhanced sensor technology provided by the European Space Agency. Together, these technologies will demonstrate precision spacecraft control, validating position-measurement of objects in weightlessness with 100-times greater accuracy than ever before. During the Space Technology 7 test flight, the DRS is expected to achieve close to the ultimate in weightlessness.

Space Technology 8

Space Technology 8 (ST 8) is a mission to validate four new sub-system-level technologies never before tried in space: Dependable Multiprocessor: A fault-tolerant software architecture running on a cluster of commercial-off-the-shelf (COTS)-based computers that enhances the immunity of a high-performance onboard processing system to the error-causing radiation environment of space provided by Honeywell International; Ultraflex 175: A deployable solar array system that is a highly efficient, lightweight power producer for both orbiting and landed spacecraft provided by ATK Space Systems; SAILMAST Ultra Lightweight Boom: A technology for strong, deployable ultra-lightweight structures that can be used to support huge, deployable solar sails and other large structures like space telescopes sunshades provided by ATK Space Systems; and Thermal Loop: A miniature thermal management system for small spacecraft that tightly controls the operating temperatures of the spacecraft and instruments while using little power provided by the Goddard Space Flight Center.

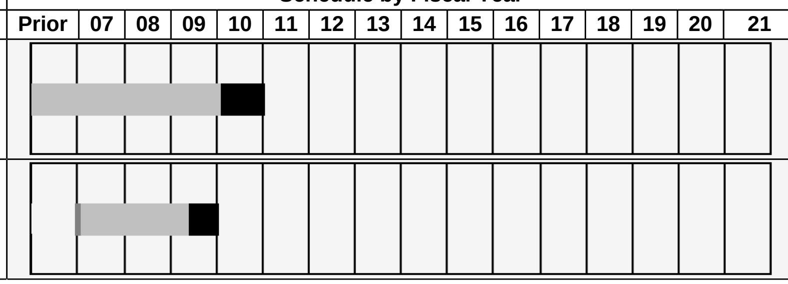
ST 8 will complete technologies to only Technical Readiness Level 6 in FY 2008.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Validate Disturbance Reduction System (DRS) by Operating in space for 240 hours.	Space Technology 7 (On European Space Agency's LISA Path Finder)	Deliver ST7 flight hardware to ESA

Mission Directorate:	Science
Theme:	Heliophysics
Program:	New Millennium

Implementation Schedule



Project	Phase	Beg	End
Space Technology 7	Tech	Apr-01	Apr-03
	Form	Apr-03	Jul-03
	Dev	Jul-03	Oct-09
	Ops	Oct-09	Sep-10
	Res		
Space Technology 8	Tech	Sep-03	Aug-06
	Form	Aug-06	Oct-06
	Dev	Oct-06	Feb-09
	Ops	Feb-09	Sep-09
	Res		

- Tech & Adv Concepts (Tech)
- Formulation (Form)
- Development (Dev)
- Operations (Ops)
- Research (Res)
- Represents a period of no activity for the Project

Program Management

The New Millennium Program is managed by Jet Propulsion Laboratory, with oversight from NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Space Technology 7	JPL	JPL	European Space Agency and Busek Corporation
Space Technology 8	JPL	JPL	NASA-GSFC, Honeywell, and ATK

Acquisition Strategy

The Science Mission Directorate (SMD) acquires advanced technology concepts through an open competitive process, such as the NASA Research Announcement (NRA) process, to ensure participation by the broadest community, and to solicit advanced technology proposals appropriate to satisfy SMD-established requirements for either a system or subsystem flight validation opportunity. Open competitions for acquisitions to implement each flight validation experiment are required unless an alternative procurement approach is approved by the SMD Associate Administrator.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	01/2007	Program, alignment and management. Review -- Program Implementation Review (PIR) for the New Millennium Program. Results reported Agency PMC 9/12/2007.	TBD
Performance	SRB/IRT	N/A	Critical Design Review for Space Technology 8. Review was not held because of the shift of ST8 into non-flight status.	N/A

Overview

NASA's Aeronautics Research Mission Directorate (ARMD) conducts high-quality, cutting-edge research that generates innovative concepts, tools, and technologies to enable revolutionary advances in our Nation's future aircraft as well as in the airspace in which they will fly. ARMD programs will facilitate a safer, more environmentally friendly, and more efficient national air transportation system. In addition, NASA's aeronautics research will continue to play a vital role in supporting NASA's human and robotic space exploration activities.

Advances in fundamental aeronautics research have driven the first two waves of aeronautics growth over the last century (first in propeller aircraft, then in jets). These revolutions have led to today's National Airspace System (NAS), the hub-and-spoke commercial air carrier industry, as well as innumerable military, public service, and business aviation capabilities. Technological advances in aviation have directly benefited the American public by improving the quality of life and creating economic prosperity for the Nation.

The current needs of the Nation have transcended the limited solutions that aviation currently offers, requiring dramatic improvements in safety, capacity, environmental compatibility, robustness, and freedom of mobility throughout the United States and across the globe. Now, a third wave of aeronautical advances offers solutions to these challenges. This third wave is not merely an extrapolation of the existing aviation capabilities, but a radical technology shift that will enable revolutionary enhancements of both the airspace system and the aircraft that fly within it.

NASA's aeronautics program is positioned better than ever to provide meaningful and relevant research aligned with national priorities. NASA's ARMD expands the boundaries of aeronautical knowledge for the benefit of the Nation and the broad aeronautics community, which includes the Agency's partners in academia, industry, and other government agencies.

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**593.8**	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**
Aeronautics	593.8	511.7	446.5	447.5	452.4	456.7	467.7
FY 2008 President's Budget Request	**529.3**	**554.0**	**546.7**	**545.3**	**549.8**	**554.7**	**--**
Aeronautics	529.3	554.0	546.7	545.3	549.8	554.7	--
Total Change from FY 2008 President's Budget Request	**64.5**	**-42.3**	**-100.2**	**-97.8**	**-97.4**	**-98.0**	**467.7**

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Budget Changes

Budget Authority ($ millions)	Actual FY 2007	Enacted FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**64.5**	**-42.3**	**-100.2**	**-97.8**	**-97.4**	**-98.0**	**467.7**
Aeronautics	**64.5**	**-42.3**	**-100.2**	**-97.8**	**-97.4**	**-98.0**	**467.7**
Programmatic Content	154.6	59.7	-0.9	-0.7	-0.3	-0.3	467.7
Programmatic Transfers	--	--	-0.3	-0.3	-0.3	-0.4	--
Institutional Adjustments	-90.1	-102.0	-99.0	-96.8	-96.8	-97.3	--

Explanation of Mission Directorate Changes

Aeronautics Research

Aeronautics

Programmatic Content:

The program changes have been made due to SBIR/STTR recalculation to IPP, and IT infrastructure investments.

Programmatic Transfers:

Program Transfers include Technical Authority transfer to CM&O as well as grants processing and quality assurance audits transfer to Corporate G&A.

Institutional Adjustments:

Institutional Adjustments reflect the Agency reallocation of overhead which includes Corporate G&A, CM&O, and Institutional Investments.

Mission Directorate: Aeronautics Research
Theme: Aeronautics

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**593.8**	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**
Aviation Safety	87.3	66.5	62.6	65.9	65.0	64.5	66.5
Airspace Systems	102.5	100.1	74.6	72.7	74.2	75.4	78.4
Fundamental Aeronautics	330.4	269.9	235.4	233.2	235.2	238.6	244.6
Aeronautics Test Program	73.5	75.1	73.9	75.8	78.0	78.2	78.2
FY 2008 President's Budget Request	**529.3**	**554.0**	**546.7**	**545.3**	**549.8**	**554.7**	**--**
Aviation Safety	76.9	74.1	76.5	80.2	78.9	78.3	--
Airspace Systems	92.6	98.1	91.1	90.3	91.4	92.7	--
Fundamental Aeronautics	305.7	293.4	289.0	285.7	290.1	294.2	--
Aeronautics Test Program	54.1	88.4	90.2	89.2	89.4	89.5	--
Total Change from FY 2008 Request	**64.5**	**-42.3**	**-100.2**	**-97.8**	**-97.4**	**-98.0**	**467.7**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**64.5**	**-42.3**	**-100.2**	**-97.8**	**-97.4**	**-98.0**	**467.7**
Aviation Safety	**10.4**	**-7.5**	**-13.9**	**-14.2**	**-13.9**	**-13.7**	**66.5**
Programmatic Content	23.5	6.1	--	--	--	--	66.5
Institutional Adjustments	-13.1	-13.6	-13.9	-14.2	-13.9	-13.7	--
Airspace Systems	**10.0**	**2.0**	**-16.5**	**-17.6**	**-17.2**	**-17.4**	**78.4**
Programmatic Content	25.7	20.1	--	-1.6	-1.1	-1.1	78.4
Institutional Adjustments	-15.7	-18.1	-16.5	-16.0	-16.1	-16.3	--
Fundamental Aeronautics	**24.7**	**-23.5**	**-53.5**	**-52.6**	**-54.9**	**-55.6**	**244.6**
Programmatic Content	76.8	30.5	-0.9	-1.5	-3.5	-3.6	244.6
Programmatic Transfers	--	--	-0.3	-0.3	-0.3	-0.4	--
Institutional Adjustments	-52.1	-54.0	-52.3	-50.8	-51.1	-51.6	--
Aeronautics Test Program	**19.4**	**-13.3**	**-16.3**	**-13.4**	**-11.4**	**-11.3**	**78.2**
Programmatic Content	28.6	3.0	--	2.4	4.3	4.4	78.2
Institutional Adjustments	-9.2	-16.3	-16.3	-15.8	-15.7	-15.7	--

Explanation of Program Changes

Aviation Safety

The Aviation Safety programmatic budget remained unchanged. (There were adjustments based on the Agency reallocation of indirect budgets.)

Airspace Systems

The small reduction in the Airspace Systems Program non-NRA Procurement Budget FY 2010-FY 2012 timeframe is realigned to the Advanced Technology Program (ATP) to fund an increase in high-priority maintenance and repair projects.

Fundamental Aeronautics

The Fundamental Aeronautics Program non-NRA Procurement Budget reduction in the FY 2010-FY 2012 timeframe is realigned to ATP to fund an increase in high-priority maintenance and repair projects, the SBIR/STTR recalculation to IPP, and the IT infrastructure investments.

The Fundamental Aeronautics programmatic transfers reflect moving the Technical Authority to Center Management and Operations (CM&O) as well as moving the grants processing and quality assurance audits budgets to Corporate G&A.

Aeronautics Test Program

The Aeronautics Test Program budget has been increased in the FY 2010-FY 2012 timeframe to fund high-priority maintenance and repair projects.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics

Theme Overview

NASA's Aeronautics Research Mission Directorate (ARMD) supports the Agency's goal (Strategic Goal 3) of developing a balanced overall program of science, exploration, and aeronautics, consistent with the redirection of the human spaceflight program to focus on exploration. Specifically, ARMD advances knowledge in the fundamental disciplines of aeronautics and develops technology for safer aircraft and higher capacity airspace systems. The ARMD research plans directly support the National Aeronautics Research and Development Policy and accompanying Executive Order signed by the President on December 20, 2006, as well as the National Plan for Aeronautics Research and Development and Related Infrastructure approved by the President in December 2007.

ARMD conducts cutting-edge research that produces concepts, tools, and technologies that enable the design of vehicles that fly safely through any atmosphere at any speed. A key focus of ARMD is the development of physics-based Multidisciplinary Design Analysis and Optimization (MDAO) tools that will provide the ability to evaluate radically new vehicle designs. In addition, ARMD is directly addressing fundamental research challenges that must be overcome in order to implement the Next Generation Air Transportation System (NextGen). This research will yield revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of the National Air Space. In conjunction with expanding air traffic management capabilities, research is being conducted to help address substantial noise, emissions, efficiency, performance, and safety challenges that are required to ensure vehicles can support the NextGen vision.

Aeronautics research and space exploration have always been and will continue to be inextricably linked. Advances in core aeronautical disciplines such as aerodynamics, aerothermodynamics, flight dynamics and control, materials, structures, and human interface technologies have been critical to the success of NASA's space program over the past several decades. Future human and robotic space exploration activities will continue to rely upon advances in key aeronautics disciplines across all flight regimes.

The performance measures for the ARMD were refined in 2007 and are reflected in the Program Commitments sections that follow.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Office of Science and Technology Policy (OSTP) National Science and Technology Council (NSTC) Committee on Technology chartered an Aeronautics Science and Technology (AS&T) Subcommittee in September 2005. NASA's Associate Administrator for ARMD is a co-chair of the Subcommittee, which drafted the Nation's first Aeronautics Research and Development Policy, released by the White House in December 2006. The policy establishes a set of U.S. aeronautics research objectives, defines the appropriate role of the federal government in aeronautics research and development (R&D), defines the roles and responsibilities of the various departments and agencies in aeronautics R&D, addresses R&D test and evaluation infrastructure, and addresses the coordination of aeronautics research across the federal government. NASA's ARMD efforts are aligned with the policy.

ARMD's research portfolio also aligns very well with the recommendations of the 2006 National Research Council (NRC) Decadal Survey. All five of the Common Themes identified in the Decadal Survey are present across ARMD's research programs, and 47 of the 51 Technical Challenges are also well represented in the portfolio. A detailed response to the Decadal Survey was documented in a Report to Congress submitted in August 2007.

Finally, in December 2007, the President approved the first National Aeronautics R&D Plan. ARMD's research portfolio is closely aligned with this plan.

Relevance to the NASA Mission and Strategic Goals:

ARMD's focus on long-term, cutting-edge research that expands the boundaries of aeronautical knowledge for the benefit of the broad aeronautics community directly supports NASA's Mission to pioneer the future in space exploration, scientific discovery, and aeronautics research. NASA's fundamental aeronautics research will have far-reaching effects on both civilian aviation and space exploration.

ARMD's work supports Sub-goal 3E.

Relevance to education and public benefits:

NASA's aeronautics program ensures long-term focus in fundamental research in both traditional aeronautical disciplines and relevant emerging fields for integration into multidisciplinary system-level capabilities for broad application. This approach will enable revolutionary change to both the airspace system and the aircraft that fly within it, leading to a safer, more environmentally friendly, and more efficient national air transportation system. Furthermore, ARMD will disseminate all of its research results to the widest practicable extent.

ARMD uses the NASA Research Announcement (NRA) process to foster collaborative research partnerships with the academic and private sector communities. The NRA process encourages awardees to spend time at NASA centers in order to enhance the exchange of ideas and expand the learning experience for everyone involved. Furthermore, ARMD has focused its educational activities to better attract the Nation's best and brightest students to aeronautics. These activities include design competitions and the establishment of graduate and undergraduate scholarships and internships.

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 3	**Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.**					
Sub Goal 3E	**Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.**					
Outcome 3E.1	**By 2016, identify and develop tools, methods, and technologies for improving overall aircraft safety of new and legacy vehicles operating in the Next Generation Air Transportation System (projected for the year 2025).**		**None**	**None**	**Green**	**Green**
APG 9AT1	Demonstrate a 10% improvement in estimation accuracy of integrated gas path sensing and diagnostics for aircraft engine health.	Aviation Safety				None
APG 9AT2	Conduct a spin test to verify enhanced disk rim attachment strength at component level and show 10% life improvement over criteria established in 2007.	Aviation Safety				None
APG 9AT3	Assess and deliver findings on initial multi-modal presentation formats and interaction methods for uncertainty display concepts and virtual visual environments with statistically significant reductions in communication errors, mental workload, and flight technical error, as well as increases in usability and situation awareness compared with baseline capability.	Aviation Safety				None
APG 9AT4	Design and evaluate preliminary concepts in on-line integrity monitoring (99% failure detection with less than 1% false positives) for adaptive control systems through simulation tests.	Aviation Safety				None
Outcome 3E.2	**By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the Next Generation Air Transportation System.**		**None**	**None**	**Green**	**Green**
APG 9AT5	Complete trajectory analysis for service provider-based automated separation assurance with time-based metering with 2-3 times increase in capacity without reduction of baseline metering accuracy or separation violations.	Airspace Systems				None
APG 9AT6	Develop algorithms to generate robust, optimized solutions for surface traffic planning and control. Evaluations will include benefits in both nominal and off-nominal conditions under increased Airportal traffic density and consider environmental constraints and aircraft operator schedule preferences.	Airspace Systems				None

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome 3E.3	**By 2016, develop multidisciplinary analysis and design tools and new technologies, enabling better vehicle performance (e.g., efficiency, environmental, civil competitiveness, productivity, and reliability) in multiple flight regimes and within a variety of transportation system architectures.**		**None**	**None**	**Green**	**Green**
APG 9AT10	Complete the CFD pretest predictions of performance and operability of a high Mach fan for a TBCC propulsion system and compare to fan test data from the GRC W8 facility.	Fundamental Aeronautics				None
APG 9AT7	Develop a database for alternative hydrocarbons using accepted testing standards, then characterize the fuels (freezing point, break point, etc) in comparison to current Jet-A.	Fundamental Aeronautics				None
APG 9AT8	Develop and validate transmission tools and technologies to support variable speed drive systems using data from several transmission test cells at GRC.	Fundamental Aeronautics				None
APG 9AT9	Demonstrate an adjoint-based design method for configuration shaping; also establish the capability to design and analyze supersonic vehicles that achieve efficiency improvements within 10% of the defined targets including engine plume effects and verify the results using wind tunnel and flight experiments.	Fundamental Aeronautics				None
Outcome 3E.4	**Ensure the continuous availability of a portfolio of NASA-owned wind tunnels/ground test facilities, which are strategically important to meeting national aerospace program goals and requirements.**		**None**	**None**	**None**	**Green**
APG 9AT11	To sustain the required aeronautics test facilities force measurement capability for the nation, implement a centralized force balance capability by FY 2009.	Aeronautics Test Program				None

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Aeronautics Theme					
APG 9AT12	Deliver at least 94% of "on-time availability" for all operations and research facilities				Yellow

Performance Achievement Highlights:

Over the next two decades, the volume of air traffic in the United States is expected to increase 2 to 3 times. This could result in increased congestion, noise, harmful emissions, and fuel consumption. In support of NextGen, NASA and the FAA are working on solutions to mitigate these issues. One potential solution, the Blended Wing-Body (BWB), was successfully flight tested this year by NASA, in partnership with the Air Force Research Lab (AFRL) and Boeing, at the Dryden Flight Research Center. The BWB is a hybrid aircraft configuration combining the best attributes of a conventional tube-and-wing aircraft with a flying wing. The highly efficient BWB airframe design offers the potential for significantly reduced fuel consumption and emissions. Because the engines can be mounted on the top, there also is potential for significant noise reduction on the ground. NASA projects that such types of advanced configurations could yield future vehicles with noise signatures 42 dB below Stage 4, LTO NOx emissions 80% below Committee on Aviation Environmental Protection (CAEP) 2, and fuel burn reductions of at least 40% compared to a B737/CFM56.

Theoretically, the BWB should be more stable than a pure flying wing, but less so than a conventional aircraft with a prominent tail. This had been demonstrated in wind tunnel tests, but until this year, no realistic, properly scaled model of a BWB had ever been flown to test its true flying qualities. During this past year, several flight tests were conducted of an aerodynamically scaled, mass balanced BWB. The experimental aircraft, having a wingspan of 21 feet (8.5% of full scale), was built by Boeing Phantomworks and Cranfield Aerospace. The purpose of the flight tests was to explore the basic low-speed flying qualities of the BWB, including stability and control, and test the on-board flight control system. The aircraft has successfully flown under a wide range of flight conditions and has not shown any unsafe or anomalous behavior.

The BWB represents a mutually beneficial partnership. Boeing Phantomworks supplied the test vehicle; NASA provided proven ground and flight test expertise; and AFRL provided wind tunnel access for transonic stability and control tests, and contractual and project management support. Coupled with recent ground tests in NASA facilities, an extensive ground-to-flight database has been established that brings this concept closer to reality.

For more information, see Sub-goal 3E in the FY 2007 Annual Performance Report, included in this budget.

Quality

Program Assessment Rating Tool (PART):

In FY 2007, the Aeronautics Technology Theme received a PART rating of "Effective" (the highest rating possible). The assessment found that this program has a clear purpose, is well designed, and focuses on research that is appropriate for government, consistent with the National Aeronautics R&D Policy, and has a comprehensive set of ambitious but realistic performance measures.

To ensure that performance continues to improve, the Theme will:
1) Conduct an annual review by experts from Other Government Agencies (OGAs) to assess the quality, relevance, and performance of the programs in ARMD.
2) Complete the NRC study, which will provide an independent assessment of the fundamental aeronautics research across ARMD.
3) Ensure that NASA's aeronautics research is in alignment with the research needs of NextGen.
4) Under the leadership of PA&E, benchmark research and technology practices in performance and budget integration and performance measurement with OGAs.

In November 2007, independent annual reviews of the four ARMD Programs were conducted. The next annual reviews are scheduled for November 2008.

All meetings conducted by the NRC regarding the independent assessment of NASA's fundamental aeronautics research were completed in 2007, with the preliminary report due for release in March 2008.

ARMD supports 84/163 R&D needs in the NextGen R&D Plan, and contributed to all of the Joint Planning and Development Office (JPDO) planning products, including the Concept of Operations, the Enterprise Architecture, the R&D Plan, and the Integrated Work Plan. In FY 2008, ARMD will continue to work with its federal agency partners in the JPDO towards the maturation of the NextGen plans, as well as participate in various technical, programmatic and advisory reviews and committees, and proposal review boards.

In FY 2007, PA&E conducted an initial survey of other federal agencies' budget and performance documentation to identify parties of interest for benchmarking in FY 2008.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert	11/2007	The 12-month review is a formal independent peer review. Experts from OGAs will report on their assessment of technical and programmatic risk and/or Program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2008

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aviation Safety

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	87.3	66.5	62.6	65.9	65.0	64.5	66.5
Integrated Vehicle Health Management	30.7	22.0	19.7	19.9	18.8	18.6	19.2
Aging Aircraft	14.9	10.0	10.6	11.3	11.2	12.0	12.4
Integrated Resilient Aircraft Control	22.2	15.3	17.1	18.5	19.0	18.2	18.8
Integrated Intelligent Flight Deck Technologies	19.5	19.3	15.2	16.3	16.0	15.7	16.1
FY 2008 President's Budget Request	76.9	74.1	76.5	80.2	78.9	78.3	0
Integrated Vehicle Health Management	28.5	22.4	24.8	24.6	23.4	23.2	0
Aging Aircraft	13.9	12.3	13.3	14.2	14.2	15.0	0
Integrated Resilient Aircraft Control	24.4	18.8	19.9	21.7	22.0	20.9	0
Integrated Intelligent Flight Deck Technologies	10.1	20.6	18.5	19.6	19.3	19.0	0
Changes from FY 2008 Request	10.4	-7.6	-13.9	-14.2	-13.9	-13.7	66.5

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Program Overview

The Aviation Safety Program (AvSP) is dedicated to the mastery and intellectual stewardship of the core competencies of aviation safety for the Nation. Furthermore, the program builds upon the unique safety-related research capabilities of NASA to improve aircraft safety for current and future aircraft, and to overcome aircraft safety technological barriers that would otherwise constrain the full realization of the Next Generation Air Transportation System (NextGen). Currently the U.S. Air Transportation System is widely recognized as among the safest in the world, which can be credited to the vigilance of industry and government working together. However, looking at the projected increases in air traffic and future system capabilities, this vigilance must continue in order for the United States to meet both the public expectations for safety and the full realization of the NextGen. To meet these challenges, the AvSP will focus on developing cutting-edge technologies to improve the intrinsic safety attributes of current and future aircraft that will operate in the NextGen. Concurrently, these technologies can be leveraged to support space exploration activities, such as enabling self-reliant and intelligent systems necessary for the long-duration travel requirements of future space vehicles.

For more information, please see http://www.aeronautics.nasa.gov/programs_avsp.htm.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aviation Safety

Program Relevance

The AvSP will provide aircraft safety related concepts, tools, and technologies that will help ensure the safety of the Nation's Air Transportation System as it transitions to meet the future needs of NextGen. These needs include: the anticipated significant increases in air traffic; increased reliance on automation; increased diversity of vehicles; and increased complexity in the system. The long-range goals of the research include: reduced occurrence of in-flight failures; onboard systems capable of self-correcting anomalies; improved crew workload allocation and situation awareness; and advanced flight controls to ensure flight safety during adverse flight conditions. AvSP also helps the country develop and maintain excellence in the aeronautics workforce by providing significant research opportunities in all of its projects.

This program supports Outcome 3E.1.

Plans For FY 2009

AvSP is comprised of four projects. All four projects have developed 10-year project plans with milestones and metrics. Highlighted here are key performance deliverables for FY 2009.

Researchers in the Integrated Vehicle Health Management (IVHM) Project will develop advanced propulsion health monitoring sensors to detect gradual and abrupt changes within the gas path of an aircraft engine. In 2009, this technology will demonstrate (through simulation) a 10% improvement in estimation accuracy.

Researchers in the Aircraft Aging and Durability (AAD) Project will develop technologies to reduce the risk of aircraft engine disk failure in advanced propulsion systems with higher operating temperatures. In 2009, the project will conduct a spin test of a third-generation superalloy engine disk to verify enhanced disk rim attachment strength at the component level.

Researchers in the Integrated Intelligent Flight Deck (IIFD) Project will deliver findings on technologies that have the potential to mitigate crew-vehicle interface safety concerns that could constrain implementation of NextGen key capabilities. Research in this area involves revolutionary applications of visual display concepts including multimodal presentation formats and interaction methods for uncertainty display concepts and virtual visual environments.

Researchers in the Integrated Resilient Aircraft Control (IRAC) Project will be developing the capability to perform in-flight integrity monitoring of adaptive flight control systems. Software for such systems is inherently self-modifying, and will likely require techniques that fall outside the range of existing verification and validation methods currently used for certifying conventional flight software. In 2009 the project will design and evaluate through simulation on-line integrity monitoring for adaptive control systems. The goal is to achieve 99% failure detection with less than 1% false positives, as measured by the percent of monitoring defects.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aviation Safety

Project Descriptions and Explanation of Changes

Aviation Safety Program

Public benefits derived from continued growth in the transport of passengers and cargo are dependent on the improvement of the intrinsic safety attributes of current and future air vehicles that will operate in NextGen. AvSP will address this challenge by conducting cutting-edge fundamental research that will yield innovative algorithms, tools, concepts and technologies from the discipline level up to the subsystem and system level. Furthermore, the Program also supports the Agency's human and robotic exploration missions by advancing knowledge, tools, and technologies in areas relevant to sustaining long endurance and remote operations in harsh environments.

AvSP is comprised of four projects. The IVHM Project addresses the challenge of using a prognostic approach to vehicle health management, in particular the integration, processing, and effective use of large amounts of data across highly integrated and complex flight critical systems. The AAD Project addresses the challenge of improving the operational resiliency of future structures and advanced materials against aging related hazards. The IIFD Project addresses the future challenges to ensure the proper integration of the human operator in a highly automated and complex operational environment. The IRAC Project addresses the challenge of using automatic adaptive control concepts to prevent the loss-of-control of an aircraft in the event of an upset or off-nominal condition.

Integrated Vehicle Health Management

The goal of the IVHM Project is to conduct research to advance the state of highly integrated and complex flight-critical health management technologies and systems. These technologies will enable nearly continuous onboard situational awareness of the vehicle health state for use by the flight crew, ground crew, and maintenance depot. Improved safety and reliability will be achieved by onboard systems capable of performing self-diagnostics and self-correction of anomalies that could otherwise go unattended until a critical failure occurs. A key enabling technology will be the ability for sharing and processing large amounts of information among the various vehicle subsystems to more accurately diagnose the system health state and execute the logic to self-correct any critical anomalies detected.

Aircraft Aging and Durability

The goal of the AAD Project is to develop advanced diagnostic and prognostic capabilities for detection and mitigation of aging-related hazards. The research and technologies to be pursued will decrease the susceptibility of current and next generation aircraft and onboard systems to premature deterioration, thus greatly improving vehicle safety and mission success. Emerging civilian and military aircraft are introducing advanced material systems, fabrication techniques, and structural configurations for which there is limited service history. There will be an emphasis in the AAD project on new material systems/fabrication techniques and the potential hazards associated with aging-related degradation. The intent is to take a proactive approach to identifying aging-related hazards before they become critical, and to develop technology and processes to incorporate aging mitigation into the design of future aircraft. Foundational research in aging science will ultimately yield multidisciplinary subsystem and system-level integrated methods for detection, prediction, and mitigation/management of aging-related hazards for future civilian and military aircraft.

Integrated Intelligent Flight Deck

The goal of the IIFD Project is to pursue flight deck related technologies that will ensure crew workload and situational awareness are both safely optimized and adapted to the future operational environment as envisioned by the NextGen. A key component of this research will be investigating methods to automatically monitor, measure, and assess the state of the crew awareness to their assigned task. The scope of IIFD includes the following: development of crew/vehicle interface technologies that reduce the risk of pilot error; development of monitoring technologies to enable detection of unsafe behaviors; development of fail-safe methods for changing the operator/automation roles in the presence of detected disability states; and development of a comprehensive surveillance system design that enables robust detection of external hazards with sufficient time-to-alarm for safe maneuvering to avoid the hazards. The products of the IIFD Project should enable system designers to eliminate the safety risk of unintended consequences when introducing new and advanced systems into an operational environment.

Integrated Resilient Aircraft Control

The goal of the IRAC Project is to conduct research to advance the state of aircraft flight control automation and autonomy in order to prevent loss-of-control in flight. Taking into account the advanced automation and autonomy capabilities as envisioned by NextGen, the research will pursue methodologies to enable an aircraft to automatically detect, mitigate, and safely recover from an off-nominal condition that could lead to a loss of control. A key component of the research will be to develop technologies that would enable an aircraft control system to automatically adapt or reconfigure itself in the event of a failed or damaged component. These adaptive control concepts will likely have applications to future space exploration missions where vehicles will be required to operate and adapt to unknown flight environments.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
In 2010, demonstrate improved IVHM for landing gear components in landing dynamics testbed	IVHM	The performance measures for the Program were refined in 2007
In 2011, demonstrate self-healing material concepts to mitigate damage in structural elements	IVHM	No change
Demonstrate sensors, software and guidelines that will enable implementation of onboard IVHM by 2016	IVHM	No change
In 2010, develop atomistic model that predicts degradation on polymer matrix interfaces	AAD	The performance measures for the Program were refined in 2007
In 2011, develop aging mitigation technique that demonstrates 50% improvement over the 2007 baseline	AAD	The performance measures for the Program were refined in 2007
Deliver validated tools and methods that enable implementation of aircraft aging mitigations by 2016	AAD	No change
In 2010, deliver validated guidelines and display requirements that meet NextGen operational needs	IIFD	No change
In 2011, complete the validation of selected part-task simulation results in the flight environment	IIFD	The performance measures for the Program were refined in 2007
In 2016, deliver tools and flight deck technologies to enable advanced automation to support NextGen	IIFD	No change
In 2010, develop tools to reduce simulation time for locating failure points in a flight envelope	IRAC	The performance measures for the Program were refined in 2007
In 2011, assess control strategies for aircraft recovery from upset stall conditions	IRAC	No change
Deliver multidisciplinary adaptive control design tools for loss-of-control and recovery by 2016	IRAC	No change

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aviation Safety

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the program. The Program Director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Integrated Vehicle Health Management (IVHM)	Principle Investigator and Project Manager who report to the Program Director	LARC, GRC, ARC, DFRC	FAA, JPDO, CAST, NOAA, DoD, Moog, Boeing, and FLX Micro
Aircraft Aging and Durability (AAD)	Principle Investigator and Project Manager who report to Program Director	LARC, GRC, ARC	FAA, CAST, DoD, JCAA, Center for Rotorcraft Innovation, Alcoa and Williams International
Integrated Intelligent Flight Deck (IIFD)	Principle Investigator and Project Manager who report to Program Director	LARC, ARC, GRC	FAA, JPDO, CAST, and Boeing
Integrated Resilient Aircraft Control (IRAC)	Principle Investigator and Project Manager who report to Program Director	LARC, DFRC, GRC, ARC	FAA, JPDO, CAST, and Air Force Research Lab (AFRL)

Acquisition Strategy

The Aviation Safety Program spans research and technology from foundational research to integrated system-level capabilities. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NASA Research Announcement is used as the means to solicit innovative proposals in key research areas that compliment NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The AvSP will award approximately $10 million in FY 2009 in grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards will also help to strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Expert Review	04/2006	For each of the Aviation Safety projects, an expert panel was convened to assess the research relevance, scope, quality, balance, and management plans proposed by the Principle Investigator and Project Manager. After the key issues and concerns were addressed through improved project proposals, the review panel submitted recommendations to the ARMD AA for approval. In addition, periodic reviews are carried out by the NASA Advisory Council (NAC).	N/A
Performance	Expert Review	11/2007	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Research Risk	Given that fundamental research is highly dynamic, there is the possibility that milestones may not be met because of things learned along the way (e.g., the milestone may not be possible to achieve or may require more effort).	The AvSP Director will monitor and track progress of all research elements on a monthly basis. In addition, as noted in the Independent Reviews section, ARMD will conduct annual reviews of the AvSP. The Program Director will use the output from these annual reviews to adjust schedule and milestones as needed to mitigate technical and programmatic risk.
Cost/Schedule Risk	Given significant change to cost and/or schedule in a technical deliverable, there is the possibility that the lower priority activities may be descoped or eliminated.	The AvSP Director will monitor and track cost/schedule progress of all research elements on a monthly basis. In addition, as noted in the Independent Reviews section, ARMD will conduct annual reviews of the AvSP. The Program Director will use the output from these annual reviews to adjust schedule and milestones as needed to mitigate cost/schedule risk.
Dependency Risk	Given that technologies from other programs (both external and internal to NASA) do not meet expected technical performance and timeliness, there is the possibility that this program's cost and schedule may slip. In addition, NextGen safety related requirements/needs may change.	The AvSP will monitor and track technology development progress in other programs under prior agreement, and maintain contingency plans as part of those agreements. In addition, the AvSP will monitor NextGen requirements through active participation in the JPDO, including all relevant planning activities, and will modify its research plans if appropriate.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Airspace Systems

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**102.5**	**100.1**	**74.6**	**72.7**	**74.2**	**75.4**	**78.4**
NextGen - Airspace	**85.1**	**83.3**	**61.3**	**56.0**	**57.3**	**58.5**	**60.8**
NextGen - Airportal	**17.4**	**16.8**	**13.3**	**16.7**	**16.9**	**16.9**	**17.5**
FY 2008 President's Budget Request	**92.6**	**98.1**	**91.1**	**90.3**	**91.4**	**92.7**	**0**
NGATS - Airspace	**78.3**	**81.2**	**74.8**	**74.2**	**75.1**	**76.2**	**0**
NGATS - Airportal	**14.3**	**16.9**	**16.2**	**16.1**	**16.2**	**16.5**	**0**
Changes from FY 2008 Request	**10.0**	**2.1**	**-16.5**	**-17.6**	**-17.1**	**-17.3**	**78.4**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Program Overview

The Airspace Systems Program (ASP) focuses on mastery, intellectual stewardship, and technical excellence in fundamental air traffic management research. The ASP directly addresses the air traffic management research needs of the Next Generation Air Transportation System (NextGen) in collaboration with the member agencies of the Joint Planning and Development Office (JPDO). NASA is working closely with the JPDO as well as other government, industry, and academic partners to enable the formation, development, integration, and demonstration of revolutionary concepts, capabilities, and technologies allowing significant increases in capacity, efficiency, and flexibility of the National Airspace System (NAS). These goals are in direct support of the guidelines in the National Aeronautics research and development policy.

Increasing the capacity and efficiency of the air transportation system in a manner that does not negatively impact safety or the environment is critically important for the Nation's economic well-being. More than half of the Nation's busiest airports are already at capacity or will reach capacity limits in the next 10-20 years. Creating new capacity en route or on the airport surface is extraordinarily expensive and can take decades to complete, particularly if environmental constraints and safe separation standards are at issue. In particular, environmental concerns forced 12 major commercial airports to cancel or indefinitely postpone expansion projects since the 1990s. Despite these constraints, air traffic is expected to continue to increase substantially in the next 20 years. All other factors remaining constant, increases will mean longer delays at airports already experiencing delays and create congestion delays at airports not currently experiencing any. The associated environmental impact and economic inefficiencies have been predicted by some to cost the Nation tens of billions of dollars annually. The risk of runway incursions and loss of airborne separation could increase as the volume of air traffic exceeds the capacity of the airspace and airports to safely and efficiently accommodate the increased growth.

For more information, please see http://www.aeronautics.nasa.gov/programs_asp.htm.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Airspace Systems

Program Relevance

JPDO outlined the needs of NextGen by specifying a vision and operating principles. Of primary importance in the principles is that future air traffic management systems will consider user needs and performance capabilities, employ trajectory-based operations, and automate, where appropriate, functions performed by pilots and controllers to optimally utilize human capabilities. The Airspace Systems Program enables the development of these revolutionary improvements to the NAS, and introduction of new systems for vehicles whose operation can take advantage of improved, modern Air Traffic Managment (ATM) systems. The users of these advancements are the FAA, state and local airport authorities, existing and new commercial and personal aviation operators, aircraft developers, and system suppliers for the above. The primary goal of the program is to enable new ATM technologies and aircraft capabilities to increase the capacity and mobility of the NAS. The objectives are to maximize operational throughput, predictability, efficiency, flexibility, and access to the airspace system while maintaining safety, security, and environmental protection, resulting in the benefits of more efficient operations and reduced flight delays.

This program supports Outcome 3E.2. The Program is comprised of two projects: NextGen-Airspace Project and the NextGen-Airportal Project.

Plans For FY 2009

The NextGen Airspace Project will focus on developing capabilities in traffic flow management, dynamic airspace configuration, separation assurance, and airspace super density operations, which are supported by the cross-cutting technical areas: trajectory prediction, synthesis, prediction, and uncertainty; performance based services; and system-level design, analysis and simulation tools. Specifically, in FY 2009, the Airspace Project will complete analysis and laboratory validation of trajectory analysis methods for the simultaneous solution of separation and time-based metering with user-preferred trajectories for multi-aircraft converging flows. Analysis will be conducted for large increases in capacity without reduction of baseline metering accuracy or separation violations under varying traffic complexities with failure modes and off-nominal conditions. Airspace will further develop traffic flow management concepts for increased efficiencies at the regional and national levels for different planning intervals. The Airspace project will also produce a detailed hierarchical structure of required total system performance elements and advanced performance measures needed to support candidate NextGen operational concepts.

The NextGen Airportal Project will focus on developing airportal and terminal capabilities in safe and efficient surface operations, coordinated arrival/departure operations, and airportal transition and integration. Specifically, in FY 2009, the Airportal Project will develop algorithms to generate robust, optimized solutions for surface traffic planning and control, and initial algorithms for airportal arrival and departure balancing. This will include evaluations of benefits in both nominal and off-nominal conditions with increased airportal traffic density and consideration of environmental constraints and aircraft operator schedule preferences. The project will also determine research issues that are on a critical path to airportal metroplex capabilities. Important to all above research activities is the development of human/automation information requirements and decision making guidelines for human-human and human-machine airportal decision making.

Project Descriptions and Explanation of Changes

Airspace Systems Program

The Airspace Systems Program was restructured during FY 2006 to directly address the air traffic management research needs of NextGen in collaboration with member agencies of JPDO. The restructured Program is comprised of two new projects: NextGen-Airspace and NextGen-Airportal. The two projects have been planned to make major contributions to air traffic needs of the future by the development of en route/transitional/terminal capabilities and surface capabilities. Both projects are, much like the airspace system itself, highly integrated, and pay close attention to information management at critical transition interfaces in the national airspace system. A major goal of the Airspace Systems Program is to explore and develop concepts and integrated solutions to define and assess the allocation of centralized and decentralized automation concepts and technologies necessary for NextGen.

In the Program Commitments section, the following acronyms apply: ANSP (Air Navigation Service Provider) and TBM (Time-Based Metering).

NextGen Airspace

The NextGen-Airspace Project will develop and explore fundamental concepts and integrated solutions that address the optimal allocation of ground and air automation technologies necessary for NextGen. The project will focus NASA's technical expertise and world-class facilities to address the question of where, when, how, and the extent to which automation can be applied to moving aircraft safely and efficiently through the NAS. Research in this project will address Four-Dimensional Trajectory Operations, including advances in the science and applications of multi-aircraft trajectory optimization that solves the demand/capacity imbalance problem while taking into account weather information and forecast uncertainties, and keeping aircraft safely separated. The project's research will develop and test concepts for advanced traffic flow management to provide trajectory planning and execution across the spectrum of time horizons from "strategic planning" to "separation assurance." The project will also conduct research to explore dynamic airspace configuration that addresses the technical challenges of migrating from the current structured, static homogenous airspace to a dynamic, heterogeneous airspace that adapts to user demands and meets changing constraints of weather, traffic congestion, and a highly diverse aircraft fleet. Ultimately, the roles and responsibilities of humans and automation influence every technical area and will be addressed thoroughly.

Specific technical goals include:

- Increasing capacity through dynamic allocation of airspace structure and controller resources;
- Effectively allocating demand through departure time management, route modification, adaptive speed control, etc., in the presence of uncertainty;
- Reducing the capacity-limiting impact of human-controlled separation assurance by developing methods to improve sequential processing and merging of aircraft in transition and cruise airspace;
- Developing accurate trajectory predictions that are interoperable with aircraft flight management systems and account for prediction uncertainty growth and propagation;
- Quantifying the performance-enhancing effects of emerging airborne technologies; and
- Developing an approach and computer modeling tools that can evaluate the systematic impact of the research for NextGen.

NextGen Airportal

The NextGen-Airportal Project will enable capacity improvements in the terminal and airport domains to achieve key capabilities of NextGen. The Airportal Project is responding to the need to achieve the maximum possible productivity in the combined use of gates, taxiways, runways, terminal airspace, and other airportal resources. Since every airport is a unique environment, and demand is not expected to increase equally at each airport as the system grows, Airportal will develop and evaluate a suite of capacity-increasing concepts and the system analysis capability to aid tailoring solutions to specific needs.

Specific technical goals include:
- Optimizing surface traffic operations to enable capacity enhancements;
- Exploring transformational approaches, enabled by NextGen capabilities, for increasing airportal throughput;
- Maximizing the capacity of individual runways;
- Maximizing the capacity of multiple runways with airspace and taxi interactions (closely-spaced parallel and converging/intersecting runways);
- Minimizing runway incursion threats in all weather conditions;
- Modeling and predicting wake vortex behavior to enable super density operations;
- Balancing arrival and departure traffic management to enable capacity achievements; and
- Balancing safety and environmental requirements.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
In 2010, conduct simulations and analysis of TBM with ANSP-based automated separation assurance	Airpsace Project	No change
In 2011, complete analysis of ANSP-based automated separation assurance in complex environments	Airspace Project	No change
By 2016, develop and evaluate future airspace concepts, capabilities, and technologies	Airspace Project	The performance measures for the Program were refined in 2007
In 2011, validate initial super-density concepts including a set of culminating experiments	Airportal Project	No change
By 2016, develop and evaluate future airportal concepts, capabilities, and technologies	Airportal Project	The performance measures for the Program were refined in 2007

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Airspace Systems

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the program. The Program Director oversees Program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
NextGen Airspace	Principal Investigator and Project Manager, who report to the Program Director.	ARC, LARC	FAA, JPDO, DOT, Air Force Research Lab (AFRL), Lockheed Martin, Air Services Australia and Eurocontrol
NextGen Airportal	Principal Investigator and Project Manager, who report to the Program Director.	LARC, ARC	FAA, JPDO, DOT and Eurocontrol

Acquisition Strategy

The Airspace Systems Program spans research and technology from foundational research to integrated system-level capabilities. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NASA Research Announcement (NRA) is used as the means to solicit innovative proposals in key research areas that complement NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The Airspace Systems Program will award approximately $19 million in FY 2009 in grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards will also help strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Expert Review	12/2006	For each of the Airspace System Program projects, an expert panel was convened to assess the research relevance, scope, quality, balance, and management plans proposed by the Principal Investigator and Project Manager. After the key issues and concerns were addressed through improved project proposals, the review panel submitted the recommendations to the ARMD AA for approval. In addition, periodic reviews are carried out by the NASA Advisory Council (NAC).	N/A
Performance	Expert Review	11/2007	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Research Risk	Given that cutting-edge research is highly dynamic, there is the possibility that planned milestones may not be met due to knowledge gained along the way (e.g., it may not be possible to achieve the milestones or may require more time and effort).	The ASP Director will monitor and track progress of all research elements on a monthly basis. In addition, as noted in the Independent Reviews section, ARMD will conduct annual reviews of ASP. The Program Director will use the output from these annual reviews to adjust schedule and milestones as needed to mitigate technical and programmatic risk.
Cost/Schedule Risk	Given significant change to cost and/or schedule in a technical deliverable, there is the possibility that lower priority activities may be descoped or eliminated.	The ASP Director will monitor and track cost/schedule progress of all research elements on a monthly basis. In addition, as noted in the Independent Reviews section, ARMD will conduct annual reviews of ASP. The Program Director will use the output from these annual reviews to adjust schedule and milestones as needed to mitigate cost/schedule risk.
Dependency Risk	Given that the NextGen requirements/needs may change, there is a possibility that the strategic roadmap and milestones will require modification.	The ASP will monitor NextGen requirements through active participation in JPDO, including all planning activities, and will modify its research plans if appropriate.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Fundamental Aeronautics

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	330.4	269.9	235.4	233.2	235.2	238.6	244.6
Subsonic - Rotary Wing	36.1	30.8	25.8	26.6	26.7	26.9	28.0
Subsonic - Fixed Wing	133.9	119.9	108.4	105.3	107.6	109.1	111.5
Supersonics	67.7	53.0	44.0	44.9	44.3	45.2	46.6
Hypersonics	92.8	66.2	57.3	56.4	56.5	57.4	58.4
FY 2008 President's Budget Request	305.7	293.4	289.0	285.7	290.1	294.2	0
Subsonic-Rotary Wing	0	32.1	30.9	30.6	30.9	31.3	0
Subsonic-Fixed Wing	164.0	129.1	130.8	129.1	131.9	133.6	0
Supersonics	61.6	54.3	52.3	51.8	52.3	53.1	0
Hypersonics	80.1	78.0	75.0	74.3	75.1	76.2	0
Changes from FY 2008 Request	24.7	-23.5	-53.5	-52.6	-54.9	-55.6	244.6

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Program Overview

The Fundamental Aeronautics (FA) Program is dedicated to the mastery and intellectual stewardship of the core competencies of aeronautics for the Nation across all flight regimes. The long-term research that the FA Program conducts is both focused and integrated across disciplines and will be used to provide feasible solutions to the performance and environmental challenges of future air vehicles. The program also pursues innovative research ideas and modeling techniques that are relevant to low-cost and reliable access to space as well as the entry phase of planetary exploration. Focused technological capabilities that range from basic knowledge of underlying physical phenomena to the understanding of the interactions that occur at the system level are pursued and developed by the program. The results of this pre-competitive research are widely disseminated and available to support the Nation's aerospace industry.

For more information, please see http://www.aeronautics.nasa.gov/fap.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Fundamental Aeronautics

Program Relevance

The work in the FA Program directly benefits the public through the development of techniques and concepts for both subsonic and supersonic vehicles that are cleaner, quieter, and more energy efficient. Research efforts in revolutionary configurations, lighter and stiffer materials, improved propulsion systems, and advanced concepts for high-lift and drag reduction all target the efficiency and environmental compatibility of future air vehicles. NASA's space exploration activities will benefit from fundamental technology advances that can impact our ability to both access space and survive the planetary entry, descent, and landing phase. The FA Program also helps the country develop and maintain excellence in the aeronautics workforce by providing significant research opportunities in all of its projects.

The program supports Outcome 3E.3. The program is comprised of four projects: the Subsonic Fixed Wing (SFW) Project, the Subsonic Rotary Wing (SRW) Project, the Supersonics Project and the Hypersonics Project.

Plans For FY 2009

The Subsonic Fixed Wing (SFW) Project will complete and validate the first generation of a multi-disciplinary analysis and design toolset to evaluate the trades between noise, emissions, and performance of future aircraft entering service in the 2012-2015 timeframe. The project will also develop a database of alternative fuels to enable assessments of their utility leading to benefits of reduced emissions. Alternative fuels must be tailored for performance both in the liquid state and in the vapor phase. Experiments will be completed that establish a database documenting thermal and stability characteristics of alternative fuels.

The Subsonic Rotary Wing (SRW) Project will advance variable/multi-speed drive system modeling tools and concepts to enable a critical capability in propulsion. Variable speed propulsion without loss of efficiency and torque is necessary to permit high-speed operation with reduced noise. In addition, a small-scale test of pressure sensitive paint performance on the blades of a rotor in forward flight will be conducted in the 14x22 Subsonic wind tunnel; and an active flow control test of the fairing of a rotor hub will be conducted to understand flow characteristics and active flow benefits.

The Supersonics Project will enable a robust computational fluid dynamics-based rapid design and analysis capability via the development of adjoint-based grid adaptation methods. The barrier to both military and civil supersonic cruise applications is overall efficiency. Advancements in the tool suite provide analysis capability of supersonic cruise efficient technologies for a range of supersonic aircraft concepts. In addition, closed loop Aero-Servo-Elastic (ASE) testing of a slender flexible supersonic aircraft configuration to validate the effectiveness of techniques for active control of ASE phenomena in this class of vehicle will be conducted.

The Hypersonics Project will advance propulsion cycle technology and increase the fidelity of the analysis capability this year. Validation of the high-Mach turbine fan aerodynamic performance CFD prediction and quantification of the uncertainties pushes the state-of-the-art in this research area. Testing of a Mach 4+ fan stage to evaluate the impact of tip clearance variation and simulated distorted inlet flow on performance operability will be completed.

Project Descriptions and Explanation of Changes

Fundamental Aeronautics Program

The FA Program encompasses the principles of flight in any atmosphere at any speed. In addition to a variety of efforts at the foundational and discipline level, the Program will develop physics-based, multidisciplinary analysis, design, and optimization (MDAO) capabilities that will make it possible to evaluate radically new vehicle designs and to assess, with quantified uncertainties, the potential impact of innovative technologies on a vehicle's overall performance and environmental compatibility. The Program also supports the Agency's human and robotic exploration missions by advancing knowledge in aeronautical areas critical to entry, descent, and landing (EDL).

The FA Program has four projects. The Subsonic Fixed Wing Project will address the challenge that future aircraft need to be quieter and cleaner to meet stringent noise and emissions regulations imposed by the expected growth in the air transportation system (two to three times higher capacity by 2025). These aircraft must also meet challenging performance requirements to make them economically viable alternatives to the existing fleet. The Subsonic Rotary Wing Project will address the technical barriers that constrain rotorcraft from reaching widespread use in civil aviation. These barriers include range, speed, payload capacity, fuel efficiency, and environmental acceptance. The Supersonics Project will conduct research to address the efficiency, environmental, and performance barriers to practical supersonic cruise, as well as the critical issue of supersonic deceleration to enable safe, precision planetary EDL of large payloads in any atmosphere. Because all access to space and all entry from space through any planetary atmosphere require hypersonic flight, the Hypersonics Project will tackle the key fundamental research issues required to make hypersonic flight and re-entry feasible.

Subsonic Fixed Wing

The goal of the Subsonic Fixed Wing Project is to conduct long-term, cutting-edge research in the core competencies of the subsonic fixed wing regime, thereby producing knowledge, data, capabilities, technologies, and design tools at the foundational, discipline, multidiscipline and system levels that will enable improved prediction methods and technologies for lower noise, lower emissions (including NOx, CO2, water vapor, volatiles, unburned hydrocarbons, particulate matter, and soot), and higher performance for subsonic aircraft. Higher performance includes energy efficiency and operability technologies that enable advanced airframe and engine systems. The 10-year strategy includes providing novel test methods and validated prediction tools that can be used to improve system trades for advanced concepts capable of meeting longer-term noise, emissions, and performance targets. The following objectives address the overall project goals:

- Improvements in prediction tools and new experimental methods that provide fundamental properties and establish validation data;

- Noise prediction and reduction technologies for airframe and propulsion systems enabling -52 dB cumulative, below Stage III (1);

- Emissions reduction technologies, alternative fuels, and particulate measurement methods enabling 80 percent reduction in landing and take-off NOx below CAEP/2 (2) and 50 percent reduction as compared to the Boeing 737 with the CFM56 engine; and

- Improved vehicle performance through design and development of lightweight, multifunctional and durable structural components, high-lift aerodynamics, and higher bypass ratio engines with efficient power plants.

Since NASA does not design or manufacture aircraft that can operationally show these improvements, we will use a combination of demonstrated component technologies and system-level assessments to show that our goals could be operationally achieved.

() Footnotes:
1 Stage III refers to a limit imposed by the ICAO (International Civil Aviation Organization) on the maximum allowable noise levels for current aircraft.
2 CAEP/2 refers to the second stage of regulation recommended by the Committee on Aviation Environmental Protection.

Subsonic Rotary Wing

The goal of the Subsonic Rotary Wing Project is to conduct long-term, cutting-edge research in the core competencies of the subsonic rotary wing regime, thereby producing knowledge, data, capabilities, technologies, and design tools at the foundational, discipline, multidiscipline, and system levels that will enable improved prediction methods and technologies for lower noise, lower emissions, and higher performance for rotary wing aircraft. Higher performance includes improved speed, range, payload capacity, propulsion efficiency, and control systems for safe operations. Advances in physics-based prediction capabilities will ultimately lead to a more robust industry ability to develop rotorcraft vehicles that fly as designed.

The specific objectives of the research are driven by five key technical challenge areas: power transmission and generation; control theory and information processing and modeling; fluid mechanics, dynamics, and aero-structural coupling; acoustics physics; and solid mechanics and advanced materials. These technical challenge areas are relevant to a broad range of industry and Government programs, inherently force the integration of multiple disciplines, and involve technical issues that are beyond the reach of current prediction tools. Each of the technical challenges brings together the analytical methods and experimental validation data that are required to advance the state of the art in a multidiscipline environment. Innovative solutions to these technical challenges, coupled with the increased ability to predict with certainty the solutions, will drive breakthrough technologies for the rotorcraft industry. Research in the Subsonic Rotary Wing Project includes the following goals:

- Develop design capabilities for low-noise rotorcraft that include the accurate calculation of blade vortex interaction noise, high-speed impulsive noise, and blade/wake interaction noise;

- Develop acoustic propagation techniques that account for atmospheric effects, terrain, and shadowing so that rotary wing vehicles can be optimized for minimal noise impact while retaining performance and handling quality standards; and

- Enable variable-speed rotor concepts that incorporate the ability to change rotor rotational speed by 50% without performance or handling qualities penalties.

Supersonics

The goal of the Supersonics Project is to conduct long-term, cutting-edge research in the core competencies of the supersonic regime, thereby producing knowledge, data, capabilities, technologies, and design tools at the foundational, discipline, multidiscipline and system levels that will address the technical challenges for two supersonic vehicle classes: practical supersonic cruise aircraft and supersonic descent for High-Mass Mars Entry Systems.

The Supersonics Project is organized along the following major technical challenges that have been identified for the two vehicle classes: efficiency (supersonic cruise, light weight and durability at high temperature); environmental challenges (airport noise, sonic boom, high altitude emissions); performance challenges (aero-propulso-servo-elastic analysis and design, cruise L/D); entry, descent, and landing challenges (supersonic deceleration); and multidisciplinary design, analysis and optimization challenges.

The Supersonics Project will develop technologies to enable overland supersonic cruise with civilian and military applications and exploration systems of high mass and precision landing in support of NASA's space exploration activities. Research in the Supersonics Project includes the following goals:

- Cruise efficiency, comprising improvements in the airframe and propulsion system of approximately 30 percent vs. the final NASA High-Speed Research (HSR) Program baseline;

- Approximately 20 EPNdB of jet noise reduction relative to an unsuppressed jet;

- A reduction of loudness on the order of 30 PLdB relative to typical military aircraft sonic booms;

- Elimination or minimized impact from high-altitude emissions; and

- A 20 to 40-fold increase in landed mass, with improved position accuracy for exploration systems.

Hypersonics

The Hypersonics Project is motivated by the fact that all access to Earth or planetary orbit, and all entry from orbit into Earth's atmosphere or any planet with an atmosphere, requires flight through the hypersonic regime. The goal of the project is to conduct long-term, cutting-edge research in the core competencies of the hypersonic regime, thereby producing knowledge, data, capabilities, and design tools at the foundational, discipline, multidiscipline, and system levels that will address the technical challenges for two high-payoff NASA-unique missions: Highly Reliable Reusable Launch Systems (HRRLS) and High-Mass Mars Entry Systems (HMMES).

Cutting-edge hypersonics research on HRRLS will enable sustained hypersonic flight through the atmosphere with space-access applications. The research focused on HMMES will result in the development of technologies and concepts that can enable the safe and accurate delivery of large payloads to the surface of Mars. This effort will facilitate the entry, descent, and landing (EDL) phase of both human and robotic planetary missions and is closely aligned with the long-term goals of NASA's space exploration activities.

The Hypersonics Project will focus its research on addressing some of the hardest challenges in hypersonics including:

- The development of materials for airframe and propulsion applications that can withstand severe temperatures for extended periods of time;

- The development of predictive models for compressible flow, turbulence, heating, ablation, combustion, and their interactions;

- The creation of advanced control techniques for vehicles that fly in the hypersonic flow regime;

- The generation of new experimental techniques that can be used to validate theoretical and computational models;

- Realizable propulsion systems that integrate high-speed turbine engines or rockets and scramjets; and

- Tying together all of the close interactions among the airframe, inlet, nozzle, and propulsion systems using a physics-based multidisciplinary design analysis and optimization approach.

The HRRLS mission class will provide new air-breathing launch vehicle architectures with increased reliability such as Two-Stage-to-Orbit Turbine-Based Combined-Cycle systems to eventually enable routine low-cost access to space. The HMMES mission research will push technology beyond the state of the art in hypersonic atmospheric entry to successfully land payloads on Mars with masses up to two orders of magnitude greater than is practically realizable today. The emphasis will be on concepts for reduced weight, atmospheric maneuverability, and safety.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
In 2010 finish suite of integrated multidisciplinary analysis tools to predict aircraft performance	Subsonics Fixed Wing	No change
By 2011 develop an integrated tool set to accurately predict performance of subsonic aircraft	Subsonics Fixed Wing	The performance measures for the Program were refined in 2007
In 2010 demonstrate a control optimization tool to control a variable speed engine & transmission	Subsonics Rotary Wing	The performance measures for the Program were refined in 2007
In 2011 validate the ability to predict the effects of active rotor systems for level flight	Subsonics Rotary Wing	No change
By 2012 demonstrate a rotor concept incorporating the ability to change rotor speed without penalty	Subsonics Rotary Wing	No change
In 2010 develop computational models to predict integrated inlet and fan performance and operability	Supersonics	The performance measures for the Program were refined in 2007
In 2011 use a design optimization study to show a 2-week MDAO cycle time for cruise efficiency	Supersonics	The performance measures for the Program were refined in 2007
By 2013 develop framework for supersonic aircraft that are efficient with low noise and emissions	Supersonics	The performance measures for the Program were refined in 2007
In 2010 complete CFD predictions of ramjet-to-scramjet mode-transition, compare to test data	Hypersonics	The performance measures for the Program were refined in 2007
In 2011 evaluate accuracy of models by comparing CFD prediction with test data from tunnel hardware	Hypersonics	No change
In 2011 validate combustor wall thermal-structural performance and critical failure modes	Hypersonics	The performance measures for the Program were refined in 2007
In 2012 develop simulation tool with accuracy to enable highly reliable reusable launch systems	Hypersonics	The performance measures for the Program were refined in 2007

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the FA Program. The Program Director oversees Program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Subsonics Fixed Wing	Principal Investigator and Project Manager who report to the Program Director	ARC, DFRC, GRC, LaRC	Air Force Research Lab (AFRL), Boeing, Pratt & Whitney, Northrop Grumman, A.R. Associates, ENrG Inc., General Electric Aviation, Gulfstream Aerospace, and United Technologies Corporation
Subsonics Rotary Wing	Principal Investigator and Project Manager who report to the Program Director	ARC, GRC, LaRC	U.S. Army, U.S. Air Force, U.S. Navy, Center for Rotorcraft Innovation (CRI), Bell Helicopter, Sikorsky, ZFL, Helowerks, Inc.,, Boeing, DARPA, FAA, Helowerks, Polyumac, Technocore, Gulfstream Aerospace, ZFL and Sikorsky
Supersonics	Principal Investigator and Project Manager who report to the Program Director	ARC, DFRC, GRC, LaRC	Gulfstream Aerospace, Lockheed Martin, AFRL, Aerion Corporation and DARPA
Hypersonics	Principal Investigator and Project Manager who report to the Program Director	ARC, DFRC, GRC, LaRC	AFRL, U.S. Air Force Office of Scientific Research (AFOSR), U. S. Navy, Deputy Undersecretary of Defense for Science and Technology, DARPA, ATK, and Dover ILC

Acquisition Strategy

Acquisitions within the program provide the basic elements for fundamental research, tools and methods development, enabling technologies, and validation and verification of research results. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NASA Research Announcement (NRA) is used as the means to solicit innovative proposals in key research areas that compliment NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The Fundamental Aeronautics Program will award approximately $43 million in FY 2009 in grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards will also help to strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Expert Review	04/2006	For each of the Fundamental Aeronautics projects, an expert panel was convened to assess the research relevance, scope, quality, balance and management plans proposed by the Principal Investigator and Project Manager. After the key issues and concerns were addressed through improved project proposals, recommendations for approval were submitted by the review panel to the ARMD AA. In addition, periodic reviews are carried out by the NASA Advisory Council (NAC).	N/A
Performance	Expert Review	11/2007	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Research Risk	Given that fundamental research is highly dynamic, there is the possibility that milestones may not be met because of knowledge gained along the way (e.g., the milestone may not be possible to achieve or may require more time or effort).	Fundamental Aeronautics will mitigate this risk by conducting assessments of all research elements as part of the formal 12-month review noted in the Independent Review section. The 10-year research plans will be updated as appropriate.
Cost/Schedule Risk	Given significant change to cost and/or schedule in a technical deliverable, there is the possibility that lower priority activities may be descoped or eliminated.	The FA Program Director will monitor and track cost/schedule progress of all research elements on a monthly basis. In addition, as noted in the Independent Reviews section, ARMD will conduct annual reviews of the FA Program. The Program Director will use the output from these annual reviews to adjust schedule and milestones as needed to mitigate cost/schedule risk.
Dependency Risk	Given that technologies from other programs (both external and internal to NASA) do not meet expected technical performance and timeliness, there is the possibility that this program's cost and schedule may slip.	The FA Program will monitor and track technology development progress in other programs under prior agreement, and maintain contingency plans as part of those agreements. In addition, the FA Program will monitor NextGen requirements through active participation in JPDO, including all relevant planning activities, and will modify its research plans if appropriate.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Test Program

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**73.5**	**75.1**	**73.9**	**75.8**	**78.0**	**78.2**	**78.2**
Aero Ground Test Facilities	**48.5**	**50.0**	**48.2**	**49.4**	**50.8**	**51.0**	**51.0**
Flight Operations and Test Infrastructure	**25.0**	**25.1**	**25.6**	**26.4**	**27.2**	**27.2**	**27.2**
FY 2008 President's Budget Request	**54.1**	**88.4**	**90.2**	**89.2**	**89.4**	**89.5**	**0**
Aero Ground Test Facilities	**52.5**	**57.6**	**58.9**	**58.0**	**58.3**	**58.4**	**0**
Flight Operations and Test Infrastructure	**1.6**	**30.8**	**31.3**	**31.2**	**31.1**	**31.1**	**0**
Changes from FY 2008 Request	**19.4**	**-13.3**	**-16.3**	**-13.4**	**-11.4**	**-11.3**	**78.2**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Test Program

Program Overview

In 2005, the President gave NASA a Vision for Space Exploration. As NASA integrated its implementation plans for the new Vision through the Exploration Systems Mission Directorate and into its already aggressive portfolio of ARMD, Science Mission Directorate, and Space Operations Mission Directorate activities, it became clear that NASA would need to review management practices with respect to its institution that would meet the cost effectiveness and efficiency needs of its users. At the time, NASA's management approach for major test facilities was for each NASA Research Center to be fully responsible for their Center's facilities. This approach limited the potential ability to pursue Agency-wide approaches and hampered interaction. In response, the Aeronautics Test Program (ATP) was developed in FY 2006 as an element of the Strategic Capabilities Assets Program (SCAP), formally reporting through ARMD, to establish corporate management of NASA's aeronautics ground test facilities to optimize utilization of the Agency's wind tunnel and air breathing propulsion test facility assets for efficiency and cost effectiveness; to sustain and improve NASA's core capability of wind tunnel and air breathing propulsion testing; and to ensure a minimum core capability is maintained. As ATP was being formulated in FY 2006, additional NASA assets came under consideration through the SCAP. In FY07, the Western Aeronautical Test Range (WATR), Support Aircraft, Test Bed Aircraft, and the Simulation and Loads Laboratories at Dryden Flight Research Center (DFRC) were added to ATP through the SCAP.

ATP is a long-term, funded commitment by NASA to retain and invest in test capabilities that are considered to be important to the Agency and the Nation. Through ATP, the Agency will adopt consistent processes and procedures across the NASA Research Centers for operations and maintenance of the major wind tunnels/ground test facilities and flight operations/test infrastructure. ATP will review the status of its assets annually, and will ensure that near-term decisions, such as that to close or invest in a facility, have been considered from a National point of view. ATP will also coordinate investments with the Department of Defense (DoD).

For more information, see http://www.aeronautics.nasa.gov/atp.

Program Relevance

NASA's Vision and Mission are implemented through its four Mission Directorates. All four of these Mission Directorates, in carrying out their mission for NASA, utilize NASA's major wind tunnels/ground test facilities, and flight operations/test infrastructure. The Aeronautics Test Program (ATP) is designed to corporately manage these assets and sustain and improve NASA's core capabilities in these assets to ensure that a minimum core capability is maintained and available to support the needed Mission Directorate testing. ATP's purpose is to ensure the strategic availability of a minimum, critical suite of aeronautical test facilities that are necessary to meet the long-term needs and requirements of the Nation.

The need for reliable facilities to support future NASA aeronautics research, NASA human and robotic space exploration development, DoD military systems development, and the commercial sector development of new civil aircraft presents the ATP with significant challenges. Today's users are looking for excellent service with extremely dependable test results, yet also demand cost effectiveness and efficiency.

The program supports Outcome 3E.4.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Test Program

Plans For FY 2009

As part of ATP's continuous efforts to improve facility operational efficiencies, the ATP-sponsored National Strain Gage Balance Team completed its technical review and concluded that NASA's capability to utilize strain gage balances in wind tunnel testing has severely eroded. These instruments are critical since they are required to measure model forces and moments and simultaneously hold the model in the wind tunnel. Final study recommendations are currently under review, and implementation will begin in FY 2008 and continue into FY 2009. This will be a multi-year project to address gaps and deficiencies in the Government and industry's state-of-the-art strain gage balance technology capability.

A series of tests in the ATP transonic wind tunnels that began in FY 2008 will be completed in FY 2009. ATP partnered with the USAF, using the Arnold Engineering Development Center's (AEDC's) 16T transonic wind tunnel. The objective is to compare the results from each facility using an agreed upon test matrix and a common wind tunnel model. The test team from each facility will participate in the tests at other facilities and share all test processes, techniques, and data reduction methods. This will lead to consistent practices not only among the ATP facilities, but with AEDC as well, and will be the first U.S. government transonic wind tunnel comparison conducted in thirty years

A comprehensive assessment of the wind tunnel systems maintenance requirements and the facility staff capabilities will be carried out in FY 2008 and used in the development of a long term investment and staffing strategy starting in FY 2009.

Also, ATP will conduct and participate in several significant meetings and collaborative activities, including quarterly reviews with the NASA Research Centers (Langley, Ames, Glenn, and Dryden) and the USAF Arnold Engineering Development Center; and semi-annual meetings with the National Partnership for Aeronautical Testing.

Project Descriptions and Explanation of Changes

Aeronautics Test Program

The Aeronautics Test Program has been organized into two projects to support the above investment portfolio. Aero Ground Test Facilities Project supports wind tunnels and aero-propulsion test facilities at Ames Research Center, Glenn Research Center and Langley Research Center and the Flight Operations and Test Infrastructure Project supports aircraft and the infrastructure at DFRC required to carry out flight research. A brief description of the projects follows.

Aero Ground Test Facilities

- Facility Operations Support: Provide 60 percent to 75 percent of the facility fixed costs for ground test facilities to ensure facility and staff availability and user price stability.

- Facility Maintenance and Upgrades: Provide funding for maintenance and upgrades that correct known deficiencies in facility safety, reliability, and productivity and enable the facilities to meet near-term and future testing requirements. These activities will result in improved facility productivity and reduced operational cost.

- Facility Test Technology: Provide funding to develop and implement new technologies that increase test capability, improve productivity and efficiency, and improve data quality.

- Facility Related Research: Activities in this project will be competed openly with a strong desire to involve universities with experimental work in major facilities. It is anticipated that one or more ATP assets will be utilized to develop technologies that will support either the facility operation or the other ARMD research programs.

Flight Operations and Test Infrastructure

- Western Aeronautical Test Range, Support Aircraft Maintenance and Operations, Testbed Aircraft: Provide up to 100 percent of the facility fixed costs for flight facilities to ensure facility and staff availability and user price stability.

- Simulation and Flight Landing Loads Laboratories: Provide up to 20 percent of the fixed costs for labs to ensure facility and staff availability and user price stability.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
In 2010-2012, deliver at least 96% of on-time availability for operations and research facilities	Facility Operations Support Project	No change

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Test Program

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the program. The Program Director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Facility Maintenance Project	Senior managers of ATP facilities at ARC, DFRC, LaRC, & GRC have key implementation responsibilities	ARC, GRC, LaRC, and DFRC	
Facility Upgrades and Test Technology Project	Senior managers of ATP facilities at ARC, DFRC, LaRC, & GRC have key implementation responsibilities	ARC, GRC, LaRC, and DFRC	DoD and Boeing
Facility Related Research Project	Senior managers of ATP facilities at ARC, DFRC, LaRC, & GRC have key implementation responsibilities	ARC, GRC, LaRC, and DFRC	
Facility Operations Support Project	Senior managers of ATP facilities at ARC, DFRC, LaRC, & GRC have key implementation responsibilities	ARC, GRC, LaRC, and DFRC	DoD

Acquisition Strategy

Acquisitions supporting ATP activity will be performed at each of the test sites consistent with the Federal Acquisition Regulation (FAR) and the NASA FAR Supplement (NFS). Each Center will be responsible for coordinating major acquisitions supporting ATP activities through the ATP Office as required by the ATP Director. Acquisitions that support the ATP facilities are usually less than $0.5 million and are initiated as early in the fiscal year as possible. This is inclusive of the annual NASA Research Announcement (NRA) activities within ARMD. Larger ATP acquisitions are typically facility investments, and the funds are usually converted to Construction of Facilities (CoF) funds.

A full and open NASA Research Announcement (NRA) is used as the means to solicit innovative proposals in key research areas that compliment NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The Aeronautics Test Program will award approximately $1.0 million in FY 2009 in grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards will also help to strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NAC and ATP Users	03/2007	Periodic reviews are carried out by the NASA Advisory Council (NAC) and the U.S. users of ATP facilities. The last ATP review was carried out by the Aeronautics Committee of the NAC in Feb. 2007; no major findings were reported. The last major community outreach meeting was held in March 2007 with NASA, DoD and U.S. aerospace industry users. The next meeting with the ATP users is planned for March 2008.	03/2008
Performance	Review Panel	11/2007	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
ATP Risk Management	ATP assets are prioritized based upon national and Agency program relevance, uniqueness, and capabilities. The assets ranked highest receive increased funding. Given significant change in program needs or national priorities, there is a risk that lower priority facilities will not be readily available if short notice of requirement is given	The Agency will review the facility prioritization on an annual basis and realign the ATP budget profile in order to ensure that facilities, which are critical to NASA programs, other government agency programs and to the U.S. aerospace industry are available when required at reasonable pricing levels. ATP will work closely with DoD through the National Partnership for Aeronautical Testing (NPAT).

Overview

The Exploration Systems Mission Directorate (ESMD) develops capabilities and supporting research and technology that enable sustained and affordable human and robotic exploration. ESMD is also developing a robotic precursor mission, human transportation elements, and life support systems for the near-term goal of lunar exploration.

Since the President and Congress committed our Nation to a multigenerational effort to explore the Moon and Mars, NASA has laid out an organization that fully utilizes Agency resources to meet this challenge. Exploration Systems includes two Themes that work together to enable sustainable exploration in the solar system: Constellation Systems and Advanced Capabilities. Development of the space transportation system to support exploration requires close coordination with the Space Operations Mission Directorate, as NASA prepares to phase out the Space Shuttle and its extensive support system. ESMD also uses the International Space Station to conduct research and demonstrate technology to enable future exploration missions. And, with the goal of human lunar exploration in sight, the Science Mission Directorate will play a key role in gathering scientific data and planning future research.

Constellation Systems has worked to develop an increasingly mature design; prime contractors for major systems are now in place, and requirements continue to undergo refinement leading up to Preliminary Design Review in 2008. Following the initial capabilities, Constellation Systems will develop crew capabilities for a lunar surface mission by 2020. Future development will provide crew, cargo transportation, and destination support capabilities required for human exploration of Mars and beyond.

An important element of Constellation Systems is the Commercial Crew and Cargo Program. The Commercial Orbital Transportation Services Projects are intended to spur private industry to provide cost-effective transportation to the International Space Station, allowing NASA to focus its internal resources on exploration.

The Advanced Capabilities Theme consists of three programs: the Lunar Precursor Robotic Program, the Exploration Technology Development Program, and the Human Research Program. Activities within these programs help prepare for human lunar exploration, test new technologies that enable exploration, and further understanding of the effects of space on human performance.

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**2,869.8**	**3,143.1**	**3,500.5**	**3,737.7**	**7,048.2**	**7,116.8**	**7,666.8**
Constellation Systems	2,114.7	2,471.9	3,048.2	3,252.8	6,479.5	6,521.4	7,080.5
Advanced Capabilities	755.1	671.1	452.3	484.9	568.7	595.5	586.3
FY 2008 President's Budget Request	**4,152.5**	**3,923.8**	**4,312.8**	**4,757.8**	**8,725.2**	**9,076.8**	**--**
Constellation Systems	3,232.5	3,117.6	3,664.2	4,131.5	8,038.4	8,368.4	--
Advanced Capabilities	920.0	806.2	648.6	626.3	686.8	708.4	--
Total Change from FY 2008 President's Budget Request	**-1,282.7**	**-780.7**	**-812.3**	**-1,020.1**	**-1,677.0**	**-1,960.0**	**7,666.8**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual Column, the 2008 Omnibus Appropriations Act (P.L. 110-161) and the 5-year Proposed Budget estimates for 2009 through 2013. FY 2008 Adjusted President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Budget Changes

Budget Authority ($ millions)	Actual FY 2007	Enacted FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-1,282.7**	**-780.7**	**-812.3**	**-1,020.1**	**-1,677.0**	**-1,960.0**	**7,666.8**
Constellation Systems	**-1,117.8**	**-645.7**	**-616.0**	**-878.7**	**-1,558.8**	**-1,847.0**	**7,080.5**
Programmatic Content	-682.0	-73.4	-32.8	-60.6	-78.0	-81.5	7,080.5
Programmatic Transfers	--	--	78.4	-86.5	-67.3	-300.4	--
Institutional Adjustments	-435.8	-572.3	-661.6	-731.6	-1,413.5	-1,465.1	--
Advanced Capabilities	**-164.9**	**-135.0**	**-196.3**	**-141.4**	**-118.2**	**-113.0**	**586.3**
Programmatic Content	--	10.2	-4.4	9.2	8.0	7.9	586.3
Programmatic Transfers	--	--	-77.0	-42.1	-8.1	0.2	--
Institutional Adjustments	-164.9	-145.2	-114.9	-108.5	-118.1	-121.1	--

Note: Programmatic reductions in FY07 reflect adjustments resulting from the FY 2007 Revised Continuing Appropriations Resolution P.L. 110-5, as discussed in the Adjusted FY 2008 PBR delivered in June 2007.

Explanation of Mission Directorate Changes

Exploration Systems

Constellation Systems

Programmatic Content:

Transfers International Space Station Cargo Crew Services funding to Space Operations Mission Directorate (SOMD), Small Business Innovative Research recalculation to Innovative Partnership Programs, IT critical infrastructure to Institutional Investments.

Programmatic Transfers:

Transfers non-lunar Space Communications to SOMD, Independent Technical Authority to Center Management & Operations, critical path engine work from Exploration Technology Development Program (ETDP) to Constellation Systems, portion of Program Support funding to ETDP. In addition, responsibility for the Delta II lien formerly held in the Lunar Reconnaissance Orbiter line has been assumed by the Science Mission Directorate; funding held for this lien is reallocated from Lunar Precursor Robotic Program to Constellation Systems.

Institutional Adjustments:

Institutional Adjustments reflect the Agency reallocation of indirect costs which includes Corporate G&A, CM&O, and Institutional Investments.

Advanced Capabilities

Programmatic Content:

No change since Revised FY 2008 IBPD.

Programmatic Transfers:

Lunar Precursor Robotic Program:
Transfers responsibility for the Delta II lien to the Science Mission Directorate; funds previously held for this offset transfer to Constellation Systems Program.

Exploration Technology Development Program:
Transfers Near Earth Objects Observations Program to Science Mission Directorate, Independent Technical Authority to Center Management & Operations, Grants Processing to Corporate G&A; transfers funds for critical path engine work to Constellation, portion of Constellation Systems Program Support budget to Exploration Technical Development Program.

Human Research Program:
No change.

Institutional Adjustments:

Institutional Adjustments reflect the Agency reallocation of indirect costs which includes Corporate G&A, Center Management & Operations, and Institutional Investments.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**2,114.7**	**2,471.9**	**3,048.2**	**3,252.8**	**6,479.5**	**6,521.4**	**7,080.5**
Constellation Systems Program	2,023.6	2,341.4	2,875.1	3,221.5	6,479.5	6,521.4	7,080.5
Commercial Crew and Cargo	91.1	130.5	173.0	31.3	--	--	--
FY 2008 President's Budget Request	**3,232.5**	**3,117.6**	**3,664.2**	**4,131.5**	**8,038.4**	**8,368.4**	**--**
Constellation Systems Program	3,232.5	3,117.6	3,664.2	4,131.5	8,038.4	8,368.4	--
Total Change from FY 2008 Request	**-1,117.8**	**-645.7**	**-616.0**	**-878.7**	**-1,558.8**	**-1,847.0**	**7,080.5**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual Column, the 2008 Omnibus Appropriations Act (P.L. 110-161) and the 5-year Proposed Budget estimates for 2009 through 2013. FY 2008 Adjusted President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-1,117.8**	**-645.7**	**-616.0**	**-878.7**	**-1,558.8**	**-1,847.0**	**7,080.5**
Constellation Systems Program	**-1,099.0**	**-553.5**	**-578.5**	**-872.8**	**-1,558.8**	**-1,847.0**	**7,080.5**
Programmatic Content	-682.0	-11.4	-32.8	-60.6	-78.0	-81.5	7,080.5
Programmatic Transfers	--	--	78.4	-86.5	-67.3	-300.4	--
Institutional Adjustments	-417.0	-542.1	-624.1	-725.7	-1,413.5	-1,465.1	--
Commercial Crew and Cargo	**-18.8**	**-92.2**	**-37.5**	**-5.9**	**--**	**--**	**--**
Programmatic Content	--	-62.0	--	--	--	--	--
Institutional Adjustments	-18.8	-30.2	-37.5	-5.9	--	--	--

Note: Programmatic reductions in FY 2007 reflect adjustments resulting from the FY 2007 Revised Continuing Appropriations Resolution P.L. 110-5, as discussed in the Adjusted FY 2008 President's Budget Request delivered in June 2007.

Explanation of Program Changes

Constellation Systems Program

Programmatic Content: transfers International Space Station Cargo Crew Services to Space Operations Mission Directorate, Small Business Innovative Research recalculation to Innovative Partnerships Program, Information Technology infrastructure to Institutional Investments.

Programmatic Transfers: non-lunar Space Communications to Space Operations Mission Directorate, remaining Technical Authority to Center Management and Operations, critical path engine funding from Exploration Technology Development Program (ETDP), portion of Program Support allocation to ETDP. In addition, responsibility for the Delta II lien previously held in the Lunar Reconnaissance Orbiter line of the Lunar Precursor Robotic Program has been assumed by the Science Mission Directorate; funding for this activity transfers to Constellation Systems.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems

Theme Overview

The Constellation Systems Theme consists of the Constellation Systems Program and the Commercial Crew and Cargo Program:

Constellation Systems Program

NASA initiated the Constellation Systems Program to achieve the NASA Strategic Goal 4 by developing new space transportation capabilities. So far, the program includes the Orion Crew Exploration Vehicle, the Ares I Crew Launch Vehicle, spacesuits and tools required by the flight crews, and associated ground and mission operations infrastructure to support initial low Earth orbit missions. Orion and Ares I are currently targeted for operation no later than 2015.

Following the initial phase, Constellation Systems will develop crew and cargo capabilities for a mission to the lunar surface, no later than 2020. As currently planned, this system will include the Ares V Cargo Launch Vehicle, Earth Departure Stage, Altair Lunar Lander, and associated support capabilities.

Commercial Crew and Cargo Program

The Commercial Crew and Cargo Program is the Exploration System Mission Directorate's effort to spur the parallel development of a cost-effective commercial space transport capability. This capability will initially be utilized by the Space Operations Mission Directorate to carry cargo to the International Space Station (ISS) and there are future options for developing a crew transportation capability.   As the Space Shuttle nears retirement, NASA's preferred solution for ISS crew and cargo delivery and return requirements is to utilize commercial services provided by space transport companies.   The Commercial Crew and Cargo Program encourages the development and demonstration of these services from domestic companies. NASA's Commercial Orbital Transportation Services (COTS) Projects are intended to facilitate U.S. private industry's development of cargo and crew space transportation capabilities with the goal of demonstrating reliable, cost-effective access to low Earth orbit.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Constellation Systems Theme supports the Nation's Vision for Space Exploration by developing the transportation and infrastructure necessary to enable a sustained and affordable human program to explore the Moon in preparation for missions to destinations beyond as well as to stimulate the development of crew and cargo transport to the International Space Station.

Since NASA's creation in 1958, NASA has been tasked with stimulating the commercial sector and has sought commercial partnerships. The Commercial Crew and Cargo Program continues that relationship. By helping emerging companies expand their services and increase their experience, NASA hopes to encourage the growth of a competitive market that will help to reduce launch costs and provide NASA with access to new capabilities. NASA seeks to stimulate the emerging U.S. space transport sector and accelerate the growth of the commercial space industry by awarding prizes and intellectual property rights for achievements in creating space technologies and systems.

Relevance to the NASA Mission and Strategic Goals:

The Constellation Systems Theme supports NASA's Mission to pioneer the future of space exploration and scientific discovery by developing the systems needed to enable scientific activities and discoveries not obtainable with robotic explorers alone. The Constellation Systems Program specifically supports NASA Strategic Goals 4 and 6 by developing new space transportation capabilities and supporting systems for the return of a human mission to the Moon and destinations beyond.

The Commercial Crew and Cargo Program satisfies the objective of Strategic Goals 2 and 5 by demonstrating launch services capabilities by emerging commercial partners and by obtaining International Space Station cargo delivery and return services provided by emerging companies.

Relevance to education and public benefits:

As with past and current human exploration programs, NASA's efforts to develop Constellation systems will accelerate the development of technologies that are important for the economy and national security while providing a training ground for the next generation of scientists and engineers. Furthermore, Constellation Systems will serve as a public symbol of the Nation's continued commitment to human space exploration, much as the Shuttle has over the past 25 years. NASA anticipates that the exploration initiatives will spark the public's imagination and inspire the Nation's youth to pursue careers in science, technology, engineering, and mathematics as a result of their renewed interest in space.

NASA, through the Commercial Crew and Cargo Program, is encouraging the U.S. commercial space sector through more creative, less traditional approaches. In FY 2006, NASA entered into Space Act Agreements with emerging companies to demonstrate International Space Station cargo transportation services.

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 4	**Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.**					
Outcome 4.1	**No later than 2015, and as early as 2010, transport three crewmembers to the International Space Station and return them safely to Earth, demonstrating an operational capability to support human exploration missions.**		**Green**	**Green**	**Green**	**Yellow**
APG 9CS1	Complete the Critical Design Review (CDR) for the Orion / Crew Exploration Vehicle (CEV).	Constellation Systems Program				Yellow
APG 9CS12	Complete the Preliminary Design Review (PDR) for the Constellation Program flight capability (PDR #1).	Constellation Systems Program				None
APG 9CS2	Complete the Critical Design Review (CDR) for the Ares I Upper Stage (US) element.	Constellation Systems Program				Yellow
APG 9CS3	Complete the Critical Design Review (CDR) for the Pad B Launch Complex development within the Ground Operations Project.	Constellation Systems Program				Green
APG 9CS4	Complete the Preliminary Design Review (PDR) of the Mission Control Center System (MCCS) within the Mission Operations Project.	Constellation Systems Program				Green
APG 9CS5	Complete the Preliminary Design Review (PDR) for the Extravehicular Activity (EVA) Space Suit Element for CEV.	Constellation Systems Program				Green
APG 9CS6	Complete the launch and flight analysis of the CEV Pad Abort 1 (PA-1) test.	Constellation Systems Program				Yellow
APG 9CS7	Complete the launch and flight analysis of the Ares 1-X sub-orbital test.	Constellation Systems Program				None
Outcome 4.2	**By 2010, successfully transition applicable Shuttle components, infrastructure, and workforce to the Constellation Systems program.**					**New**
APG 9CS8	Demonstrate progress towards the transition of Space Shuttle and Space Station workforce and infrastructure for utilization in Constellation, including the transfer of the Vertical Assembly Building, configuration of Launch Complex 39-B and the Mobile Launch Platform 1 for the Ares 1-X test.	Constellation Systems Program				None

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 5	**Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.**					
Outcome 5.2	**By 2010, demonstrate one or more commercial space services for ISS cargo and/or crew transport.**		**Green**	**Green**	**Green**	**Green**
APG 9CS10	Have at least three funded and unfunded Partners receiving technical assistance through the COTS Assistance Team (CAT) and making progress toward orbital demonstrations of commercial crew and cargo systems.	Constellation Systems Program				Yellow
APG 9CS9	Have at least one Partner complete a minimum of one orbital demonstration flight in FY 2009.	Constellation Systems Program				Yellow
Strategic Goal 6	**Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.**					
Outcome 6.5	**No later than 2020, demonstrate the capability to conduct an extended human expedition to the lunar surface and lay the foundation for extending human presence across the solar system.**					**None**
APG 9CS11	Conduct the Lunar Capabilities SRR to define the lunar mission architecture transportation requirements.	Extended Lunar Stay Capability				None

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Constellation Systems Theme					
APG 9CS12	Complete all development projects within 110% of the cost and schedule baseline.				White
APG 9CS13	Reduction in ground operations cost (through 2012) of the Constellation Systems based on comparison with the Space Shuttle Program.				None

Performance Achievement Highlights:

The Constellation Systems Program Systems Requirements Review (SRR) was completed in November 2006 which initiated a "season of SRRs" for the Constellation projects (Orion, Ares I, Ground Operations, Mission Operations, Extravehicular Activity). This "season of SRRs" culminated with a Program Baseline Synchronization Review in May 2007 that integrated findings and aligned the individual project SRRs in preparation for the Systems Definition Review (SDR) in Summer 2008 and Preliminary Design Review in late 2008. As part of the normal systems engineering process, the baseline architecture for Orion and Ares I as well as the other elements of the Constellation Systems Program continue to undergo refinement via key system-level and element-level trades and analyses to validate the design concepts against the requirements and/or determine whether changes to the baseline design concepts are warranted. This trades and analyses activity initiates the SDR phase of the projects.

The Constellation Systems Program has also moved beyond initial concepts and into development, hardware fabrication and testing. Engineers at NASA's Marshall Space Flight Center in Huntsville, Alabama, have conducted almost 4000 hours of wind tunnel testing on subscale models of the Ares I Crew Launch Vehicle to simulate how the current vehicle design performs in flight. Subscale engine main injector hardware have undergone hot-fire testing at Marshall. These tests support development of the upper stage engine for NASA's Ares I crew launch vehicle and Earth Departure Stage of the Ares V cargo launch vehicle. Both the Orion and Ares projects have conducted numerous recovery parachute drop tests in Yuma, Arizona, to better understand the reefing performance of the pilot and main chutes. In 2007, the Orion Project tested several options for landing systems which included air bag systems of varying configurations and began fabrication of a flight test article for Pad Abort Test -1, which is currently scheduled for 2008.

In August 2006, RpK and SpaceX entered funded Space Act Agreements with NASA to develop cargo transportation to and from low Earth orbit by 2010. In FY 2007, SpaceX implemented the plans outlined in their agreement, while RpK encountered difficulty and worked with the Agency on a resolution. Unfortunately, RpK was unable to perform against the agreement milestones and their Space Act Agreement was terminated.

For more information, see Strategic Goals 4 and 5 in the FY 2007 Annual Performance Report, included in this budget.

Quality

Program Assessment Rating Tool (PART):

The Constellation Systems Theme received a FY 2006 PART rating of "Adequate." The rating reflected a strong ability to convey the program's purpose and design, combined with a low rating in program accountability due to a lack of independent review planning at that time, as well as an inability to demonstrate performance and efficiencies due to the immaturity of the program, which was still in formulation at that time.

Several performance improvement areas were identified. Specifically, the Constellation Program is to:
1) Conduct planned internal reviews;
2) Plan and conduct a comprehensive external program review; and
3) Develop and baseline metrics for the transition of activities and assets from the Space Operations Mission Directorate programs to Constellation Systems.

Constellation Systems progressed through all of the Constellation Systems project System Requirements Reviews. The next internal reviews are the System Definition Reviews scheduled to finish by the third quarter of fiscal year 2008 for all projects. The Preliminary Design Review for the Constellation Systems Program is scheduled for completion by the fourth quarter of fiscal year 2008. NASA is implementing a plan for external evaluation through Standing Review Boards, which are evaluating performance throughout the design lifecycle of the program and projects. Baseline metrics (i.e., cost, schedule, throughput, effectiveness) for transition of activities and assets from Space Operations to Constellations Systems are under development. The program is working closely with the Space Operations Mission Directorate to ensure metrics are captured.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	IPAO standing review board	10/2007	Program Acceptance Review (PAR). Per NASA 7120 guidelines, independent reviews of NASA programs will not be conducted as separate reviews. Instead, members of the IPAO will participate as non-voting members of program and project reviews and submit an independent report. The purpose of the PAR is to review the systems engineering best practices, evaluate the architecture and its consistency with available budget, schedule, and risk management.	09/2008

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**2,023.6**	**2,341.4**	**2,875.1**	**3,221.5**	**6,479.5**	**6,521.4**	**7,080.5**
Program Integration and Operations	**661.8**	**530.8**	**748.2**	**815.8**	**2,337.0**	**2,332.8**	**3,070.0**
Crew Exploration Vehicle	**479.5**	**775.7**	**1,101.4**	**1,104.9**	**1,745.9**	**1,556.8**	**1,282.8**
Crew Launch Vehicle	**882.3**	**999.2**	**1,018.5**	**1,276.8**	**2,031.7**	**1,744.7**	**1,497.7**
Cargo Launch Vehicle	**0**	**35.7**	**7.0**	**24.0**	**365.0**	**887.0**	**1,230.0**
FY 2008 President's Budget Request	**3,232.5**	**2,881.7**	**3,505.4**	**4,090.2**	**8,038.4**	**8,368.4**	**0**
Program Integration and Operations	**1,084.9**	**662.2**	**767.1**	**1,408.2**	**4,080.6**	**4,716.8**	**0**
Crew Exploration Vehicle	**1,001.1**	**950.8**	**1,560.2**	**1,410.7**	**1,607.0**	**1,125.1**	**0**
Crew Launch Vehicle	**916.1**	**1,224.8**	**1,126.7**	**1,220.0**	**1,817.2**	**1,334.9**	**0**
Cargo Launch Vehicle	**0**	**43.8**	**51.5**	**51.3**	**533.6**	**1,191.6**	**0**
Commercial Orbital Transportation Services	**230.4**	**0**	**0**	**0**	**0**	**0**	**0**
Changes from FY 2008 Request	**-1,208.9**	**-540.2**	**-630.3**	**-868.7**	**-1,558.8**	**-1,847.0**	**7,080.5**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual Column, the 2008 Omnibus Appropriations Act (P.L. 110-161) and the 5-year Proposed Budget estimates for 2009 through 2013. FY 2008 Adjusted President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program

Program Overview

The Vision for Space Exploration calls for sustained and affordable exploration program to explore the solar system, including a return to the Moon by the end of the next decade, to establish a sustained human presence there and open the path to other destinations including Mars. NASA's space exploration activity is now in a period of transition, as NASA works to complete the International Space Station and retire the Shuttle fleet by 2010 while developing new vehicles needed for exploration.

Already, the Constellation Systems Program is focused on the next generation of human spacecraft. The Ares I Cargo Launch Vehicle will propel the Orion Crew Exploration Vehicle to low Earth orbit. Both Ares and Orion draw on the best elements of the Apollo and Shuttle programs to create safe, reliable, and affordable systems. These vehicle designs were conceived during the FY 2005 Exploration Systems Architecture Study, and have continued to undergo refinement as plans for a new space exploration transportation system take shape. In addition to Orion and Ares I, work is underway to develop the extravehicular activity suits and tools required by flight crews, as well as associated ground and mission operations systems.

Orion will be America's new spacecraft for human space exploration. It will carry four crew members to the Moon and serve as the primary exploration vehicle for future missions. It also will be capable of ferrying up to six astronauts (plus additional cargo) to and from the International Space Station if commercial transport services are unavailable. The Ares I will consist of a solid rocket booster and an upper stage that can carry Orion into low Earth orbit. Both Orion and Ares I are currently targeted for operation no later than 2015, and the first sortie mission to the Moon is planned for no later than 2020. While the program is working to an earlier schedule, NASA cannot commit to bringing these new U.S. human spaceflight capabilities online by 2014.

Constellation Systems has set aside $95.45M of FY 2009 budget authority for the design, construction and modification of Constellation Systems facilities. Details of the program direct Construction of Facilities (CoF) projects are included in the Supporting Data CoF section of the IBPD.

For more information, please see: http://www.nasa.gov/mission_pages/constellation/main/index.html

Program Relevance

The Constellation Systems Program is responsible for providing the capabilities essential to achieving NASA's Mission to advance U.S. scientific, security, and economic interests through a robust space exploration program. Doing so will enable significant national aspirations such as extending operational experience in a hostile planetary environment, developing capabilities needed for opening the space frontier, enabling new economic opportunities, preparing for human exploration of Mars, providing for science operations and discovery, and enabling national, commercial and scientific goals for the development and use of the Moon.

Orion and Ares I are the first elements of this bold, new direction, and are key to carrying out the low Earth orbit and lunar missions described in the NASA Strategic Plan. The support systems currently under development are also critical components of the program.

This program supports Outcomes 4.1, 4.2, and 6.5.

Plans For FY 2009

Major elements of the Constellation Systems Program will complete formulation in FY 2009 and move into implementation. Development activity will be marked by such events as the completion of the flight project Preliminary Design Reviews (PDRs) for the Orion and the Ares I projects (in late FY 2008 and early FY 2009, respectively). Completion of the flight project PDRs will allow the Constellation Program Integrated Stack PDR to begin in early FY 2009, which will verify that both flight projects are ready to proceed. FY 2009 will also include PDR activities for operational capabilities, which includes Ground Operations, Mission Operations and Extravehicular Activity (EVA) Systems.

The operational capabilities PDR activity will begin in early FY 2009 with the Ground Operations Project. Successful completion of the PDR will enable the project to infuse operations and supportability factors into the development of the ground systems required to support Orion and Ares I. In FY 2009, the EVA Systems project will hold a PDR, the successful completion of which will allow the project to move into implementation of related project elements, including spacesuits, Orion interface hardware, umbilicals and space helmets. Rounding out the operational capabilities PDR will be the Mission Operations project, with completion of PDR activities in the third quarter of FY 2009. Late in FY 2009, the Constellation Systems Program will then convene the operational capabilities PDR Board.

Project Descriptions and Explanation of Changes

Project Descriptions

The projects that comprise Constellation Systems's initial capabilities phase include Orion Crew Exploration Vehicle and Ares I Crew Launch Vehicle, Extravehicular Activity systems, and the ground and mission operations infrastructure needed to support low Earth orbit missions to the International Space Station as a replacement to the Space Shuttle. Orion and Ares I are targeted for operations no later than 2015. The lunar capability will include the Ares V Cargo Launch Vehicle, Earth Departure Stage, Altair Lunar Lander, and associated support capabilities to support lunar missions starting no later than 2020.

In June 2007, NASA provided an adjusted FY 2008 President's Budget Submit to Congress. Any significant project-level changes made since that revision are explained in the Project documents.

Orion Crew Exploration Vehicle

Orion is NASA's next-generation piloted spacecraft. For missions to the Moon, Orion will carry up to four astronauts to low Earth orbit, where it will link up with a lunar lander for the trip to lunar orbit. The lunar lander will descend to the Moon's surface for up to a week for sortie missions and up to six months for outpost missions, while Orion orbits, awaiting its return. The two vehicles will rendezvous at the end of the surface mission, and the crew will return to Earth in Orion. The capsule will re-enter the atmosphere and descend using parachutes back to Earth.

Changes: No significant changes since the Adjusted FY 2008 President's Budget Request to Congress was provided.

Additional detail can be found in the Crew Exploration Vehicle (Orion) Project section of this document.

Ares I Crew Launch Vehicle

The mission of the Ares I project is to deliver a safe, reliable, and affordable launch system that supports the nation's space exploration goals. Ares I is intended to deliver crews to low Earth orbit for human trips to the Moon. It will also be able to deliver crew to the International Space Station, if necessary. Orion and Ares I are currently targeted for operation no later than 2015.

Changes: No significant changes since the Adjusted FY 2008 President's Budget Request to Congress was provided.

Additional detail can be found in the Crew Launch Vehicle (Ares I) Project section of this document.

Ground Operations

Ground Operations consists of the launch site infrastructure necessary to receive, inspect, assemble, integrate, test, simulate, monitor and perform launch processing operations and landing/recovery of the flight hardware.

Changes: No significant changes since the Adjusted FY 2008 President's Budget Request to Congress was provided.

Additional detail can be found in the Ground Operations Project section of this document.

Mission Operations

Mission Operations includes the systems and infrastructure necessary for the Constellation Systems command and control during ascent/descent and mission operation execution for abort test, uncrewed and crewed flights. It also supports the interoperability of the control center facilities with other control centers and test sites.

Changes: No significant changes since the Adjusted FY 2008 President's Budget Request to Congress was provided.

Additional detail can be found in the Mission Operations Project section of this document.

EVA

The Extravehicular Activity (EVA) Systems project encompasses the elements necessary to protect crew members and allow them to work effectively in the pressure and thermal environments which exceed human capability during all mission phases. The EVA system includes pressure suits, EVA life support systems, umbilicals, EVA tools and mobility aids, EVA-specific vehicle interfaces, EVA servicing equipment, suit avionics, individual crew survival equipment (i.e., integral to the pressure suit), and ground support systems.

Changes: No significant changes since the Adjusted FY 2008 President's Budget Request to Congress was provided.

Ares V

Ares V is a two-stage, Shuttle-derived heavy launch vehicle that will carry cargo to support the lunar missions. Late next decade, the Earth Departure Stage, which is the Ares V upper stage, will carry larger payloads such as the lunar lander into orbit.

Changes: No significant changes since the Adjusted FY 2008 President's Budget Request to Congress was provided.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
2 Flights per year for lunar sortie missions starting in 2020	Constellation	None
First Lunar Mission Test Flight in September 2019	Ares V	1 year; 2018 to 2019

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program

Implementation Schedule

Project	Phase	Beg	End
Orion	Tech		
	Form	Nov-04	Sep-08
	Dev	Sep-08	Sep-15
	Ops	Sep-15	Sep-20
	Res		
Ares I	Tech		
	Form	Nov-04	Sep-08
	Dev	Sep-09	Sep-15
	Ops	Sep-15	Sep-20
	Res		
Ground Operations	Tech		
	Form	Sep-06	Sep-09
	Dev	Sep-09	Sep-15
	Ops	Sep-15	Sep-20
	Res		
Mission Operations	Tech		
	Form	Oct-05	Sep-09
	Dev	Sep-09	Sep-15
	Ops	Sep-15	Sep-20
	Res		
Extravehicular Activity	Tech		
	Form	Sep-05	Sep-09
	Dev	Sep-09	Sep-15
	Ops	Sep-15	Sep-20
	Res		

Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Constellation Systems Program Office located at the Johnson Space Center in Houston, TX, has program management responsibility for the Constellation Systems Program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Orion	Project Office at Johnson Space Center	Johnson Space Center	None
Ares I	Project Office at Marshall Space Flight Center	Marshall Space Flight Center	None
Ground Operations	Project Office at Kennedy Space Center	Kennedy Space Center	None
Mission Operations	Project Office at Johnson Space Center	Johnson Space Center	None
Extravehicular Systems	Project Office at Johnson Space Center	Johnson Space Center	None

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program

Acquisition Strategy

The acquisition strategy for the Constellation Systems Program includes a combination of sole source and full and open competition opportunities; however, the overall goal is to maximize competition whenever possible. The only sole source contracts awarded are related to the Ares I project which include development activities for the Reusable Solid Rocket Motor First Stage and J-2X Upper Stage Engine. These sole source contracts were awarded because no other provider for the capabilities identified by NASA was available. For example, ATK-Thiokol was awarded the Ares I first stage contract because they are the only provider in the Nation that can manufacture solid rocket motors of the size needed for the Ares I. The J-2X sole source contract was awarded to Pratt Whitney Rocketdyne because they are the designers of the J-2 and J-2S engines from which the J-2X evolves.

To date, all other contracting activities for the Constellation Systems Program have been and will be awarded through full and open competition. Competitive contracts awarded to date include the Orion development contract to Lockheed Martin, the manufacturing contract for the Ares I upper stage to the Boeing Company and the Ares I upper stage instrument unit avionics production contract to the Boeing Company. The Extravehicular Activity Systems contract will be awarded through full and open competition by mid 2008. The Constellation Systems Program continues to develop its integrated acquisition strategy for the Ground Operations and Mission Operations Projects, as well as the follow-on production contracts for Orion and Ares I and development contracts for the lunar capability.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	IPAO /Systems Review Board	10/2007	Program Acceptance Review (PAR). Per NASA 7120 guidelines, independent reviews of NASA programs will not be conducted as separate reviews. Instead, members of the Independent Program Assessment Office (IPAO) will participate as non-voting members of program and project reviews and submit an independent report. The purpose of the PAR is to review the systems engineering best practices, evaluate the architecture and its consistency with available budget, schedule, and risk management.	09/2008

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
1119 - CEV Control Mass Effectiveness	Risks to: Performance, Schedule and Cost. There is a possibility that excessive growth in spacecraft mass will lead to reductions in mission performance and/or functionality	Establish mass properties group to: * Make design decisions affecting weight allocation; * Analyze designs and estimate current weights; and * Identify effects of changes on current and target weights.
1195 - Constellation Systems Program Life Cycle Cost	Risks to: Cost. Previous program experience shows that the largest component of lifecycle cost is recurring manufacturing and operations. There is a possibility that current Constellation Systems Programs may not have the correct requirements and process checks that would enable a reduction in lifecycle cost.	The plan consists of three primary efforts: [1] Incorporate operability requirements into the program baseline (recurring cost targets). [2] Baseline the Program Management Plan to establish affordability assessments as an integral part of the program execution processes. [3] Assess industry best practices to identify potential requirement changes and process improvements.
1804 - Synchronization of Ares and Orion architectures	Risks to: Schedule and Cost. With the instability in definition of the Orion configuration, there is a possibility that the Ares I project will not be able to accomplish a successful Preliminary Design Review.	The Orion and Ares teams are participating in a series of Technical Interchange Meetings to expedite data exchange. In addition the Constellation Systems Program is developing and integrated program Preliminary Design Review plan to ensure that integrated analysis occurs in time to support project needs.
1230 - Orion Vehicle Vibroacoustic Environments	Risks to: Cost and Schedule. The current design concept has high predicted vibroacoustic levels and the adaptation of existing or modified components is intended for use in many CEV applications. There is a possibility that the Orion project may incur schedule slips and increased cost due to component qualification failures and/or potential associated re-cycle of assembly level qualification.	Launch Abort System design concept was modified to reduce acoustic loads. Preliminary wind tunnel test indicate that the new concept significantly reduces loads.
1401 - First Crewed Lunar Return without adequate ground or flight test qualification plan	Risks to: Schedule and Cost The absence of lunar-return flight test prior to Lunar Initial Operational Capability (IOC) coupled with current ground test facility limitations may mean that full certification of the Thermal Protection System heat shield will not be achieved for Lunar return entry prior to the first Lunar IOC crewed mission.	Upgrades to existing arc jet facilities are being assessed that would allow representative testing on the ground. The possibility of a flight test is also being assessed.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Ground Operations

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	**208.9**	**202.0**	**303.4**
FY 2008 President's Budget Request	**--**	**356.8**	**301.9**
Total Change from 2008 President's Budget Request	**208.9**	**-154.8**	**1.5**

Note: 1. FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013.

2. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book.

Project Purpose

The Ground Operations Project will provide all launch and recovery capabilities needed during the Design, Development, Test and Evaluation phases of exploration missions. These capabilities include personnel, launch control centers, integration buildings, launch pads, fueling systems, transporters, mobile launch platforms, recovery ships and landing site equipment, command/control software and hardware. Project activity includes development of operational processes and documentation necessary for Agency operational organizations to perform pre-launch and launch processing, and recovery after landing.

As Constellation Systems projects and programs mature during Design, Development, Test and Evaluation, the project will transition selected Space Shuttle and International Space Station ground support equipment, infrastructure and key contractor functions from those programs as they become available and as coordinated with these programs.

Project Preliminary Parameters

The Ground Operations Project is currently engaged in defining the complete processing system at the launch site. Characteristics of a launch site system undergoing definition include numbers of integration cells/launch pads, launch rate capability, and the associated life cycle costs.

Estimated Project Deliverables

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Ground Operations Project	Multiple Architectural and Engineering Contracts	N/A	Multiple contracts for Operations Integration at Kennedy Space Center	Multiple contracts for Operations Integration at Kennedy Space Center

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Ground Operations

Estimated Project Schedule

Ground Operations received Authority to Proceed in September 2006.

Milestone Name	Formulation Agreement Estimate	FY 2008 PB Request	FY 2009 PB Request
Formulation			
Mobile Launch Platform	N/A	12/08	09/09
PAD 39B	N/A	12/08	08/09
VAB Modification	N/A	N/A	03/12

Project Management

The Ground Operations Project Office located at the Kennedy Space Center in Florida has key responsibility for management of Ground Operations activity.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Ground Operations Project	Kennedy Space Center will manage the Government project effort.	Kennedy Space Center	None

Acquisition Strategy

Ground Operations will rely on a combination of in-house government as well as existing and competed contracts with architectural and engineering firms to perform the necessary analyses and designs for ground infrastructure and systems. Additionally, due to the highly coupled nature of using existing Space Shuttle Program and International Space Station facilities, the project is actively seeking operational expertise of civil servants and contractors to facilitate improved processing designs and lessons-learned to ensure lowest life cycle costs and safer processing.

Further acquisition planning is still ongoing to incorporate Agency planning for Space Shuttle Program transition.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO Standing Review Board	04/2007	The System Requirements Review was the first independent review for the Ground Operations Project. The results will be documented.	06/2008
Other	National Academy, Public Admin	06/2006	Sought understanding of the government/contractor mix in preparation for workforce planning across Space Shuttle Program/Constellation Systems Program transition.	N/A

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Uncertainty of Operational Efficiencies	There is a possibility that ground operations is not adequately budgeted for ground processing.	Mitigate: Stretch requirements not fully endorsed, monitor and promote solutions, team on Constellation Operations Optimization List items with Constellation points of contact for requirements development.
Ground infrastructure baseline may not support launch rate/launch interval as defined In the CARD	There is a possibility that our current ground infrastructure baseline may not meet the needs of the Program based on the Constellation Architectural Requirements Docuement (CARD).	Mitigate: Constellation Change Control Board endorsed offline stacking, refine Crew Exploration Vehicle\Launch Abort System hazardous processing implementation details, continue stretch requirements push.
Synchronization of Ground Systems and Orion Architectures	With the extremely dynamic definition of the Orion spacecraft configuration, there is a possibility that the Ground Operations Project will incur additional costs by designing ground systems using immature spacecraft reference designs.	Mitigate: Boards, panels, Systems Integration Group, System Requirements Definition participation for Orion design influence, coordination and communication.
Synchronization of Ground Systems and Ares Architectures	With the extremely dynamic definition of the Ares Launch Vehicle configuration, there is a possibility that the Ground Operations Project will incur additional costs by designing ground systems using immature launch vehicle reference designs.	Mitigate: Boards, panels, Systems Integration Group, System Requirements Definition participation for Ares design influence, coordination and communication.
Maturity/Identification of Ares 1-X Flight Test Vehicle requirements that drive Ground Support	There is a lack of maturity and/or identification of Ares I-X Flight Test Vehicle development requirements. There is a possibility that Ground Support development costs and schedules could be impacted.	Mitigate: Ground Support Integrated Product Team to monitor working groups, requirements development, Tiger Teams, to identify immature\missing requirements.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Mission Operations

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	**28.3**	**54.0**	**86.0**
FY 2008 President's Budget Request	**--**	**47.4**	**111.3**
Total Change from 2008 President's Budget Request	**28.3**	**6.6**	**-25.3**

Note: 1. FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013.

2. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book.

Project Purpose

The Constellation Systems Mission Operations Project will provide all mission operations capabilities needed to execute the Constellation Systems missions. This includes the personnel, mission control centers, training systems, planning systems, mission command/control software and hardware necessary to plan missions, prepare personnel, train and execute mission operations across the International Space Station, Lunar and Mars Design, Development, Test and Evaluation phases of exploration missions. Budget supports development of processes and documentation necessary for Agency operational organizations to perform mission strategic planning, flight manifesting, astronaut and flight controller training, as well as mission control for ascent, on-orbit and return/landing. Mission Operations will utilize significant Space Shuttle Program and International Space Station facilities and systems expertise as the Constellation Systems projects and programs mature in Design, Development, Test and Evaluation.

Project Preliminary Parameters

The Mission Operations Project is currently engaged in defining the requirements of the Constellation Systems mission system. Characteristics of such a system include number of control rooms, mission planning timeline, training timeline and associated lifecycle costs.

Estimated Project Deliverables

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Mission Operations	Mission Operations Div, Shuttle Program contractors, internal Constellation Systems personnel	N/A	Single Contract for Mission Operations Integration at Johnson Space Center.	Multiple Contracts for Mission Operations Plan, Train, Fly at Johnson Space Center.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Mission Operations

Estimated Project Schedule

Mission Operations received authority to proceed in September 2006.

Milestone Name	Formulation Agreement Estimate	FY 2008 PB Request	FY 2009 PB Request
Formulation			
Training Systems System Requirements Review	N/A	05/07	05/08
Mission Operations Contracts for Constellation	N/A	01/11	01/09
Mission Operations System Requirements Review	N/A	03/07	03/07

Project Management

The Mission Operations Project office located at Johnson Space Center (JSC) in Houston, TX, has management responsibility for mission operations activity, relying on matrix support from the Mission Operations Directorate at JSC.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Mission Operations Project	Johnson Space Center will manage the Government project effort.	Johnson Space Center	None

Acquisition Strategy

This effort will rely on the Mission Operation Project, as well as matrixed Mission Operations Directorate government and support contractor personnel to perform necessary analysis and planning for mission systems. Due to the highly coupled nature of using existing Space Shuttle and International Space Station Programs, flight hardware interfaces and some legacy infrastructure, Mission Operations is also actively seeking operational expertise of these government and contractors to facilitate improved planning timelines, training capabilities and lessons-learned to ensure lowest lifecycle costs and efficient mission execution.

Future acquisition planning is still ongoing to incorporate Agency planning for Space Shuttle Program transition.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO Standing Review Board	04/2007	The System Requirements Review is the first independent review for the Mission Operations project. The results will be documented in a formal report.	03/2008
Other	NASA Advisory Committee	07/2007	Formal introduction to Mission Operations project, structure, planning, risks and approach	TBD

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Mission Operations

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Constellation Training Facility Acquisition Strategy	The acquisition strategy for the Constellation Training Facility is under formulation and as yet undefined. There is a possibility that the Constellation Training Facility will not have the manpower and materials necessary to support the project thus resulting in impacts to costs, schedule, and simulation capability.	Mitigate: Develop acquisition strategy, initiate Constellation Training Facility Operations Concept to characterize budget, personnel, requirements and schedule.
Constellation Procedure/Planning Tool Development	The 4/24/2007 Mission Operations Project Control Board proposed a reduction in contractor funding. There is a possibility that all of the tools required to support the Constellation program for the start of Orion flights to the International Space Station will not be available.	Mitigate: Review funding profiles and budget content for electronic versus paper ground and crew procedures. Prioritize and evaluate alternatives and operations risks for Program review.
Requirement/Processes Identification for Software and Data Recon	The roles and responsibilities between Projects and Program are not sufficiently defined. There is a possibility that immature requirements will impact formulation and development of the Mission Operations Project Reconfiguration System.	Mitigate: Modify software requirements processes to minimize org handoffs and ensure full requirements identification, host Constellation Reconfiguration System Technical Interchange Meeting, develop Operations Concept.
Flight Software Schedule Impact on Mission Ops	The Integrated flight software delivery schedule is not yet defined. There is a possibility that Mission Operations will not receive integrated flight software that supports the current facility development schedules and the current flight schedules.	Mitigate: Implement common software processes across Constellation Systems through new avionics software control board and common software interfaces.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Mission Operations

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Impact of Missing Requirements to the Mission Systems (MS) Systems Requirements Document (SRD)	With requirements uncertainty existing post-System Requirements Review (SRR) due to deferral of Interface Requirement Documents (IRDs) and late identification of interfaces, there is a possibility that the requirements baselined, in the MS SRD, at the March Mission Operations SRR will change significantly and the development of the Level III IRDs and Level IV requirements will be delayed.	Mitigate: Focus meetings on interface requirements and processes, develop IRDs for all 14 external interfaces, route through Ops Integration office for other Mission Directorate amd international interfaces.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Crew Exploration Vehicle

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	479.5	775.7	1,101.4
FY 2008 President's Budget Request	1,001.1	950.8	1,560.2
Total Change from 2008 President's Budget Request	-521.7	-175.1	-458.7

Note: 1. FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013.

2. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book.

Project Purpose

Orion is America's next-generation piloted spacecraft. For missions to the Moon, Orion will carry up to four astronauts to low Earth orbit, where it will link up with a lunar surface access module for the trip to lunar orbit. The access module will descend to the Moon's surface while Orion orbits, awaiting its return. The two vehicles will rendezvous at the end of the surface mission, and Orion will transport the astronauts back to Earth, where the capsule will re-enter the atmosphere and descend on parachutes.

Orion will also have the capability to service the International Space Station (ISS). The vehicle will be capable of transporting six crew to and from the ISS, and remaining docked for six months as a rescue return vehicle.

The Orion Project is supported by technology risk reduction efforts funded by the Exploration Technology Development Program, such as the Thermal Protection System activities based at Ames Research Center.

Project Preliminary Parameters

Orion will be a five meter-diameter vehicle, capable of transporting four astronauts to the Moon and six astronauts to the ISS then returning them safely to Earth. The combined crew and service modules will provide power, life support, and propulsion for rendezvous, orbit correction, and de-orbit. In the event of a launch mishap, a Launch Abort System will separate the crew module from the launch vehicle. A thermal protection system will protect the crew during re-entry, and the landing attenuation system will provide safe impact loads for landing.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Crew Exploration Vehicle

Estimated Project Deliverables

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
Crew Module	Lockheed-Martin (Prime Contractor Selected August 2006)	Piloted vehicle	same	same
Service Module	Lockheed-Martin (Prime Contractor Selected August 2006)	Provides power, propulsion, and other support services for the Crew Module	same	same
Launch Abort System	Lockheed-Martin (Prime Contractor Selected August 2006)	Separates Crew Module from launch vehicle in the event of a launch mishap	same	same

Estimated Project Schedule

Because the Constellation Systems Program and the Orion Project are early in formulation, the design review dates submitted in the FY 2008 President's Budget were very preliminary. Since then, the project has matured and the dates for the System Requirements Review, Systems Design Review, Preliminary Design Review, and Critical Design Review have been adjusted to correspond with the most current schedule.

Note that because this project is still in formulation, the estimated dates below will likely change.

Milestone Name	Formulation Agreement Estimate	FY 2008 PB Request	FY 2009 PB Request
Formulation			
System Requirements Review	n/a	January 2007	2nd Qtr FY2007
System Design Review	n/a	April 2007	4th Qtr FY2007
Preliminary Design Review	n/a	March 2008	3rd Qtr FY2008
Critical Design Review	n/a	April 2009	4th Qtr FY2009

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Crew Exploration Vehicle

Project Management

Orion is managed by the Orion Project Office located at Johnson Space Center (JSC) in Houston, TX, with support from Langley Research Center (LaRC) in Virginia and Glenn Research Center (GRC) in Ohio.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Crew Module	Orion Project Office and Crew Module Office, JSC	JSC	None
Service Module	Orion Project Office and Crew Module Office, JSC; Service Module Office, GRC	GRC	None
Launch Abort System	Orion Project Office, JSC; Launch Abort System Office, LaRC	LaRC	None

Acquisition Strategy

The contract for Schedule A Orion Design, Development, Test, and Evaluation was awarded to Lockheed Martin in August 2006. Optional Schedules B and C, for additional production and sustaining engineering, are also part of the contract. Lockheed Martin's subcontractors include Hamilton Sundstrand, Honeywell, Orbital Sciences Corporation, and United Space Alliance.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO Standing Review Board	n/a	The System Requirements Review is the first independent review for Orion project.	PDR

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
1119 - Orion Weight	Risks to: Performance, Schedule and Cost. It is possible that excessive growth in spacecraft mass will lead to reductions in mission performance and/or functionality.	Establish mass properties group to make design decisions affecting weight allocations, analyze designs and estimate current weights, identify effects of changes on current and target weights.
1230 - Orion Crew Exploration Vehicle (CEV) Vibroacoustic Environments	Risks to: Cost and Schedule. The current design concept has high predicted vibroacoustic levels and the adaptation of existing or modified components is intended for use in many CEV applications. There is a possibility that the project may incur schedule slips and increased cost due to component qualification failures and/or potential associated re-cycle of system/assembly level qualification.	Launch Abort System design concept was modified to reduce acoustic loads. Preliminary wind tunnel test indicate that the new concept significantly reduces loads.
1401 - First Crewed Lunar Return without adequate ground or flight test qualification plan	Risks to: Schedule and Cost The absence of lunar-return flight test prior to Lunar Initial Operational Capability (IOC) coupled with current ground test facility limitations may mean that full certification of the Thermal Protection System heat shield will not be achieved for Lunar return entry prior to the first Lunar IOC crewed mission.	Upgrades to existing arc jet facilities are being assessed that would allow representative testing on the ground. The possibility of a flight test is also being assessed.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Crew Launch Vehicle

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	**882.3**	**999.2**	**1,018.5**
FY 2008 President's Budget Request	**916.1**	**1,224.8**	**1,126.7**
Total Change from 2008 President's Budget Request	**-33.7**	**-225.6**	**-108.2**

Note: 1. FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013.

2. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book.

Project Purpose

The mission of the Ares I Project is to deliver a safe, reliable, and affordable launch system that expands America's scientific reach through space exploration, dedicated to enabling human trips to the Moon and Mars. An integral part of the Vision for Space Exploration, Ares I is currently scheduled to be operational no later than 2015.

Ares I as defined by the Exploration Systems Architecture Study was a shuttle-derived launch vehicle, with a first stage based on the Shuttle solid rocket motors. Since that time, the design has evolved, and Constellation Systems has identified the J-2X as the Ares I Crew Launch Vehicle upper stage engine and Ares V Cargo Launch Vehicle upper stage, which also functions as the Earth Departure Stage. The J-2X is a derivative of the J-2 engine that was used in the Saturn rocket and its advanced development engine successor, J-2S, which improved performance and gave throttle capability to the engine.

For more information, please visit: http://www.nasa.gov/mission_pages/constellation/ares/index.html.

Project Preliminary Parameters

The Ares I project has been tasked to design, develop, test, and evaluate a human-rated crew launch vehicle comprised of a five-segment Shuttle-derived Reusable Solid Rocket Booster, and a new J-2X upper stage engine. Ares I will feature a 24.5-metric ton lift capability, and will serve as a versatile transportation system that will carry crew to low Earth orbit for exploration missions to the Moon and destinations beyond. In its initial phases, Ares I will also have the capability to deliver crew and cargo to the ISS.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Crew Launch Vehicle

Estimated Project Deliverables

Ares I-X will fly in April 2009 and the second flight (Ares I-Y) is planned for September 2012. The initial operating flight will take place in March 2015. Beginning no later than 2020, two flights per year are planned for lunar sortie missions.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
First Stage	ATK-Thiokol	Initial phase of the launch ascent configuration	5-segment RSRBs with 24.5-metric ton lift capability	same
Upper Stage engine	Pratt & Whitney Rocketdyne	Propulsion source for second phase of the launch ascent configuration	1 J-2X Engine	same
Upper Stage	To be determined	Earth Departure Stage of the launch ascent configuration	Powered by a liquid oxygen/liquid hydrogen J-2X engine	same
Ares I-X	Marshall Space Flight Center	First unmanned test article for flight controllability and environment characterization	same	same

Estimated Project Schedule

The Ares I project was authorized to proceed in September 2005.

Milestone Name	Formulation Agreement Estimate	FY 2008 PB Request	FY 2009 PB Request
Formulation			
Preliminary Design Review	March 2008	April 2008	August 2008
Critical Design Review	August 2009	September 2009	March 2010
Ares I First Flight (Full Functional Configuration - Orion 1)	September 2012	September 2012	April 2013
Ares I First Operational Flight	September 2014	March 2015	March 2015

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project In Formulation:	Crew Launch Vehicle

Project Management

The Ares I Project Office located at the Marshall Space Flight Center in Huntsville, AL, has project management responsibility for Ares I.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
First Stage	Ares Project Office at Marshall Space Flight Center	Marshall Space Flight Center	None
Upper Stage Production	Ares Project Office at Marshall Space Flight Center	Marshall Space Flight Center	None
Upper Stage Main Engine	Ares Project Office at Marshall Space Flight Center	Marshall Space Flight Center	None
Ares I-X	Ares Project Office at Marshall Space Flight Center	Langley Research Center	None

Acquisition Strategy

The Ares I First Stage was awarded as a sole source acquisition to ATK-Thiokol. The Ares I and preliminary Ares V five-segment Reusable Solid Rocket Booster design work will be considered a contract within a contract. Ares I and Ares V work for Exploration will be accomplished under Schedule B of the Space Shuttle contract in place with ATK; Schedule A is the current Space Shuttle program contract effort, which will terminate in 2010. This approach is being used to capture the benefit of utilizing Shuttle assets for the Ares I effort that will lower technical, cost and schedule risk.

J-2X Upper Stage Engine was selected as a non-competitive acquisition, performed by Pratt & Whitney Rocketdyne (PWR). The J-2X predecessor (J-2S) from which the J-2X will be derived is the exclusive property of PWR. The decision to select the J-2X engine in effect selected the contractor as well.

The Instrument Unit Avionics Production and the Upper Stage Production were awarded via full and open competition to the Boeing Company.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO Standing Review Board	01/2007	System Requirements Review	N/A

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
First Stage Thrust Oscillations	Risk to performance. First Stage thrust could possibly cause unacceptable structural vibration.	A mitigation plan has been developed to characterize the thrust oscillation loads and assess the design impacts by 3/15/08. Implementation plan development will follow.
Ability for Ares I to Meet Performance Requirements	Risk to performance and cost. There is a possibility that Ares will not be able to maintain mass allocation and/or performance margins necessary to meet gross lift off weight and payload to orbit requirements with the current design maturity of both the Ares and Orion vehicles.	Mitigation plan has been developed. It primarily consists of conducting higher fidelity design and analyses cycle before vehicle Preliminary Design Review and continuing to monitor payload to orbit Technical Performance Measurements on a monthly basis. Also, continuing to work with Orion project to identify and minimize any additional impacts for the integrated stack.
Launch Vehicle Operability	Risk to performance and cost. There is a possibility that the Ares design will not result in adequate availability or reduce life cycle cost to an affordable level.	Tracking the Technical Performance Measurements associated with the ground processing system readiness, launch availability, and recurring cost requirements. Report status on operations and cost Technical Performance Measurements at Monthly status meetings.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Commercial Crew and Cargo

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**91.1**	**130.5**	**173.0**	**31.3**	**0**	**0**	**0**
Commercial Orbital Transportation Services	91.1	130.5	173.0	31.3	0	0	0
FY 2008 President's Budget Request	**0**	**236.0**	**158.8**	**41.3**	**0**	**0**	**0**
Commercial Orbital Transportation Services	0	236.0	158.8	41.3	0	0	0
Changes from FY 2008 Request	**91.1**	**-105.4**	**14.3**	**-10.0**	**0.0**	**0.0**	**0.0**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual Column, the 2008 Omnibus Appropriations Act (P.L. 110-161) and the 5-year Proposed Budget estimates for 2009 through 2013. FY 2008 Adjusted President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Commercial Crew and Cargo

Program Overview

It is one of the Agency's Strategic Goals to encourage the pursuit of appropriate partnerships with the emerging commercial space sector. The Exploration Systems Mission Directorate's major effort in this area is the Commercial Orbital Transportation Services (COTS) projects, overseen by the Commercial Crew and Cargo Program Office. The COTS projects are an effort by the Agency to encourage the development of a robust market in commercial Low Earth Orbit (LEO) transportation services by providing seed capital and appropriate technical assistance to promising space firms as the initial phase of a two-phase development strategy. The second phase, to be formulated and executed by the Space Operations Mission Directorate, will provide a market for commercial firms by commercially procuring these LEO transportation services in order to supply the International Space Station (ISS).

Phase I of the development strategy involves signing funded and unfunded Space Act Agreements with multiple potential providers, or "COTS Partners." These partners are to demonstrate capabilities that can be used for ISS resupply: Capability A, the delivery of unpressurized cargo; Capability B, the delivery of pressurized cargo; and Capability C, the delivery and return of cargo to and from orbit. Currently, the Funded Space Act Agreements include an unfunded option to demonstrate Capability D, the transport of crew to and from the ISS.

The Agency has signed Space Act Agreements with the COTS partners in order to maximize the flexibility of the partners' development efforts. Partners are paid only upon the Agency certifying that they have passed a series of discrete developmental milestones; if they fail to make progress, they are not paid. Government requirements are kept to a minimum, and are only concerned with assuring safe interaction with the ISS. The partners and the COTS projects are also not required to follow the standard NASA Program and Project Management Processes and Requirements. This relationship is intended to encourage innovation and allow the Partner to use alternatives to the standard NASA engineering approaches while still being held accountable for the requirements that NASA would impose if it were to utilize that partner for commercial transportation services.

The COTS Projects are key to accomplishing NASA's Strategic Goals, by stimulating a robust commercial market in orbital transport services to be used for ISS resupply and by encouraging innovative partnerships.

Program Relevance

The Commercial Crew and Cargo Program is instrumental in achieving NASA's Strategic Goals for encouraging appropriate commercial partnerships with the commercial space industry and for operation of the International Space Station in a manner consistent with NASA's International Partner commitments and the needs of human exploration. By fostering the development of a robust commercial market in space transportation services, the Program will also encourage the United States' economic development and spacefaring capabilities.

The program supports Outcome 5.2.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Commercial Crew and Cargo

Plans For FY 2009

The primary plans of the C3PO for FY 2009 are the successful continuation of the Space Act Agreements of the COTS partners, culminating in an orbital flight demonstration by at least one Partner and progress being demonstrated by the other funded and unfunded partners.

Project Descriptions and Explanation of Changes

Commercial Crew and Cargo

The Commercial Orbital Transportation Services partner agreements are actually not projects by the standard NASA definition of the term, but individual firms that have entered into Space Act Agreements (SAAs) with the Agency. The Commercial Crew and Cargo Program Office has signed two types of SAA with its Partners, "Funded" and "Unfunded." "Funded Partners" are those that NASA is assisting with financing and technical assistance, while "Unfunded Partners" receive NASA's technical assistance but are not paid.

As of FY 2009 budget formulation, NASA has signed a funded SAA with Space Exploration Technologies (SpaceX), and unfunded SAA with Constellation Services International (CSI), PlanetSpace, SpaceDev, SpaceHab, and Transitional Space (t/Space). NASA is currently conducting a competition to choose another funded partner(s) who is expected to be aboard by first quarter calendar year 2008, pending resolution of any legal challenges.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Three successful demonstration flights by each funded Partner for unpressurized or pressurized cargo.	COTS Projects	

Program Management

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Commercial Crew & Cargo COTS Partners	Johnson Space Center will manage the effort	Technical support from all NASA centers as needed.	Unfunded SAAs signed with: SpaceDev, CSI, t/Space, SpaceHab, and Planetspace.

Acquisition Strategy

In FY 2009, the Commercial Crew and Cargo Program will continue to execute the funded Space Act Agreements signed with SpaceX in August 2006, and the unfunded agreements signed in FY 2007 and subsequent. Currently, there is no acquisition strategy for Capability D (crew transport). The Phase II procurement will be the responsibility of the Space Operations Mission Directorate.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Commercial Crew and Cargo

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other		00/0000	The Commercial Crew and Cargo Program and its constituent Commercial Orbital Transportation Services Projects are not subject to NPR 7120.5D, "NASA Space Flight Program and Project Management Requirements," and hence do not undergo standard Agency independent review but are subject to internal independent reviews.	00/0000

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
COTS Partners may not be able to achieve cargo and crew capabilities on planned schedule.	Commercial Orbital Transportation Services (COTS) partners may have technical or financial problems and can't stay on schedule; there is a possibility that cargo and crew services would not be available to the Space Station Program in the timeframe that they need them.	- International Space Station (ISS) secured alternate logistical support. - Work closely with COTS partners to help them stay on schedule.
JAXA PROX System may not be available for use by COTS Partners	ISS currently does not have an ISS Rendezvous System (Proximity System) for COTS partners to use, there is a possibility that COTS partners would not be able to deliver cargo or crew to the ISS.	- JAXA PROX will become a standard service. JAXA Interface Requirements Document is in negotiation. - Encourage commercial development of alternative to PROX system.
Common Berthing Mechanism may not available for use by COTS Partners	ISS currently does not have a common berthing mechanism for COTS partners to use on their vehicle; there is a possibility that COTS partners would not be able to deliver cargo or crew to the ISS.	- ISS will obtain necessary Common Berthing Mechanism drawings from Boeing. - COTS partners negotiate Common Berthing Mechanism manufacture with Boeing.
COTS partners may not be able to dock (vs berth) with the ISS	ISS does not have a standardized low impact docking system; there is a possibility that Commercial Crew and Cargo un-funded partners would not be able to dock with the Space Station and therefore would not be able to deliver cargo to the ISS.	- ISS is developing an Interface Requirements Document for docking. - Encourage partners requiring docking system to develop an alternative mechanism to dock with ISS.
NASA will require COTS partners to purchase TDRSS coverage	Given the NASA requires COTS partners to purchase TDRSS service; there is a possibility that COTS partners costs would go up significantly and their schedule would be affected if they choose to not use TDRSS services.	- Change Space Act Agreement to allow NASA to provide TDRSS support. - Partners develop alternatives to TDRSS support.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Commercial Crew and Cargo
Project In Development:	Commercial Orbital Transport. Services

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**--**	**91.1**	**130.5**	**173.0**	**31.3**	**--**	**--**	**--**	**--**	**426.0**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	91.1	130.5	173.0	26.3	--	--	--	--	420.9
Operations / Close-out	--	--	--	--	--	--	--	--	--	--
Other	--	--	0.0	0.0	5.0	--	--	--	--	5.1
FY 2008 President's Budget Request	**--**	**--**	**236.0**	**158.8**	**41.3**	**--**	**--**	**--**	**--**	**436.0**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	--	236.0	158.8	41.3	--	--	--	--	436.1
Operations / Close-out	--	--	--	--	--	--	--	--	--	--
Other	--	--	0.0	0.0	0.0	--	--	--	--	-0.1
Changes from FY 2008 Request	**--**	**91.1**	**-105.4**	**14.3**	**-10.0**	**--**	**--**	**--**	**--**	**-10.1**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	91.1	-105.5	14.2	-15.0	--	--	--	--	-15.2
Operations / Close-out	--	--	--	--	--	--	--	--	--	--
Other	--	--	0.1	0.1	5.0	--	--	--	--	5.2

Note: FY 2009 President's Budget Request is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Commercial Crew and Cargo
Project In Development:	Commercial Orbital Transport. Services

Explanation of Project Changes

A realignment of existing program funds was required in FY 2008-2010 to support scheduled milestone payments to Commercial Orbital Transportation System (COTS) partners.

In September 2007, one of the funded partners - Rocketplane Kistler - (RpK) was given notice that NASA had determined that it had failed to perform under the terms of their Space Act Agreement. This determination was due to the fact that RpK had missed their fourth and fifth milestones. This notice allowed NASA to terminate the Agreement 30 days later if, after negotiating with the partner, the Agency found that further efforts were not in the interests of the Agency. On 18 October, NASA notified RpK that it was terminating RpK's Agreement for Failure to Perform. On 22 October, NASA reopened the COTS competition to choose one or more funded partners for the Commercial Crew and Cargo Program funds that were not paid to RpK due to their lack of milestone progress. NASA expects these new partners by the first quarter of calendar year 2008.

Although the Project account was reduced in the 2008 Omnibus Appropriations Bill, NASA remains committed to the goals and techniques of the program and its constituent COTS partner agreements. Therefore, NASA has rebalanced the FY 2009 and FY 2010 budgets within the Theme to restore the Project to its original $500M total in the FY 2006-2010 runout.

Project Purpose

The Commercial Crew and Cargo Program supports demonstration of Commercial Space Transportation Services from domestic companies as "Phase I" of a two-phase effort to utilize commercial services to supply the ISS. NASA's Commercial Orbital Transportation Services (COTS) potential partner agreements are designed to facilitate these demonstrations by commercial providers with the goal of enabling multiple suppliers of reliable, cost effective access to low Earth orbit. The second part of this effort, "Phase II," will be the actual procurement of services and will be undertaken by the Space Operations Mission Directorate.

In the near-term, International Partner Purchases are necessary because the U.S. currently has no alternative to the Space Shuttle. In the long-term, NASA would prefer to utilize domestic commercial space transportation providers, both to ensure availability of U.S. sources and to expend taxpayer dollars at home. The COTS partner agreements are designed to stimulate the development of a robust market in domestic orbital transportation services that NASA could then take advantage of to resupply the International Space Station in the future.

Project Parameters

Phase I of the Commercial Crew and Cargo Program involves signing funded and unfunded Space Act Agreements with multiple potential commercial providers, or "COTS partners." These partners are to demonstrate capabilities that can be used for ISS resupply: Capability A, the delivery of unpressurized cargo; Capability B, the delivery of pressurized cargo; and Capability C, the delivery and return of cargo to and from orbit. Currently, the Space Act Agreements (SAAs) include an unfunded option to demonstrating Capability D, the transport of crew to and from the ISS.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Commercial Crew and Cargo
Project In Development:	Commercial Orbital Transport. Services

Project Commitments

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
COTS	SpaceX and Additional partner selected.	Three successful demonstration flights by each funded partner for unpressurized or pressurized cargo.	Space Act Agreements define request.	Space Act Agreements define request.

Schedule Commitments

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
SpaceX - Demo 1 Systems COTS Partner: SpaceX - Demo 1 Systems	November 2006	November 2006	November 2006
SpaceX - Demo 1 Preliminary Design Review (PDR)	January 2007	January 2007	February 2007
SpaceX - Demo 1 System Critical Design Review (CDR)	August 2007	August 2007	August 2007
SpaceX - Demo 1 Readiness Review (RR)	February 2008	February 2008	February 2008
SpaceX - Demo 1 Mission	September 2008	September 2008	September 2008
SpaceX - Demo 2 Mission	June 2009	June 2009	June 2009
SpaceX - Demo 3 Mission	September 2009	September 2009	September 2009
RpK - SRR	February 2007	February 2007	February 2007

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Commercial Crew and Cargo
Project In Development:	Commercial Orbital Transport. Services

Project Management

The Commercial Crew and Cargo Program Office located at Johnson Space Center has management responsibility for this activity.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Commercial Crew and Cargo COTS Partner Agreements Phase I Capabilites A-C	Johnson Space Center will manage the effort.	Technical support from all NASA Centers as needed.	Unfunded SAAs signed with: SpaceDev, CSI, t/Space, SpaceHab, and Planetspace.

Acquisition Strategy

In FY 2009, the Commercial Crew and Cargo Program will continue to execute the funded Space Act Agreement signed with SpaceX in August 2006, and the unfunded agreements signed in FY 2007 and subsequent. Currently, there is no acquisition strategy for Capability D (crew transport). The Phase II procurement described earlier will be the responsibility of the Space Operations Mission Directorate.

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
COTS partners may not be able to achieve cargo & crew capabilities on planned schedule.	Given the Commercial Orbital Transportation Services (COTS) partners have technical or financial problems and cannot achieve schedule, there is a possibility that cargo and crew services would not be available to the Space Station Program in the timeframe required.	Develop a plan to end non-performing Space Act Agreements and engage other companies to take their place. Depend on International Partners for International Space Station resupply, if COTS partners do not succeed.

Mission Directorate: Exploration Systems
Theme: Advanced Capabilities

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**755.1**	**671.1**	**452.3**	**484.9**	**568.7**	**595.5**	**586.3**
Human Research Program	148.7	146.9	151.9	152.8	153.2	158.7	162.7
Exploration Technology Development	359.1	326.0	244.1	296.6	398.8	420.2	407.1
Lunar Precursor Robotic Program	247.3	198.2	56.3	35.5	16.7	16.5	16.5
Prometheus Power and Propulsion	--	--	--	--	--	--	--
FY 2008 President's Budget Request	**920.0**	**806.2**	**648.6**	**626.3**	**686.8**	**708.4**	**--**
Human Research Program	178.5	183.3	185.5	185.7	185.9	192.4	--
Exploration Technology Development	439.3	393.4	351.6	397.3	480.7	495.9	--
Lunar Precursor Robotic Program	284.6	229.5	111.5	43.2	20.2	20.1	--
Prometheus Power and Propulsion	5.5	--	--	--	--	--	--
Centennial Challenges	12.1	--	--	--	--	--	--
Total Change from FY 2008 Request	**-164.9**	**-135.1**	**-196.3**	**-141.4**	**-118.2**	**-112.9**	**586.3**

Note: FY 2009 President's Budget Requestis in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual Column, the 2008 Omnibus Appropriations Act (P.L. 110-161) and the 5-year Proposed Budget estimates for 2009 through 2013. FY 2008 Adjusted President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-164.9**	**-135.1**	**-196.3**	**-141.4**	**-118.2**	**-112.9**	**586.3**
Human Research Program	**-29.8**	**-36.4**	**-33.6**	**-32.9**	**-32.7**	**-33.7**	**162.7**
Programmatic Content	--	-2.6	--	--	--	--	162.7
Institutional Adjustments	-29.8	-33.8	-33.6	-32.9	-32.7	-33.7	--
Exploration Technology Development	**-80.2**	**-67.4**	**-107.5**	**-100.8**	**-82.0**	**-75.6**	**407.1**
Programmatic Content	--	2.2	-4.4	9.2	8.0	7.9	407.1
Programmatic Transfers	--	--	-42.0	-42.1	-8.1	0.2	--
Institutional Adjustments	-80.2	-69.6	-61.1	-67.9	-81.9	-83.7	--
Lunar Precursor Robotic Program	**-37.3**	**-31.3**	**-55.2**	**-7.7**	**-3.5**	**-3.6**	**16.5**
Programmatic Content	--	10.6	--	--	--	--	16.5
Programmatic Transfers	--	--	-35.0	--	--	--	--
Institutional Adjustments	-37.3	-41.9	-20.2	-7.7	-3.5	-3.6	--
Prometheus Power and Propulsion	**-5.5**	**--**	**--**	**--**	**--**	**--**	**--**
Programmatic Content	-5.5	--	--	--	--	--	--
Centennial Challenges	**-12.1**	**--**	**--**	**--**	**--**	**--**	**--**
Programmatic Transfers	-12.1	--	--	--	--	--	--

Explanation of Program Changes

Human Research Program

No change.

Exploration Technology Development

Programmatic Transfers: Near Earth Object Observation to the Science Mission Directorate, remaining Technical Authority to Center Management and Operations, grants processing to Corporate G&A, funding for critical engine work to Constellation Systems, portion of Program Support allocation from Constellation Systems.

Lunar Precursor Robotic Program

Programmatic Transfer: Responsibility for the Delta II lien now resides with the Science Mission Directorate; $35 million in funding previously set aside for this activity is re-allocated to Constellation Systems. In FY 2008, LPRP received congressional direction to spend $42 million to pursue a robotic lunar lander.

Prometheus Power and Propulsion

Programmatic Content: Prometheus Power and Propulsion is no longer a discrete program; any related content that remains now resides in the Exploration Technology Development Program.

Centennial Challenges

Programmatic Transfer: Funding and management responsibility for the Centennial Challenges Program now resides in the Innovative Partnerships Program Office.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities

Theme Overview

The Advanced Capabilities Theme is composed of three programs that provide advanced technologies and knowledge to enable the Nation's Vision for Space Exploration through the use of ground and space flight activities.

The Exploration Technology Development Program (ETDP) provides new technologies that will enable NASA to conduct future human missions and reduce risk and lifecycle cost. Primary customers for this effort are the designers and developers of flight systems in the Constellation Systems. ETDP investments reduce the risk of infusing new technologies into flight projects by maturing them to the level of demonstration in a relevant environment, in time to support the Preliminary Design Review of the target flight system. The 22 technology projects can be grouped in the following categories: Structures, Materials and Mechanisms; Protection Systems; Non-Toxic Propulsion; Energy Storage; Thermal Control; Avionics and Software; Environmental Control and Life Support; Crew Support and Accommodation; ISS Research and Operations; In-Situ Resource Utilization and Robotics, Operations and Supportability; and Fission Surface Power Systems.

The Human Research Program investigates and mitigates the highest risks to astronaut health and performance in support of NASA exploration missions. The program's primary goal is to develop and provide human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration. Projects include: the ISS Medical Project; Behavioral Health and Performance; Space Human Factors and Habitability; Human Health Countermeasures; Space Radiation; and Exploration Medical Capability.

The Lunar Precursor Robotic Program (LPRP) is developing the Lunar Reconnaissance Orbiter (LRO), which will launch in late 2008 along with the Lunar Crater Observing and Sensing Satellite (LCROSS). LRO's topographic mapping, resource identification and mapping, and radiation characterization is important to Constellation Systems efforts to return humans to the Moon by 2020. Data from other LPRP activities will support astronaut safety, landing site selection, and engineering requirements for lunar surface hardware. In addition, per Congressional direction, the Exploration Systems Mission Directorate will initiate in FY 2008 a lander project at the Marshall Space Flight Center as a pathfinder for an anticipated network of small lunar science landers.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Advanced Capabilities Theme supports the Nation's Vision for Space Exploration by developing innovative technologies and gathering scientific data needed to implement a sustained and affordable human and robotic program to explore the solar system and beyond.

NASA's effort in this area contributes to implementation of the global exploration strategy, which includes participation from 13 other national space agencies, as well as more than a thousand individuals around the world from academia, the private sector, and the general public. Activity at the global level is focused on answering such questions as, "Why should we return to the Moon?" and "What will we accomplish there?".

The Advanced Capabilities Theme uses the International Space Station (ISS) as a research and technology demonstration location, supporting ISS's designation as a national laboratory. NASA leverages the microgravity environment of the ISS to conduct human, life and microgravity research, demonstrate countermeasures to maintain human health and performance during exploration missions, and demonstrate vital technologies in the space environment.

Relevance to the NASA Mission and Strategic Goals:

Advanced Capabilities activity supports NASA's Mission to pioneer the future in space exploration and scientific discovery by acquiring new and vital knowledge and by identifying, developing, and transitioning new technologies that enable the systems concepts and capabilities needed to expand and sustain human presence in space.

Advanced Capabilities supports NASA's achievement of Strategic Goals 2, 3 (Sub-Goal 3F), 4, and 6.

Relevance to education and public benefits:

Advanced Capabilities' programs support educational outreach activity at the K-12, undergraduate, and graduate levels. By providing ideas for the Space Grant and Graduate Student Research Programs, NASA promotes educational opportunities for students at colleges and universities across the nation.

In implementing these programs, NASA plans to leverage the expertise of academia, government agencies, and industry to carry out research and development efforts. By advancing diverse, novel technologies through projects with non-traditional NASA research partners, small businesses and others, public benefits will include new technologies such as power generation, communications, computing, robotics, and improved materials from space exploration research and execution for use by industry and the general public.

In addition, HRP will further advance the medical knowledge and diagnostic and treatment technologies NASA uses to keep humans healthy and productive in space, improving the medical treatment and health of humans on Earth. Research into human adaptation to microgravity has helped scientists better understand changes that come with aging, such as bone loss, muscle atrophy, and loss of balance. NASA-developed telemedicine technologies that help doctors on Earth monitor and treat astronauts in space through computer-assisted imaging and diagnostics, video, and telecommunications, help doctors deliver quality medical care to people in underserved areas of the world.

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 2	**Complete the International Space Station in a manner consistent with NASA's International partner commitments and the needs of human exploration.**					
Outcome 2.3	**Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.**		**None**	**None**	**None**	**New**
APG 9AC1	Deliver 3 out of 4 of the following exploration technology payloads to SOMD for launch to the ISS: Multi-User Droplet Combustion Apparatus, Light Microscopy Module / Constrained Vapor Bubble, Boiling Experiment Facility (BXF), Space Acceleration Measurement System accelerometers for CIR, FIR and BXF.	Exploration Technology Development				New
APG 9AC2	Complete the development of 3 out of 4 of the following non-exploration payloads: Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions, Shear History Extensional Rheology Experiment, Advanced Plant Experiments on Orbit, Smoke Point in Coflow Experiment, Binary Critical Aggregation Test - 4.	Exploration Technology Development				New
APG 9AC3	Complete the selection of investigators for the BION (Russian collaboration) flight.	Exploration Technology Development				New
Strategic Goal 3	**Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.**					
Sub Goal 3F	**Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration.**					
Outcome 3F.1	**By 2008, develop and test candidate countermeasures to ensure the health of humans traveling in space.**		**Green**	**Green**	**Green**	**Green**
APG 9AC4	Develop an operational protocol that meets the standards of the Office of the Chief Health and Medical Officer for a countermeasure to lower the risk of renal stone formation due to increased bone loss during long duration missions in microgravity to below 1%.	Human Research Program				Green
APG 9AC5	Validate a ground analog fractional-gravity test methodology to assess whether 1/6th g is protective of physiological systems, including bone loss, and if not, what countermeasures are needed	Human Research Program				Green
APG 9AC6	Provide recommendations for optimized EVA suit weight, pressure, center of gravity and kinematics.	Human Research Program				None

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome 3F.2	**By 2010, identify and test technologies to reduce total mission resource requirements for life support systems.**		Green	Green	Green	Green
APG 9AC7	Evaluate three alternative distillation technologies for primary water processing as part of closed loop water recovery systems.	Exploration Technology Development				None
Outcome 3F.3	**By 2010, develop reliable spacecraft technologies for advanced environmental monitoring and control and fire safety.**		Green	None	Green	Green
APG 9AC8	Complete the System Design Review for the Colorimetric Solid Phase Extraction Water Biocide Monitor.	Exploration Technology Development				None
Strategic Goal 4	**Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.**					
Outcome 4.1	**No later than 2015, and as early as 2010, transport three crewmembers to the International Space Station and return them safely to Earth, demonstrating an operational capability to support human exploration missions.**		Green	Green	Green	Yellow
APG 9AC11	Deliver a prototype 5-meter diameter ablative heat shield for Orion to the Constellation Systems Program	Exploration Technology Development				None
Strategic Goal 6	**Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.**					
Outcome 6.1	**By 2008, launch a Lunar Reconnaissance Orbiter (LRO) that will provide information about potential human exploration sites.**		Green	None	Green	Green
APG 9AC12	Launch the Lunar Reconnaissance Orbiter. (LRO)	Lunar Precursor Robotic Program				Green
APG 9AC13	Launch the Lunar Crater Observation and Sensing Satellite. (LCROSS)	Lunar Precursor Robotic Program				Green
Outcome 6.2	**By 2012, develop and test technologies for in situ resource utilization, power generation, and autonomous systems that reduce consumables launched from Earth and moderate mission risk.**		Green	Green	Green	Green
APG 9AC14	Demonstrate in field tests a proof-of-concept pressurized rover with EVA suitports that could enable surface exploration beyond the vicinity of the lunar outpost and improve EVA work efficiency.	Exploration Technology Development				None
Outcome 6.3	**By 2013, sufficiently develop and test technologies for nuclear power systems to enable an informed selection of systems for flight development to provide power to a lunar outpost.**		Green	White	Green	Green

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9AC15	Demonstrate full-scale radiator panels in the laboratory at temperatures and heat transfer rates relevant to the reference 40-kilowatt fission surface power system for the lunar outpost.	Exploration Technology Development				Green
Outcome 6.5	**No later than 2020, demonstrate the capability to conduct an extended human expedition to the lunar surface and lay the foundation for extending human presence across the solar system.**					**None**
APG 9AC16	Begin successful science data collection from the Lunar Reconnaisance Orbiter (LRO) in support of human lunar missions.	Lunar Precursor Robotic Program				Green
APG 9AC17	Begin successful science data collection from the Lunar Crater Observation and Sensing Satellite (LCROSS) in support of human lunar missions.	Lunar Precursor Robotic Program				Green

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Advanced Capabilities Theme					
APG 9AC18	Complete all development projects within 110% of the cost and schedule baseline.				White
APG 9AC19	Increase the amount of research beam time for space radiation experiments at NSRL, hence science data collection, by reducing the non-science overhead to 25% from 33% for set up, tuning and maintenance.				None
APG 9AC20	Given an annual constant dollar technology funding, demonstrate improvements in the EVA Work Efficiency Index for humans and robots working cooperatively to deploy the power system infrastructure for the lunar outpost. Work Efficiency Index = (Time to complete a task using humans and robots) / (Time to complete a task using humans only).				None

Performance Achievement Highlights:

- The Human Research Program completed final on-orbit operations of the Renal Stone investigation. For the study, which began during International Space Station Expedition 3 in 2001, investigators examined diet logs combined with urine samples from 20 astronaut subjects to test whether potassium citrate is an effective countermeasure against the formation of kidney stones while crewmembers are in orbit. The risk of kidney stones is elevated in space due to the mobilization of calcium from bone loss and the effects of microgravity on fluid distribution in the body.

- The LRO Program successfully met the critical milestones for the performance period. All instruments and the core spacecraft have completed the Critical Design Review and program partners are fabricating and assembling the hardware. Early integration testing has begun, with full instrument and vehicle integration and testing to begin in fall 2007. NASA successfully completed all design milestones for the Lunar Crater Observation and Sensing Satellite (LCROSS), which will launch with LRO, and the project partners have begun subsystem fabrication and assembly. NASA began the integration and test phase for the LCROSS spacecraft in October 2007 and the mission is on-track for launch with LRO by the end of 2008.

- ESMD completed a demonstration of oxygen production from simulated lunar regolith using a technology called RESOLVE. Also, ESMD demonstrated remotely supervised deployment of lunar infrastructure at the Desert Rats field test.

- The Fission Surface Power System (FSPS) project transitioned to a focused development and test effort for nuclear power systems that could provide abundant, constant surface power for a lunar outpost at any surface location to enable long-duration stays on the Moon while being extensible for Mars missions. The project team completed the Affordable Fission Surface Power System Study with participation by nuclear power experts from both NASA and the U.S. Department of Energy. The team also continued FSPS concept definition activities: initiating a formal reference concept selection; continuing risk-reduction technology research, including development and operation of FSPS component and system test facilities; and preparing a draft project plan.

For more information, see Strategic Goals 2, 3 (Sub-goal 3F), 4 and 6 in the FY 2007 Annual Performance Report, included in this budget.

Quality

Program Assessment Rating Tool (PART):

The 2007 PART review of the Advanced Capabilities Theme's constituent programs, Exploration Technology Development and Human Research, resulted in an rating of "Adequate." The evaluation validated that the programs were focused on providing knowledge and technology to enable future human exploration missions beyond low Earth orbit. The Advanced Capabilities Theme did not receive a higher rating largely due to the following reasons: the Theme had not received independent evaluations of sufficient scope and quality; and the Theme had not demonstrated sufficient efficiencies.

Note: Prior to the FY 2008 Budget Estimates, the work associated with Advanced Capabilities was budgeted under two Themes, Human Systems Research and Technology (HSRT) and Exploration Systems Research and Technology (ESRT). HSRT underwent PART assessment in 2005 (see below); ESRT was not assessed.

Progress has been made to address the suggested areas of improvement. The Aeronautics and Space Engineering Board of the National Research Council (NRC) has formed a committee to perform an independent assessment of NASA's restructured ETDP. Details of the committee charter and scope of work can found at: http://www8.nationalacademies.org/cp/projectview.aspx?key=48849. The NRC plans to issue an interim report of its findings in March, 2008.

The ETDP also has aligned its portfolio to meet various Constellation Systems Program development milestones, thus making it more relevant to reduce its technical and programmatic risks.

The Human Research Program has reviewed or is in the process of reviewing all the directed research projects using Non-Advocate Review Panels. The Institute of Medicine of the National Academies will review the "NASA Research Human Health Risks" starting January 2008 (anticipated completion date June 2008). Independent Program Implementation Review will be completed August 2008.

NASA established an efficiency baseline for measurement on the research throughput of the Space Radiation Research Facility in 2006, and will continue to strive for efficiencies in this area and maintain this as a performance improvement action for several years.

Benchmarking activities related to research and technology practices are planned in FY 2008 with the National Cancer Institute and the Department of Treasury.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	National Academies (IOM)	New	The Institute of Medicine (IOM) will review the "NASA Research on Human Health Risks"	01/2008
Quality	External Independent Reviews	03/2007	Independent Formulation Review of Directed Research Projects	03/2008
Quality	External Independent Reviews	05/2006	Program Implementation Review	06/2008
Quality	Peer Panel Reviews	05/2007	Peer review of NASA Research Announcements	05/2008
Quality	National Research Council	10/2007	Assessment of program effectiveness and technical quality	TBD

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	148.7	146.9	151.9	152.8	153.2	158.7	162.7
ISS Medical Project	18.9	19.2	19.9	20.1	19.1	19.8	20.4
Research Infusion Projects	129.9	127.7	131.9	132.7	134.1	138.9	142.4
FY 2008 President's Budget Request	178.5	183.3	185.5	185.7	185.9	192.4	0
ISS Medical Project	0	23.6	24.3	24.4	23.1	23.9	0
Research Infusion Projects	178.5	159.7	161.2	161.4	162.8	168.5	0
Changes from FY 2008 Request	-29.8	-36.4	-33.6	-33.0	-32.7	-33.8	162.7

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual Column, the 2008 Omnibus Appropriations Act (P.L. 110-161) and the 5-year Proposed Budget estimates for 2009 through 2013. FY 2008 Adjusted President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Human Research Program

Program Overview

The Human Research Program (HRP) is focused on investigating and mitigating the highest risks to human health and performance in support of NASA exploration missions. ESMD and Constellation Systems documents provide the mission architecture definitions, mission concepts of operations, vehicle, habitat, and space suit performance requirements, and other technical information needed to focus the HRP efforts for specific exploration missions. HRP conducts research, develops countermeasures, and undertakes technology development to inform and support compliance with NASA's health, medical, human performance, and environmental standards. The goal of HRP is to enable safe, reliable, and productive human space exploration. The specific objectives of HRP are:

1. Develop capabilities, necessary countermeasures, and technologies in support of human space exploration, focusing on mitigating the highest risks to crew health and performance.

2. Define and improve human spaceflight medical, environmental and human factors standards.

3. Develop technologies that serve to reduce medical and environmental risks, to reduce human systems resource requirements (mass, volume, power, data, etc.) and to ensure effective human-system integration across exploration systems.

4. Ensure maintenance of Agency core competencies necessary to enable risk reduction in the following areas:
a. Space medicine;
b. Physiological and behavioral effects of long duration spaceflight on the human body;
c. Space environmental effects, including radiation, on human health and performance; and
d. Space human factors.

To enable the program to accomplish these objectives, HRP contains seven projects that manage the biomedical deliverables in support of the exploration architecture: 1) Space Radiation, 2) Behavioral Health and Performance, 3) Exploration Medical Capability, 4) Space Human Factors and Habitability, 5) Human Health Countermeasures, 6) ISS Medical Project, and 7) Program Science Management/National Space Biomedical Research Institute (NSBRI).

This program supports APGs that will: develop an operational protocol to meet the crew health standards for a countermeasure to lower the risk of renal stone formation; validate a ground analog fractional-gravity methodology to assess whether lunar gravity is protective of physiological systems; and provide recommendations for optimizing EVA suit weight, pressure, center of gravity, and kinematics.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Human Research Program

Program Relevance

The Human Research Program (HRP) enables human exploration missions by developing products that reduce risks to the crew. These risk reductions can be employed in the design of exploration vehicles, in the selection and training of flight crews, and in the planning and execution of mission operations. The HRP, in consultation with customers and stakeholders, shall determine areas of specific focus and shall be responsive to customer needs, goals, and objectives for maintaining crew health and performance during exploration missions. The primary customers for HRP outcomes and products are: ESMD's Constellation Systems Program, Office of the Chief Health and Medical Officer (OCHMO), and Space Operations Mission Directorate. The major stakeholders of HRP products are OCHMO, flight surgeons, the Astronaut Office, flight control teams, Constellation Systems Program, and spacecraft development project offices. Customers and stakeholders will provide inputs to the projects by reviewing the requirements, countermeasures, and technologies to ensure that products are usable, crew health is maintained, operating efficiency is improved, and vehicle designs are conducive to safe and efficient crew performance.

This program supports Outcome 3F.1.

Plans For FY 2009

Space Radiation will use the NASA Space Radiation Laboratory at Brookhaven National Lab to evaluate the increased risk of cancer as a function of age, age at exposure, radiation quality, latency, and gender. These efforts will support more accurate prediction of risks and facilitate longer stays in space.

Exploration Medical Capability will develop technology that will allow NASA to meet the level of care standards for space exploration missions including: rapidly-deployed EVA sensors, medical-grade water production system, ventilation system that uses cabin oxygen instead of stored oxygen, capability to analyze blood and saliva-borne biomarkers, and tools for medical decision-making during exploration missions.

Space Human Factors and Habitability (SHFH) will primarily use ground based analog models to optimize human systems performance in the design of the Orion Crew Exploration Vehicle and other exploration vehicles. SHFH will also evaluate human toxicity of long-term exposure to lunar dust and develop food-packaging systems to ensure safe storage and delivery of food on long-term missions.

Behavioral Health and Performance will undertake ground-based analog and ISS flight-based studies to evaluate contributing factors to health or performance degradation, errors, and/or failures during critical mission operations. These studies will evaluate sleep loss and circadian rhythm, medication side effects, fatigue, team cohesion, and training protocols.

Health and Human Countermeasures will undertake ground based analog and ISS flight studies to reduce both the crew health risks during exploration missions and long-term health risks afterward. These studies will include cardiac structure and function, stability of pharmaceuticals and nutrients in a space environment, development of a food system that meets all nutrition requirements for long-duration missions, and bone demineralization monitoring techniques.

Program Science Management/NSBRI will release two joint NASA/NSBRI research solicitations in support of space exploration. These national solicitations will focus on health effects from space radiation and human physiological changes associated with exploration. NSBRI will also implement approximately 60 exploration-focused research grants.

Project Descriptions and Explanation of Changes

Project Descriptions

HRP contains seven projects that manage the biomedical deliverables in support of the exploration architecture. The Space Radiation Project includes research on human health effects to enable accurate prediction of risks associated with exposure, establishment of requirements for protection, and development of monitoring technologies. The Behavioral Health and Performance Project includes identification and characterization of the risks associated with training, living, and working in space, and the development of strategies, tools, and technologies to mitigate these risks. The Exploration Medical Capability Project includes research to support development of space medical standards, next-generation medical care, crew health maintenance technologies, and an integrated medical model for probabilistic risk assessment. The Space Human Factors and Habitability Project includes research and development activities that support the design and development of next generation crewed space vehicles, inform environmental health standards for spacecraft and habitats, and aid the development of extended shelf-life foods with reduced packaging mass. The Human Health Countermeasures Project includes exercise devices and exercise prescriptions, research on how the body reacts in space, as well as requirements for the use of drugs, nutrition, and exercise as effective countermeasures to the potentially harmful effects of space on the human body. The ISS Medical Project includes current ISS biomedical research capabilities and on-orbit validation of next generation on-orbit equipment, medical operations, procedures, and crew training concepts. The Program Science Management/NSBRI program area contains two activities: Program Science Management (providing leadership, support, and integration) and NSBRI Cooperative Agreement funding.

Changes:
Addressing the Space Radiation Project gaps for exploration is the number one priority of the Human Research Program. These gaps represent a significant challenge to HRP, and this reprioritization of funds will enhance space radiation project support to Constellation Systems.

Even with this reprioritization, space radiation gaps remain in the following areas:

a. Major tissues that contribute to cancer risk (e.g., liver, stomach, bladder);

b. Non-cancer effects such as heart disease, acute, and synergistic effects of radiation on bone loss;

c. Research on Biological Countermeasures to reduce the radiation risk; and

d. Directed studies of dose-rate effects.

To accommodate this change within the flat HRP budget, the Program Office determined the lowest priority areas that could be reduced and not impact near-term deliverables in support of the Constellation Program. The following projects were impacted from FY 2009 to FY 2013: Human Health and Countermeasures, Space Human Factors and Habitability, Exploration Medical Capability, and Program Science Management.

ISS Medical Project (ISSMP)

ISSMP provides planning, integration, and implementation services for HRP research tasks and evaluation activities requiring access to space or related flight resources on the ISS, Shuttle, Soyuz, Progress, or other spaceflight vehicles and platforms. This includes support to related pre-flight and post-flight activities.

ISSMP services include: operations and sustaining engineering for all HRP ISS flight hardware; experiment integration and operation, including individual research tasks and on-orbit validation of next generation on-orbit equipment; medical operations; procedures; and crew training concepts, as well as operation and sustaining engineering for the Telescience Support Center located at the Johnson Space Center (JSC), which provides real-time operations and data services to all HRP flight experiments. This project integrates HRP-approved flight activity, and complements and interfaces with external implementing organizations, such as the ISS Payloads Office and International Partners, to accomplish the HRP's objectives.

This effort is led by JSC with Baseline Data Collection support from the Kennedy Space Center (KSC), in Russia at Star City, and at the Baikonur Cosmodrome in Kazakhstan.

Changes: Increased civil servant workforce at Ames Research Center, offset by reduction in Exploration Medical Capabilities.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Human Research Program

Exploration Medical Capability (EMC)

The EMC Project is responsible for defining requirements for crew health maintenance during exploration missions, developing treatment scenarios, extrapolating from the scenarios to health management modalities and evaluating the feasibility of those modalities for use during Exploration missions. The EMC Project is also responsible for the evolution of exploration missions health care options based on past experience, anticipated needs, and input from flight surgeon and crew offices.

The Vision for Space Exploration objectives present significant new challenges to crew health care capabilities. These challenges include the hazards created by the terrain of lunar or planetary surfaces that may be difficult to traverse during exploration, the effects of gravity transitions, low gravity environments, and limited communications with ground-based personnel for diagnosis and consultation. Each challenge has associated medical implications and medical requirements and technologies to ensure safety and success. The major deliverables for the EMC Project consist of input to the following standards and requirements:

a. Medical standards of care;
b. Crew selection and retention criteria;
c. Fitness for duty criteria;
d. Requirements for medical equipment, clinical care capabilities, medical equipment;
e. Technology development;
f. Medical informatics; and
g. Integrated medical requirements for each mission.

This effort is led by Johnson Space Center. Glenn Research Center and Ames Research Center contribute technology development and clinical care expertise to the EMC Project.

Changes: Rescoped non-invasive metabolic sensors research, elevated exploration analog effort to program level.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Human Research Program

Behavioral Health & Performance (BHP)

The BHP Project identifies and characterizes the behavioral and performance risks associated with training, living and working in space, and return to Earth. The BHP Project develops strategies, tools, and technologies to mitigate these risks. One set of deliverables for the BHP Project consists of input to the BHP health and medical standards, requirements, and operational tools for exploration. A second set of deliverables consists of: knowledge, tools, and technology to prevent performance degradation, human errors or failures during critical operations resulting from sleep loss, circadian desynchronization, fatigue or work overload; deterioration of morale and motivation; interpersonal conflicts or lack of team cohesion, coordination, and communication; team and individual decision-making, performance readiness factors (fatigue, cognition, and emotional readiness); behavioral health disorders; and individual selection and crew assignments.

The lead center for this work is JSC in close collaboration with the Ames Research Center (ARC). ARC provides special expertise in the following areas: a) sleep and fatigue, cognition, team performance and decision-making, and technology for assessing these factors, b) development and validation of biomarkers (e.g., non-intrusive physiological measures) for predicting performance and behavioral health degradations, and c) tests of assessment and mitigation strategies in operational analog spaceflight environments.

The BHP Project also works in close collaboration with its National Space Biomedical Research Institute (NSBRI) partners. The Neurobehavioral and Psychosocial Adaptation Team and the Sleep and Chronobiology Team have expertise in predictive modeling, and the development and testing of BHP related countermeasures and technologies for monitoring and assessing crew performance and health status.

Changes: None.

Space Human Factors & Habitability (SHFH)

The Space Human Factors and Habitability Project consists of three main focus areas: Space Human Factors Engineering, Advanced Environmental Health, and Advanced Food Technology.

The major deliverables for the space human factors engineering projects are: validated models for predicting the effects of interface designs on human performance; methods for measuring human and human-system performance; design concepts for and evaluations of advanced crew interfaces and habitability systems; and requirements for spacecraft and space missions. The lead Center for this work is Johnson Space Center (JSC), in close collaboration with Ames Research Center (ARC), which provides special expertise in perception, cognition, automation and display design and evaluation, and individual and team performance, complementing JSC's expertise in habitability and ergonomics.

The major deliverables for the advanced environmental health projects are inputs to environmental health standards and requirements for exploration spacecraft and habitats. Advanced Environmental Health (AEH) research assesses the acute and long-term health impacts of targeted pollutants in the environment including lunar dust, microorganisms, and atmospheric contaminants. The AEH Project is evaluating human toxicity to lunar dust during long-term exposure in support of exploration missions. This work will provide a basis for establishing crew lunar dust exposure limits by the Office of the Chief Health and Medical Officer and will have design implications for lunar environmental systems under the Constellation Systems Program. The lead Center for this work is JSC in close collaboration with ARC, which provides special expertise in pulmonary diseases and selected aspects of dust toxicity.

The deliverables for the advanced food technology projects are extended shelf life foods with improved nutritional content and quality and reduced packaging mass to provide easier trash management. The advanced food research effort provides a safe, nutritious, and acceptable food system to maintain crew health and performance. Technology development addresses nutritional, psychological, safety, and acceptability requirements while minimizing mass, volume, waste, power, and trace gas emissions. The lead Center for this work is JSC.

Changes: None.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Human Research Program

Human Health Countermeasures (HHC)

The HHC Project provides the biomedical expertise for the development and assessment of medical standards, vehicle and spacesuit requirements dictated by human physiological needs and develops a validated and integrated suite of countermeasures for exploration missions that ensure the maintenance of crew health during all phases of the mission. Countermeasures target human physiology and performance capabilities at risk from space flight missions at each stage of mission performance. Pre-flight countermeasures involve crew selection, physical fitness and exercise, physiological adaptation training, and health stabilization. In-flight countermeasures cover physiological and nutritional health, physical fitness, and mission performance. Post-flight countermeasures target rehabilitation strategies.

The major deliverables for the HHC Project are input for the refinement of health and medical standards, validated human health prescriptions, validated exercise system requirements, extravehicular activity (EVA) pre-breathe protocols, integrated physiological countermeasures, partial gravity human performance predictions and requirements, and criteria for the agency fitness for duty and crew selection/retention standards. HHC also provides integrated physiology data measurements and human support systems testing that will enable the design and development of a new lunar EVA suit for exploration missions. This work includes the measurement of physiological data during astronaut exertion to optimize the performance of suit designs and the testing of human support systems to deliver in-suit food, water, and contingency needs.

HHC provides agency core biomedical capabilities and expertise that enables the development of medical standards, the assessment of the risks to crew health and performance, and the validation of countermeasures.

HHC is a multi-center project led by JSC and includes work at Ames and Glenn Research Centers. ARC provides the animal models capability, and GRC provides advanced technology capability. International agencies currently cooperate on joint flight proposals, reduced gravity studies, and collaborative bed rest campaigns. It is anticipated that such international collaborations will continue in the future.

Changes: Reduced overall content; reprioritized remaining projects to address research gaps.

Space Radiation

The Space Radiation Project performs investigations to assure the crews can safely live and work in the space radiation environment without exceeding the acceptable radiation safety limits as set by Office of the Chief Health and Medical Officer. The major deliverables for the Space Radiation Project include inputs to standards for radiation health, habitability, and environments; requirements for radiation protection, early technology development for monitoring equipment, caution and warning, models and tools to assess and predict risks due to space radiation exposure, and strategies to mitigate exposure effects.

Although information exists to recommend crew exposure limits and spacecraft design requirements for missions in low Earth orbit, there is insufficient knowledge of the health effects of radiation, the space radiation environment, and countermeasure efficacy to provide recommendations on crew exposure limits and design requirements for extended lunar and Mars missions. Therefore, a major focus of the Space Radiation Project will be basic and fundamental research to expand the knowledge base and reduce the uncertainty inherent in current exposure limits and design requirements.

The Space Radiation Project is a multi-center project led by JSC, and includes work at the Langley Research Center (LaRC) and ARC. LaRC provides computational modeling capability, and ARC provides biomolecular mechanisms capability. The intramural and extramural groups use national laboratories to conduct research using accelerator-based simulation of space radiation.

Changes:

1. Added NASA Space Radiation Laboratory (NSRL) beam time/capability for performing space radiation research to support reduction in uncertainty of health risks.

2. Augmented research solicitation for cancer and central nervous system research grants.

3. Directed research on physics of radiation transport in shielding at LaRC: physics of light ions cross sections and transport with sensitivity and data need assessments.

4. Added LaRC/JSC Support to Lunar Architecture Team/Mars Architecture Team assessments: ongoing support of exploration assessments in support of the Exploration Systems Mission Directorate and the Agency.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Human Research Program

Program Science Management/National Space Biomedical Research Institute (PSM/NSBRI)

The Program Science Management/National Space Biomedical Research Institute (PSM/NSBRI) area contains two distinct activities: Program Science Management and the cooperative agreement with the NSBRI. The NSBRI budget will be shown as a separate activity in the HRP budget providing the planned NSBRI budget for the budget horizon and activities associated with that budget.

Program Science Management provides the overall leadership of the program and the functions that support and integrate the sub-elements of the program. Those functions include: strategic research planning; programmatic risk assessment; exploration requirements development; baseline budget and schedule development; cross-project integration; external leveraging; competitive research acquisition process; external review process; prioritization of research objectives and content; and all aspects of managing the program and projects. Program Science Management also includes all management coordination activities with other NASA programs, participating NASA Centers, the ESMD Advanced Capabilities Directorate, Office of the Chief Health and Medical Officer, and Space Operations Mission Directorate offices at Headquarters. Program Science Management supports the development of external relationships with domestic and international partners to help achieve the research goals and objectives of the program. Domestic partners include other U.S. government agencies, academic institutions, and commercial entities.

A central aspect of this activity is the program integration efforts to ensure close coordination of exploration customer needs and program deliverables to meet those needs and includes the development of the HRP Integrated Research Plan. The HRP Integrated Research Plan contains the prioritized set of research and technology development activities that minimize the human health risks for specific exploration missions showing dependencies such as research requiring the ISS.

The NSBRI cooperative agreement maximizes NASA's return on biomedical research and development investments. The NSBRI consortium consisting of twelve member institutions provides facilities and equipment to support research and technology development aimed at preventing or addressing health problems related to exploration missions. In support of NASA, NSBRI defines, selects and conducts external space biomedical research associated with human exploration risks for approximately 60 grants involving investigators at more than 70 institutions across the United States in 22 states. The National Space Biomedical Research Institute has given NASA access to the national biomedical infrastructure and enabled significant leveraging of NASA resources. Additionally the NSBRI, working with NASA, is in a good position to define and manage new partnerships with companies that may include facilitating the transfer of critical technologies.

This effort is led by the JSC HRP Program Office.

Changes: None.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Launch 60-72 ISS Research payloads from 2007 through 2012	HRP/ISSMP	No change
National Space Biomedical Research Institute (NSBRI): NASA Cooperative Agreement that defines, selects and conducts space biomedical research associated with human exploration risks involving investigators at more than 70 institutions in 22 states	HRP/PSM	No change
NASA Space Radiation Laboratory: Interagency agreement w/DOE critical to studying cancer risks & other deleterious health effects of human beings exposed to space radiation (SR); Only US facility where the full spectrum of SR events can be simulated	HRP/SR	No change
University of Texas, Medical Branch at Galveston (UTMB) Bed Rest Facility: Interagency agreement with NIH critical to human health countermeasure development and risk reduction prior to spaceflight	HRP/HHC	No change
Exploration Medical Capability (EMC): Medical care and crew health maintenance technologies (monitoring, diagnostic, treatment tools and techniques); medical data management; probabilistic risk assessment	HRP/EMC	No change
Behavioral Health & Performance (BHP): Behavioral health selection, assessment, and training capabilities; intervention and communication techniques to support exploration missions	HRP/BHP	No change
Space Human Factors & Habitability (SHFH): Anthropometry, display/control, usability, cognition, habitability, lighting, ergonomics; advanced food development; lunar dust characterization and toxicological testing	HRP/SHFH	No change
Human Health Countermeasures (HHC): Integrated physiological, pharmacological and nutritional countermeasures suite; Extra-Vehicular Activity (EVA) related physiology research to support lunar EVAs	HRP/HHC	No change
Program Science Management/NSBRI: Requirements development, strategic planning, & risk management; Science Management including announcement development, research selection, & grants monitoring; NSBRI funding & integration; Peer & Non-advocate Review	HRP/PSM	No change
ISS Medical Project (ISSMP): ISS research integration and operations, including Human Research Facility Racks 1 & 2	HRP/ISSMP	No change
Space Radiation (SR): Human health effects, limiting factors for vehicle environments and crew selection; computational shielding modeling; measurement and warning technologies	HRP/SR	

Program Management

The Human Research program office is located at Johnson Space Center.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Space Radiation	Human Research Program Office at Johnson Space Center	Johnson Space Center (Supporting Centers: LaRC and ARC)	National Space Biomedical Research Institute, Department of Energy, Brookhaven National Laboratories, Numerous National Universities; contractors include Wyle Laboratories and USRA.
Behavioral Health & Performance	Human Research Program Office at Johnson Space Center	Johnson Space Center (Supporting Center: ARC)	National Space Biomedical Research Institute, Numerous National Universities; contractors include Wyle Laboratories and USRA.
Human Health Countermeasures	Human Research Program Office at Johnson Space Center	Johnson Space Center (Supporting Centers: ARC and GRC)	National Space Biomedical Research Institute, National Institutes of Health, University of Texas Medical Branch, Numerous National Universities; contractors include Wyle Laboratories and USRA.
Space Human Factors & Habitability	Human Research Program Office at Johnson Space Center	Johnson Space Center (Supporting Center: ARC)	National Space Biomedical Research Institute, Numerous National Universities; contractors include Wyle Laboratories and USRA.
Exploration Medical Capability	Human Research Program Office at Johnson Space Center	Johnson Space Center (Supporting Centers: GRC and ARC)	National Space Biomedical Research Institute, Numerous National Universities; contractors include Wyle Laboratories and USRA.
ISS Medical Project	Human Research Program Office at Johnson Space Center	Johnson Space Center (Supporting Center: KSC)	European Space Agency, Japanese Aerospace Exploration Agency, German Aerospace Center (DLR), Canadian Space Agency, Numerous National Universities; contractors include Wyle Laboratories.

Acquisition Strategy

FY 2008: Joint NASA/NSBRI Space Radiation NASA Research Announcement, which will focus on better understanding and reducing the risks that crews could face from space radiation on exploration missions.
FY 2008: Joint NASA/NSBRI NASA Research Announcement to Support Crew Health and Performance in Space Exploration Missions, which will focus on the following research areas: Bone Loss; Cardiovascular Alterations; Human Performance Factors, Sleep, and Chronobiology; Muscle Alterations and Atrophy; Neurobehavioral and Psychosocial Factors; Nutrition, Physical Fitness, and Rehabilitation; Sensorimotor Adaptation; Smart Medical Systems; Biomedical Technology Development; and Lunar Analog Bed Rest Investigations.
FY 2008: Directed Research Projects which will focus on Exercise, Musculoskeletal, and Cardiovascular countermeasures; Behavioral Health; Immunology; Nutrition; Extravehicular Activity Physiology; Food and Drug Stability; and Space Radiation Health.
FY 2009: Joint NASA/NSBRI Space Radiation NASA Research Announcement (radiation research areas will be determined by future iterative gap analysis).
FY 2009: Joint NASA/NSBRI NASA Research Announcement to Support Crew Health and Performance in Space Exploration Missions (research areas will be determined by future iterative gap analysis).
FY 2009: Directed Research Projects (research areas will be determined by future iterative gap analysis).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	External Independent Reviews	03/2007	Independent Formulation Review of Directed Research Projects	03/2008
Quality	External Indpendent Reviews	05/2006	Program Implementation Review	06/2008
Quality	Peer Panel Reviews	05/2007	Peer review of NASA Research Announcements	05/2008
Quality	National Academies IOM	New	The Institute of Medicine (IOM) will review the "NASA Research on Human Health Risks"	01/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Data Accessibility for HRP Researchers	HRP researchers do not have access to the multiple biomedical data sets that could be used to characterize and mitigate certain health effects of space flight. These data sets are not integrated and the processes for accessing the existing data sets are restricted due to privacy policies of both by the United States and the International Partners.	Develop process for identifying and vetting proposed investigations involving HRP data mining research activities and providing required data access. Define and implement the technical architecture for enabling HRP researchers to access approved data sets. Develop appropriate process for sharing data with International Partners based on legal constraints.
Insufficient International Space Station (ISS) Flight Resources for Critical HRP Investigations	Given that ISS flight resources are very limited by available launch/return vehicles and by the number of ISS crewmembers, there is a possibility that HRP cannot complete all critical flight investigations in all areas where there are gaps in current capability (at Countermeasure Readiness Level 7-to-8 or Technology Readiness Level 6) to meet both Agency standards and Constellation Systems needs.	Communicate the risk of not achieving HRP goals to the Constellation Systems Program. HRP will refine its baseline of critical flight investigations, work with the ISS Program to maximize flight resources, look for additional efficiencies by restructuring flight investigations to be more suitable for current ISS resources, and look for synergy with Medical Operations and International Partners.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Exploration Technology Development

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**359.1**	**326.0**	**244.1**	**296.6**	**398.8**	**420.2**	**407.1**
ISS Research	**32.5**	**39.4**	**24.8**	**25.8**	**25.2**	**25.4**	**27.1**
Technology Infusion Projects	**326.5**	**286.6**	**219.3**	**270.7**	**373.6**	**394.9**	**380.0**
FY 2008 President's Budget Request	**439.3**	**393.4**	**351.6**	**397.3**	**480.7**	**495.9**	**0**
ISS Research	**33.2**	**33.5**	**30.4**	**30.8**	**30.5**	**16.7**	**0**
Technology Infusion Projects	**406.1**	**359.9**	**321.2**	**366.5**	**450.2**	**479.2**	**0**
Changes from FY 2008 Request	**-80.2**	**-67.3**	**-107.5**	**-100.8**	**-81.9**	**-75.7**	**407.1**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual Column, the 2008 Omnibus Appropriations Act (P.L. 110-161) and the 5-year Proposed Budget estimates for 2009 through 2013. FY 2008 Adjusted President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Program Overview

The Exploration Technology Development Program (ETDP) develops new technologies that will enable NASA to conduct future human and robotic exploration missions, while reducing mission risk and cost. The primary customer of the ETDP are the designers of flight systems in the Constellation Systems program. By maturing new technologies to the level of demonstration in a relevant environment early enough to support a flight system's Preliminary Design Review (PDR), NASA can significantly reduce both cost and risk. ETDP is currently maturing near-term technologies to enable Orion IOC in 2015, and developing long-lead technologies needed for the lunar exploration missions no later than 2020.

The projects in the ETDP were formulated to address the high priority technology needs for lunar exploration identified by the Exploration Systems Architecture Study (ESAS), with further refinement by the Lunar Architecture Team (LAT). They can be grouped into the following categories: Structures, Materials, and Mechanisms; Protection Systems; Non-Toxic Propulsion; Energy Storage; Thermal Control; Avionics and Software; Environmental Control and Life Support; Crew Support and Accommodation; In-Situ Resource Utilization; Robotics, Operations and Supportability; and Fission Surface Power Systems. All technology projects are managed at NASA Centers.

The ISS Research and Operations Project within ETDP includes ISS flight experiments, free-flyer experiments, and ground-based research that investigate the effects of microgravity on fluid physics, combustion, and fundamental biology for both exploration and non-exploration research.

For more information: http://www.nasa.gov/directorates/esmd/acd/technology_dev.html.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Exploration Technology Development

Program Relevance

ETDP is developing near-term technologies to reduce mission risk and cost for Orion, such as a prototype ablative heat shield, the parachute and landing attenuation system, a low-impact docking system, and environmental monitoring and life support systems. The program is also developing long-lead technologies to enable future lunar exploration, such as components for advanced space suits, precision landing and propulsion systems for the lunar lander, structural concepts for crew habitats, robotics for assembly and maintenance of the lunar outpost, in-situ resource utilization systems to enable sustainable operations, energy storage for solar power systems, and fission surface power systems for long duration and productive stays at lunar outposts and exploration of Mars. The program is also developing two environmental monitoring instruments that detect atmospheric contaminants in crew habitats.

Based on the NASA Authorization Act of 2005, EDTP supports physical science research by preparing and launching the Fluids and Combustion Facility for the ISS. Multiple Life Science experiments will be developed for the MicroSat Free Flyer series and the Bion M-1 Russian Free Flyer.

This program supports Outcomes 3F.2, 3F.3, 2.3, 4.1, 6.2, and 6.3.

Plans For FY 2009

The Avionics and Software Project will develop a Solid Rocket Motor health monitoring system for the Ares 1 first stage.

The Structures, Materials, and Mechanisms Project will develop lightweight, high-strength fabrics to reduce the stowed volume of the Orion main parachutes.

The Environmental Control and Life Support Project will evaluate three alternative distillation technologies for closed-loop water recovery systems, and complete the System Design Review (SDR) for the Colorimetric Solid Phase Extraction (CSPE) Water Biocide Monitor.

The Crew Support and Accommodations Project will develop lightweight oxygen tanks and an oxygen recharge system for spacesuits.

The Robotics, Operations, and Supportability Project will demonstrate in field tests a proof-of-concept pressurized rover with EVA suit-ports that could enable surface exploration beyond the vicinity of the lunar outpost and improve EVA work efficiency.

The Fission Surface Power Systems Project will demonstrate full-scale radiator panels at temperatures and heat transfer rates relevant to a reference 40-kilowatt fission surface power system.

The ISS Research and Operations Project will deliver the following exploration technology payloads for launch to the ISS:
* Multi-User Droplet Combustion Apparatus (MDCA)/Flame Extinguishment Experiment (FLEX);
* Light Microscopy Module (LMM)/Constrained Vapor Bubble (CVB);
* Capillary Flow Experiment (CFE); and
* Space Acceleration Measurement System (SAMS) accelerometers.

The ISS Research and Operations Project will complete the development of the following non-exploration payloads:
* Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE-2);
* Shear History Extensional Rheology Experiment (SHERE); and
* Binary Critical Aggregation Test - 4 (BCAT-4).

Project Descriptions and Explanation of Changes

Project Descriptions

The ETDP projects were formulated in FY 2006 to address high priority technology needs identified by the Exploration Systems Architecture Study (ESAS). Program content has evolved since ESAS to reflect better definition of system requirements in the Constellation Systems Program, and to incorporate new technology needs for the lunar outpost identified by the Lunar Architecture Team (LAT) in FY 2007. To ensure that technology development is meeting mission requirements, technical performance goals have been established for all projects with the Constellation Systems Program. Once technology products have reached the required level of maturity, the Constellation Systems Program assumes management responsibility for inserting them into the design of its flight projects.

Structures, Materials and Mechanisms

This project is developing the prototype docking mechanism, parachute, and landing attenuation system for the Orion Crew Exploration Vehicle. It will also develop structural concepts for a lightweight composite command module in order to reduce launch mass and cost. The structural test facilities at Langley Research Center will support this project.

Changes: Transferred critical path engine work to Constellation; reduced cryogenic mechanisms work to reflect updated LAT-2 (2007) architecture delaying requirement to enter cold lunar craters.

Protection Systems

This project is developing a prototype human-rated ablative heat shield for the Crew Exploration Vehicle to dissipate heat during reentry, advanced thermal protection system materials for future missions that will enter the atmosphere of Mars, and technologies for protecting lunar surface systems from the adverse effects of lunar dust. The arcjet test facilities at Ames Research Center will support this project.

Changes: Rephased dust characterization work to reflect refined lunar lander design schedule, allowing more time to mature lander and surface system requirements.

Non-Toxic Propulsion

This project is developing cryogenic propulsion systems for the Crew Exploration Vehicle (CEV) and the Lunar Surface Access Module (LSAM), and technologies for long-term storage of non-toxic cryogenic propellants such as liquid hydrogen, oxygen, and methane. Cryogenic propellants have higher performance than propellants that are storable at room temperature such as hydrazine. Hydrazine produces toxic vapors, and requires ground operations personnel to use specialized handling procedures and protective gear to insure their safety. Non-toxic cryogenic propulsion systems will reduce ground operations costs associated with handling hazardous propellants by eliminating the need for specialized procedures. Cryogenic propellant storage will minimize the boiloff of propellants in the ascent stage of the LSAM during long stays on the surface. Rocket engine test facilities at Glenn Research Center and Marshall Space Flight Center will support this project.

Changes: Increased focus and requirements for cryogenic fluid management (CFM) resulted in removal from propulsion project; CFM content transferred in from Robotics, Operations and Supportability. CFM work increases in the outyears to support integrated testing of requirements derived from the 2006 Lunar Architecture Team. Increases to the advanced propulsion work starting in FY 2011 focus on innovative technologies ranging from electric to ion drive systems necessary for Mars-forward planning.

Energy Storage

This project is developing advanced lithium-ion batteries and regenerative fuel cells for energy storage. These technologies will enable a solar power system to store energy for use by the outpost during the lunar night, and they will provide power for mobile systems such as Extra Vehicular Activity (EVA) suits and rovers. The goals of this project are to double the energy density of state-of-the-art batteries and fuel cells, and develop new materials that will enable these devices to function at low temperatures on the Moon. The battery and fuel cell test facilities at Glenn Research Center and the Jet Propulsion Laboratory will support this project.

Changes: Adjusted to reflect the 2006 Lunar Architecture Team requirement for higher efficiency fuel cells and improved cell safety.

Thermal Control

This project is developing heat pumps, evaporators, and radiators for thermal control of the CEV and lunar surface systems such as habitats, power systems, and EVA suits. Thermal control systems dissipate waste heat and maintain a comfortable working environment in crew habitats. Thermal test facilities and Johnson Space Center and Glenn Research Center will support this project.

Changes: Maturing Constellation Systems definition resulted in reduced near-term requirements.

Avionics and Software

This project is developing autonomous precision landing and hazard avoidance systems that will enable missions to land in close proximity to the lunar outpost. This technology may be demonstrated on future lunar robotic missions to reduce risk for crewed lunar landings.

Changes: Added solid rocket motor health monitoring work and increased the integration and testing of landing and hazardous avoidance work in alignment with lunar lander project priorities.

Environmental Control and Life Support

This project is developing technologies for atmospheric management, environmental monitoring and control, advanced air and water recovery systems, and waste disposal for use inside crew habitats. These technologies will enable sustainable life support systems for long-duration missions and protect crew health from hazardous contaminants. Existing life support systems are open-loop, which means that consumables such as water and oxygen must be resupplied from Earth. The goal is to develop closed-loop systems in which essential elements are recycled. Life support test facilities at Johnson Space Center will support this project. Environmental monitoring instruments will be demonstrated on International Space Station (ISS), and are planned for infusion into the CEV and the lunar outpost.

Changes: Refined CEV requirements resulted in adjusted waste and water need dates.

Crew Support and Accommodation

This project is developing component technologies for an advanced EVA suit. The current spacesuit used on the Shuttle and ISS cannot be used for walking on the Moon due to limited mobility and high mass. Advanced EVA surface suits with improved mobility will be tested in JSC neutral buoyancy and thermal vacuum facilities, and in annual desert field tests that simulate lunar surface operations.

Changes: Added new content aligned w/ Constellation EVA project; research adn development for lunar surface EVA suit.

ISS Research and Operations

This project is performing Exploration and Non-Exploration Research using facilities on the ISS and free-flying robotics spacecraft (Free Flyers) Exploration Research directly addresses exploration mission needs in human health and countermeasures; applied physical sciences for fire prevention, detection, and suppression; multiphase fluid flow; life support; and thermal control applications. An example is the Fluids and Combustion Facility that is being developed for flight on the ISS in 2008. This facility will investigate the physics of fluid flow and combustion in microgravity that has potential application for propellant handling, thermal control, and fire suppression on future exploration systems.

Non-Exploration Research was created as a result of the NASA Authorization Act of 2005, which requires NASA to carry out basic, applied, and commercial research on the International Space Station (ISS), Free Flyers and ground based laboratories, which is not directly linked to the Vision for Space Exploration. This research focuses on reduced gravity investigations in the life and physical sciences in fields such as microbial, cellular and animal research, materials science, fluid physics and combustion science. Other details of the non-exploration microgravity research being conducted on ISS are included in the Supporting Data section of this document.

The knowledge gained from these investigations has the potential of uncovering information that may lead to novel applications both on Earth and in space. Another motivation for this research is to sustain the existing United States scientific expertise and capabilities in microgravity research. Biological experiments will also be conducted on the Russian Foton M3 Free Flyer and the future Bion M-1. Results of non-exploration experiments may inform the development of future exploration research by uncovering previously unknown phenomena.

Changes: Refined content estimates to align with ISS flight manifest and ETDP funding profile.

In-Situ Resource Utilization

This project is developing chemical processing and robotics technologies for regolith (lunar soil) excavation and handling, for producing oxygen from regolith, and for collecting and processing lunar ice and other volatiles. The utilization of in-situ resources will enable a sustainable lunar outpost by reducing the mass of consumables that must be resupplied from Earth such as water, oxygen, and rocket propellants. In-situ resource utilization (ISRU) has not been demonstrated. The goal of this project is to develop proof-of-concept ISRU systems that could be demonstrated on future lunar robotic missions. Test facilities at Johnson Space Center will support this project.

Changes:
Updated 2006 Lunar Architecture Team requirements led to reduction in excavation work; oxygen production focus remains. Pursuing international collaborations to augment technology development efforts.

Robotics, Operations, and Supportability

This project is developing technologies for surface mobility and equipment handling, human-system interaction, and lunar surface supportability. Dexterous robots and autonomous rovers capable of traversing rough terrain will assist the crew in exploring and in assembling and maintaining the lunar outpost. Robotics laboratories at Ames Research Center, Johnson Space Center, and the Jet Propulsion Laboratory will support this project. Prototype robots will be demonstrated in annual desert field tests that simulate lunar surface operations.

Changes: Funding for critical path engine work to Constellation; CFM effort moved to Non-Toxic Propulsion for improved focus. More definition of Lunar Lander project and updated timelines from 2006 Lunar Architecture Team led to reduction in some lunar surface handling and mobility work. Constellation Systems Program requirements maturation led to effort to develop coatings to mitigate corrosion for ground operations.

Fission Surface Power Systems

This project is developing concepts and technologies for affordable nuclear fission surface power systems for long duration stays on the moon and exploration of Mars. NASA is collaborating with the Department of Energy on development of fission surface power system concepts. Power conversion test facilities at Glenn Research Center and nuclear test facilities at the Department of Energy will support this project.

Changes:
New content to support future power needs; one of six options studied under the 2007 Lunar Architecture Team.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Develop a modular regenerative fuel cell system for energy storage at the lunar outpost	Energy Storage	2012
Develop and Test lightweight structural concepts for lunar surface habitats	Structures, Materials, and Mechanisms	2010
Develop surface mobility system to transport crew & large payloads to support lunar outpost assembly	Robotics, Operations, and Supportability	2010
Test Proof-of-Concept 40KW fission surface power system with reactor simulator	Fission Surface Power Systems	2012
Prototype heat shield for CEV (Constellation Systems Program)	Protection Systems	No Change
Lunar Lander descent engine (Constellation Systems Program)	Non-Toxic Propulsion	No Change
Carbon dioxide and moisture removal system (Constellation Systems Program)	Environmental Control and Life Support	No Change
ENose and VCAM atmospheric contaminant monitoring instruments (ISS Program)	Environmental Control and Life Support	Shuttle delays slipped launch date to 2009
Prototype Thermal Radiator for CEV (Constellation Systems Program)	Thermal Control	No Change
Fluids and Combustion Facility (ISS Program)	ISS Research and Operations	Shuttle delays slipped launch date to 2009
Precision Landing and Hazard Avoidance System Demonstration (2012 - Constellation Program)	Avionics and Software	Reprioritization due to impacts of FY07 continuing resolution and outyear budget reductions
Advanced EVA Suit components -life support, thermal control, power (Constellation Systems Program)	Crew Support and Accommodation	No Change

Program Management

The Exploration Technology Development program office is located at NASA Langley Research Center.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Structures, Materials, and Mechanisms	ETD Program Office - Langley Research Center	Langley Research Center	Jacobs Engineering, University of Alabama Huntsville, Sierra Lobo, ATK, ILC Dover, Lockheed Martin, Swales, National Institute of Aerospace, University of Toledo, Bigelow Aerospace
Protection Systems	ETD Program Office - Langley Research Center	Ames Research Center (Thermal Protection); Glenn Research Center (Dust Mitigation)	Boeing; for Dust: ASRC Aerospace Corporation/Sierra Lobo, HRP, NESC, Colorado School of Mines, Smithsonian Institute, Lunar Planetary Institute
Non-Toxic Propulsion	ETD Program Office - Langley Research Center	Glenn Research Center	ATK, KT Engineering, Northrup Grumman, Aerojet, Pratt & Whitney Rocketdyne, ATG
Energy Storage	ETD Program Office - Langley Research Center	Glenn Research Center	TJ Technologies, Naval Surface Warfare Center, Lawrence Berkeley (DOE), University of Akron, Teledyne Energy Systems, Infinity Technologies, ElectroChem, Texas A&M, Lockheed Martin
Thermal Control	ETD Program Office - Langley Research Center	Johnson Space Center	GRC, JPL, Hamilton Sundstrand, Mainstream, Paragon Space Development Corporation
Avionics and Software	ETD Program Office - Langley Research Center	Marshall Space Flight Center (Rad Hard Electronics); Johnson Space Center (Precision Landing)	Georgia Institute of Technology, Auburn University, BAE Systems, Boeing, IBM, Lynquent Corporation, University of Arkansas, University of Maryland, University of Tennessee, Vanderbilt University, AFRL, Sandia National Lab, University of Idaho, Draper Laboratory, LaRC, JPL, FastMetrix, SAIC, University of Texas, Utah State, Jacobs Engineering, APL.
Environmental Control and Life Support	ETD Program Office - Langley Research Center	Jet Propulsion Laboratory (Environmental Control); Johnson Space Center (Life Support)	MSFC, GRC, ARC, KSC, George Washington University
Crew Support and Accommodation	ETD Program Office - Langley Research Center	Johnson Space Center	Hamilton Sundstrand, ILC Dover
ISS Research and Operations	NASA Headquarters and ETD Program Office - Langley Research Center	Glenn Research Center	European Space Agency, Russian Space Agency

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Exploration Technology Development

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
In-Situ Resource Utilization	ETD Program Office - Langley Research Center	Johnson Space Center	US Army, Caterpillar, Canadian Space Agency, JAXA, ESA, DOE, Lockheed Martin, Orbitec, Pioneer Astronautics, NCSER, Arctic Slope Regional Corp., Case Western Reserve Univ., ANALEX, Corp., ZIN, Corp., TFOME Corp, Seimens Corp., Parker Hanifin Corp., National Instruments Corp., Teledyne Brown Engineering, Battelle-PNNL, Lunar Geotechnical Institute, University of Hawaii, University of Tennessee, Colorado School of Mines, Case Western Reserve, Mass. Institute of Tech., Florida Institute of Tech, Sverdrup, University on New Brunswick, and NORCAT
Robotics, Operations, and Supportability	ETD Program Office - Langley Research Center	Johnson Space Center	QSS Group Inc./Carnegie Mellon University West, Cal Tech (JPL), Jacobs Sverdrup, Metrica, SKT, MIT/Univ of Massachusetts, Alliance Space Systems, NIA, Swales/Lockheed, Northrop-Grumman, Carnegie Mellon University, Case Western Reserve Univ., Mars Technology Program, in planning: DOD, DARPA; for Supportability: National Center for Space Exploration Research, Zin Technologies, Bioastronautics, UMR, ASRC, Sierra Lobo, Creare, Inc., ASRC Aerospace Corporation/Sierra Lobo
Fission Surface Power Systems	ETD Program Office - Langley Research Center	Glenn Research Center	Department of Energy

Acquisition Strategy

A competitive research announcement for the Bion M-1 mission is planned. All projects are managed at NASA Centers, which issue contracts for research and development support. These contracts are listed in the table above under Partners.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	National Research Council	10/2007	Assessment of program effectiveness and technical quality	TBD

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Technology Requirements	Technologies may not meet system requirements defined by the Constellation Program and the Lunar Precursor Robotics Program after they are developed.	Conduct architecture studies to identify probable capabilities required. Customers endorse technical performance goals.
Technology Progress	On time delivery of mature technologies.	Progress towards technical milestones will be key decision criterion for project continuation.
Technology Transition	Lack of commitment from customers to incorporate technologies into system designs.	Develop a technology insertion plan with program agreement for each technology.
Technology Pull vs. Technology Push	Over emphasis on high-maturity, near-term technologies required by a mission (technology pull) versus low-maturity, far-term technologies without immediate mission application (technology push) may reduce opportunities for innovation.	Require projects to pursue some high risk technologies. Work with customers to align push technologies with gaps.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	247.3	198.2	56.3	35.5	16.7	16.5	16.5
Lunar Precursor Robotic Program Management	44.0	16.3	16.4	16.4	16.5	16.5	16.5
Lunar Reconnaissance Orbiter	199.2	147.5	40.0	19.1	0.2	0.1	0
Lunar Robotics Lander	4.1	34.3	0	0	0	0	0
FY 2008 President's Budget Request	284.6	229.5	111.5	43.2	20.2	20.1	0
Lunar Precursor Robotic Program Management	11.4	20.0	20.0	20.0	20.0	20.0	0
Lunar Reconnaissance Orbiter	120.7	209.5	91.5	23.2	0.2	0.1	0
Lunar Robotics Lander	112.8	0	0	0	0	0	0
Lunar Precursor Robotic Program Support	9.6	0	0	0	0	0	0
Future Missions	30.0	0	0	0	0	0	0
Changes from FY 2008 Request	-37.3	-31.3	-55.2	-7.7	-3.6	-3.5	16.5

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual Column, the 2008 Omnibus Appropriations Act (P.L. 110-161) and the 5-year Proposed Budget estimates for 2009 through 2013. FY 2008 Adjusted President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program

Program Overview

The Lunar Precursor and Robotic Program (LPRP) supports America's return to the Moon by executing the Lunar Reconnaissance Orbiter and Lunar Crater Observing and Sensing Satellite missions to conduct research and prepare for future human exploration.

These LPRP missions will gather data important for reducing the risks of returning humans to the Moon by 2020, such as examining the lunar radiation environment, which has implications for astronaut safety. Surface imaging and mapping will assist landing site selection by identifying terrain hazards (slope, roughness, and obstacles), as well as areas of scientific and operational interest. Temperature and lighting conditions over an annual cycle, along with a good characterization of radiation, are needed for mission and hardware design. Resource identification and mapping will inform decisions about possible future use of in-situ resources.

LPRP's Lunar Reconnaissance Orbiter (LRO) mission is in development, with launch planned by the end of calendar year 2008. LRO will provide critical information about the Moon to enable selection of safe landing sites with compelling exploration and scientific features. Using a robust suite of instruments to measure the topography of the moon's surface, LRO will take high-resolution images of sites of interest, globally assess thermal and radiation environments, and assay potential resources.

Launching with LRO is the Lunar Crater Observation and Sensing Satellite (LCROSS). This low-cost secondary payload will investigate the presence of lunar volatiles in a permanently shadowed region of the lunar surface.

LRO and LCROSS will advance scientific understanding of, and facilitate human return to, the Moon by: producing high-quality maps of lunar terrain, illumination, and resources; producing high-resolution images of large areas of the lunar surface; establishing a lunar geographic coordinate system from the mapping and imaging data; providing information on the lunar radiation environment, and gathering specific information about resource availability from lunar craters.

Per Congressional direction, in FY2008 ESMD will also fund a lander project as a pathfinder for an anticipated network of small lunar science landers.

Program Relevance

LPRP executes the projects that will achieve Outcomes 6.1 ("by 2008, launch a Lunar Reconnaissance Orbiter (LRO) that will provide information about potential human exploration sites") and 6.2 ("By 2012, develop and test technologies for in-situ resource utilization, power generation, and autonomous systems that reduce consumables launched from Earth and moderate mission risk.").

LPRP supports Outcomes 6.1 and 6.2.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program

Plans For FY 2009

Instrument and subsystem integration and testing are the primary FY 2008 activities for both the Lunar Reconnaisance Orbiter (LRO) and Lunar Crater Observation and Sensing Satellite (LCROSS), with final preparation for launch late in calendar year 2008. LCROSS will complete its mission in February 2009 by impacting the Lunar surface, investigating the possible presence of water in a permanently shadowed crater.

LPRP also plans to develop an integrated lunar data set, which will combine data from previous NASA and international lunar missions with data from LRO and follow-on missions to meet the needs of human lunar return and provide engineering, technical, and safety standards for a human lunar sortie by 2020.

In FY 2008 and FY 2009, ESMD will use appropriations identified in FY 2008 to conduct Phase A definition, initiate related technical demonstrations for ESMD risk reduction, and begin Phase B.

Project Descriptions and Explanation of Changes

Lunar Reconnaissance Orbiter (LRO)

The Lunar Reconnaissance Orbiter Project is a lunar-orbiting satellite with six instruments and a technology demonstration payload to perform initial reconnaissance of the Moon. The orbiter will map and image the Moon's surface, take high-resolution images of areas of interest, assess light, thermal, and radiation environments, and map resources. The LCROSS impactor and shepherding spacecraft, which are co-manifested with LRO, will attempt to identify water in a permanently shadowed crater.

Changes: No changes in scope, schedule, or direct cost.

Lunar Robotics Lander

In FY2008, the Exploration Systems Mission Directorate will fund a lander project as a pathfinder for an anticipated network of small lunar science landers based on requirements of the Agency's expanded Lunar Science Program, to be outlined in the FY 2009 budget request. NASA envisions that the first two small landers will launch in the 2013/2014 timeframe. During FY 2008-2009, ESMD will use appropriations identified in FY 2008 to conduct Phase A definition, initiate related technical demonstrations for ESMD risk reduction, begin Phase B, and if necessary, begin procurement of long-lead items. The Exploration Systems and Science Mission Directorates will continue to work together combining resources to assure the goals of the science lander are achieved.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Launch LRO/LCROSS mission early in FY2009	LPRP/LRO	No Change

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program

Implementation Schedule

Project	Schedule by Fiscal Year																Phase Dates		
	Prior	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21		Beg	End
LRO (includes LCROSS)																	Tech		
																	Form	May-04	Mar-06
																	Dev	May-06	Nov-08
																	Ops	Dec-08	Nov-09
																	Res	Dec-09	Dec-13

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

LPRP is managed at Marshall Space Flight Center (MSFC). The LRO and LCROSS spacecraft are managed by project offices at Goddard Space Flight Center and Ames Research Center, respectively. The lunar lander is managed at a project office at MSFC.

Acquisition Strategy

LRO and LCROSS are under contract.

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Program Architecture Definition	Immaturity of Lunar Robotic Requirements leads to lack of program architecture definition.	LPRP requirements needed to support the Constellation Systems program's first lunar sortie and resulting architecture are being defined by several studies. The most important of these is the LAT, which completed its Phase 2 definition late in calendar year 2007.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program
Project In Development:	Lunar Reconnaissance Orbiter

FY 2009 Budget Request

Budget Authority ($ millions)	Prior	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	BTC	LCC TOTAL
FY 2009 President's Budget Request	**182.8**	**199.2**	**147.5**	**40.0**	**19.1**	**0.2**	**0.1**	**--**	**--**	**588.8**
Formulation	93.2	--	--	--	--	--	--	--	--	93.2
Development / Implementation	89.6	199.2	130.2	2.0	--	--	--	--	--	421.0
Operations / Close-out	--	--	--	21.9	3.9	--	--	--	--	25.8
Other	0.0	0.0	17.3	16.1	15.2	0.2	0.1	--	--	48.8
FY 2008 President's Budget Request	**182.8**	**120.7**	**209.5**	**91.5**	**23.2**	**0.2**	**0.1**	**--**	**--**	**628.1**
Formulation	93.2	--	--	--	--	--	--	--	--	93.2
Development / Implementation	89.6	120.7	208.7	2.0	--	--	--	--	--	421.0
Operations / Close-out	--	--	--	21.9	3.9	--	--	--	--	25.8
Other	0.0	0.0	0.8	67.6	19.3	0.2	0.1	--	--	88.1
Changes from FY 2008 Request	**--**	**78.5**	**-62.0**	**-51.6**	**-4.1**	**0.0**	**0.0**	**--**	**--**	**-39.3**
Formulation	--	--	--	--	--	--	--	--	--	--
Development / Implementation	--	78.5	-78.5	--	--	--	--	--	--	--
Operations / Close-out	--	--	--	--	--	--	--	--	--	--
Other	--	0.0	16.5	-51.6	-4.1	0.0	0.0	--	--	-39.3

Note: FY 2009 President's Budget Request is in Direct Dollars (although some indirect funding remains in the Prior Year totals) and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the FY 2008 enacted, and the 5-year Proposed Budget estimates for 2009 through 2013.

Explanation of Project Changes

No change in scope, schedule, or cost to either project.

Both projects completed the Critical Design Review in FY 2007. They are in the Fabrication phase now and entered the Integration and Testing phase in fall 2007 (FY 2008).

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program
Project In Development:	Lunar Reconnaissance Orbiter

Project Purpose

The Lunar Reconnaissance Orbiter (LRO) is the first mission in NASA's return to the Moon and the implementation of the Vision for Space Exploration. LRO will orbit the Moon for one year in its primary mission, carrying out extensive measurements of lunar topography, resources, and thermal and radiation environments. This data about the lunar surface is critical for site selection, safe landing, and astronaut safety of the first human lunar sortie by 2020.

LRO will orbit the Moon in a circular, 50-kilometer polar orbit. During its mission, it will:

-Precisely measure lunar terrain, with altitude resolution of 10 centimeter locally and one meter absolute from the Moon's center of mass, at an average data grid density of 0.001 degrees latitude and 0.04 degrees longitude;

-Assess meter-scale surface features to enable safety analysis of potential lunar landing sites;

-Characterize illumination and thermal environments over a full year;

-Characterize lunar mineralogy, and investigate the presence of water and other volatiles in permanently shadowed regions;

-Measure the radiation environment to assess the potential biological impacts to human explorers; and

-Demonstrate the technical performance of a synthetic aperture radar for communication and scientific investigation of the lunar surface.

The Lunar Crater Observation and Sensing Satellite (LCROSS) will launch with LRO as a secondary payload to investigate lunar surface volatiles, primarily water, in a permanently shadowed site. The LCROSS Shepherding Spacecraft will separate from the upper stage of an Atlas V. The upper stage will impact the lunar surface in a permanently shadowed region near a lunar pole, creating a cloud of about 200 metric tons of ejecta. The Shepherding Spacecraft will observe the impact and ejecta to detect and characterize the possible presence of water. The impact and ejecta may also be observed by ground and other space-based telescopes.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program
Project In Development:	Lunar Reconnaissance Orbiter

Project Parameters

LRO has a dry mass of about 1,000 kilograms. To achieve the required high resolution observations, LRO will use a 50-kilometer polar orbit. LRO will be stabilized in three axes to about one arc-minute of pointing accuracy. Data downlink capability will be up to 900 gigabits per day.

LRO contains a suite of six competitively selected instruments, plus a technology demonstration payload offering additional measurements. The project will integrate the results from all six instruments to provide high fidelity information to advise future exploration activities. The instruments are:

* Lunar Orbiter Laser Altimeter (LOLA) for precise topographical measurements;
* LRO Camera (LROC) for high resolution imaging of the lunar surface;
* Lunar Exploration Neutron Detector (LEND) to search for evidence of water ice;
* Diviner Lunar Radiometer to map the temperature of the lunar surface;
* Lyman-Alpha Mapping Project (LAMP) sensor to observe the lunar surface in the far ultraviolet; and
* Cosmic Ray Telescope for the Effects of Radiation (CRaTER) to measure the Moon's radiation environment and assess the equivalent radiation dose to human tissue.

LRO also includes the Mini-RF (Radio Frequency) technology demonstration payload, which will collect radar data to complement the other LRO measurements.

LCROSS consists of a 900-kilogram, 480-watt Shepherding Spacecraft and the spent upper stage of the Atlas V launch vehicle. After LRO separates from the launch vehicle, LCROSS will use a lunar gravity assist to achieve a highly inclined lunar orbit, returning towards a lunar pole about 80 to 120 days later. As LCROSS approaches the Moon, the Shepherding Spacecraft will release the 2,000-kilogram upper stage. The upper stage will impact in a permanently shadowed crater near the pole, excavating about 200 metric tons of material from the surface. The Shepherding Spacecraft will observe the impact and resulting cloud of ejecta with visible and near-infrared cameras and spectrometers and a photometer. LCROSS will be able to detect the presence of water ice in the excavated regolith to concentration sensitivity of 0.5% or better.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program
Project In Development:	Lunar Reconnaissance Orbiter

Project Commitments

LRO will launch late in calendar year 2008 for a one-year prime mission. Information from LRO will be used for hardware design, mission planning, and landing site selection for the first human lunar sortie by 2020. This information will:

* Aid navigation and landing safety:
  - High resolution visible imagery;
  - High resolution mapping and altimetry; and
  - Rock abundance.

* Locate and identify resources:
  - Map surface temperatures at various times of the lunar day over a full year;
  - Detect and map surface materials and minerals;
  - Identify and map surface and subsurface water ice; and
  - Map solar illumination at various times of day over a full year.

* Characterize the enviroment for life in lunar orbit and on the surface:
  - High-energy radiation;
  - Neutron radiation; and
  - Radiation effects on human tissue.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
LCROSS Shepherding Spacecraft	Northrup-Grumman	Volatiles Investigation	no change	no change
LCROSS Payload Suite	NASA/ARC	Instruments on the Shepherding Spacecraft	no change	no change
CRaTER	Boston University	Radiation instrument	no change	no change
DIVINER	UCLA	Surface temperature mapping instrument	no change	no change
LAMP	Southwest Research Instrument	Far-ultraviolet imager	no change	no change
LEND	Russian Institute for Space Research	Neutron detector to search for evidence of water ice	no change	no change
LOLA	NASA/GSFC	Laser altimeter	no change	no change
LROC	Arizona State University	High-resolution imager	no change	no change
Mini-RF	Naval Air Warfare Center	Radar technology demonstrator	no change	no change
Launch Vehicle Integration	NASA/KSC	Integrate LRO and LCROSS to Atlas V launch vehicle	no change	no change

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program
Project In Development:	Lunar Reconnaissance Orbiter

Schedule Commitments

LRO received confirmation to proceed from formulation to implementation in May 2006, and Critical Design Review took place in November 2006. Launch Readiness Review will occur in August 2008, in preparation for launch late in calendar year 2008.

Milestone Name	Confirmation Baseline	FY 2008 PB Request	FY 2009 PB Request
Development			
LRO Authority to Proceed	May 2004	May 2004	no change
LCROSS Authority to Proceed	April 2006	April 2006	no change
LRO Critical Design Review	November 2006	November 2006	no change
LCROSS Confirmation Review	December 2006	December 2006	no change
LCROSS Critical Design Review	February 2007	February 2007	no change
LRO/LCROSS Pre-ship Review (PSR)	August 2008	August 2008	no change
LRO/LCROSS Launch	Late in 2008 (FY 2009)	Late 2008 (FY2009)	no change

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program
Project In Development:	Lunar Reconnaissance Orbiter

Development Cost and Schedule Summary

The current year cost estimate reflects FY 2007 and FY 2008 operating plan changes.

Project	Base Year	Base Year Development Cost Estimate ($M)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Lunar Reconnaissance Orbiter	2007	420.8	2008	421.0	0	Launch Readiness	10/30/2008	10/30/2008	0

Development Cost Details

Both the Baseline and Current Year Development Cost Estimate elements were estimated while NASA's full cost accounting methodologies were changing. The element estimates are based on LRO's Confirmation Review.

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**420.8**	**421.0**	**0.2**
LRO Spacecraft	90.8	94.2	3.4
LRO Instruments and Payload	38.2	48.2	10.0
LCROSS Spacecraft and Instruments	59.1	60.0	0.9
Systems I&T	8.5	8.7	0.2
Ground Systems	11.3	12.6	1.3
Program Management, Other Direct Costs, and Agency Costs	33.7	13.5	-20.2
Project Reserve	56.9	61.5	4.6
Launch Vehicle for LRO/LCROSS	122.3	122.3	0.0

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program
Project In Development:	Lunar Reconnaissance Orbiter

Project Management

The LRO Project Office at Goddard Space Flight Center has overall responsibility for LRO; the LCROSS Project Office at Ames Research Center has responsibility for LCROSS.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
LRO Spacecraft	LRO Project Office, GSFC	GSFC in-house	Boston University, UCLA, Russian Space Research Institute, Southwest Research Institute, Arizona State University, Naval Air Warfare Center
LCROSS Spacecraft	LCROSS Project Office, ARC	Northrup-Grumman	None

Acquisition Strategy

NASA/GSFC is building the LRO spacecraft in-house, with instrument providers as noted in the Project Commitments section. Northrup-Grumman is building the LCROSS sensing satellite, with payload suite procurement and integration performed by NASA/ARC. All major procurements have been let.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	NASA IPAO	11/2006	Authority to Proceed / The LRO project underwent a review for Authority to Proceed in April 2006. The review determined that an alternative launch vehicle was required to avoid the nutation problem. The review also determined that a secondary spacecraft should be competitively selected to take advantage of the increased capacity of the new launch vehicle.	n/a
Performance	Independent Review Team	02/2007	LRO spacecraft Critical Design Review (CDR) / The LRO spacecraft passed CDR and was given authorization to proceed on its development path in preparation for launch in late calendar year 2008. The project's cost was baselined for reporting to Congress. The LCROSS Spacecraft passed its CDR in February 2007. Pre-ship Review (PSR) for LRO/LCROSS is scheduled for August 2008.	08/08

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program
Project In Development:	Lunar Reconnaissance Orbiter

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Aggressive Schedule	Planned launch for late in calendar year 2008 forces a challenging and aggressive development schedule. Although the orbital mechanics of the LRO/LCROSS missions allow for launch every two weeks, the schedule is driven by the need to inform Constellation Systems hardware design and mission planning efforts to enable a human lunar sortie by 2020.	LRO and LCROSS are applying program management best practices to identify and correct any issues before they result in schedule slips.

Overview

The Space Operations Mission Directorate (SOMD) is responsible for providing mission critical space exploration services to both NASA customers and to other partners within the United States and throughout the world: flying the Space Shuttle to assemble the International Space Station; ensuring safe and reliable access to space; maintaining secure and dependable communications between platforms across the solar system; and ensuring the health and safety of our Nation's astronauts.

At the heart of SOMD is nearly half a century of experience at safely and reliably building, flying, and maintaining some of the world's most advanced and complex aerospace systems. The Vision for Space Exploration and the NASA Strategic Plan recognize the role of the International Space Station as a unique orbital outpost for carrying out the scientific and engineering research needed for prolonged stays on the Moon and Mars. The lessons being learned during the construction and operation of the International Space Station are directly applicable to the challenges that may be faced by explorers on the lunar and Martian surfaces.

Getting the full use out of the ISS means completing assembly of the orbiting facility in a manner consistent with NASA's International Partner commitments and the needs of human exploration. As the only vehicle that can launch the remaining elements of the ISS, support teams of orbiting astronauts, and serve as a platform for joint human and robotic assembly operations at both the ISS and the Hubble Space Telescope, the Space Shuttle plays an important role. SOMD is responsible for ensuring the safety and continued success of the Space Shuttle Program. Though the fleet of Space Shuttle orbiters will be retired once their role in ISS assembly is complete in FY 2010, portions of the Space Shuttle's legacy (including manufacturing facilities, ground operations equipment, launch pads, flight hardware, workforce skills, and experience) will be the foundation for the next series of exploration vehicles being developed by the NASA Exploration Systems Mission Directorate (ESMD). SOMD and ESMD continue to work together to identify transition and retirement activities that take maximum advantage of potential efficiencies between current and planned systems.

In addition to these high-profile programs, SOMD is also responsible for ensuring that the critical infrastructure needed for space access and space communications is available to meet the needs of NASA's customers. The Launch Services Program facilitates access to space for all NASA space science missions. The Rocket Propulsion Test Program maintains NASA's wide variety of test facilities for use by both the Space Shuttle and Constellation Systems Programs. The Crew Health and Safety Program ensures that NASA's astronauts are fully prepared for current and future missions. Finally, the Space Communications and Navigation Program operates NASA's extensive network of terrestrial and orbiting communications nodes, as well as all of the associated hardware and software needed to pull down the terabytes of data generated by NASA's fleet of crewed vehicles and robotic spacecraft.

Following is the SOMD budget distribution by Theme with an explanation of changes.

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**5,113.5**	**5,526.2**	**5,774.7**	**5,872.8**	**2,900.1**	**3,089.9**	**2,788.5**
Space Shuttle	3,315.3	3,266.7	2,981.7	2,983.7	95.7	--	--
International Space Station	1,469.0	1,813.2	2,060.2	2,277.0	2,176.4	2,448.2	2,143.1
Space and Flight Support (SFS)	329.2	446.3	732.8	612.1	628.0	641.7	645.4
FY 2008 President's Budget Request	**6,108.3**	**6,791.7**	**6,710.3**	**6,625.7**	**3,036.6**	**2,978.0**	**--**
Space Shuttle	4,017.6	4,007.5	3,650.9	3,634.4	116.2	--	--
International Space Station	1,762.6	2,238.6	2,515.1	2,609.2	2,547.5	2,600.8	--
Space and Flight Support (SFS)	328.1	545.7	544.3	382.0	372.9	377.2	--
Total Change from FY 2008 President's Budget Request	**-994.7**	**-1,265.6**	**-935.6**	**-752.9**	**-136.5**	**111.8**	**2,788.5**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Budget Changes

Budget Authority ($ millions)	Actual FY 2007	Enacted FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-994.7**	**-1,265.6**	**-935.6**	**-752.9**	**-136.5**	**111.8**	**2,788.5**
Space Shuttle	**-702.3**	**-740.8**	**-669.1**	**-650.8**	**-20.5**	**--**	**--**
Programmatic Content	-17.6	-2.8	-6.2	-3.7	--	--	--
Programmatic Transfers	--	--	-1.7	-1.8	--	--	--
Institutional Adjustments	-684.7	-738.0	-661.2	-645.3	-20.5	--	--
International Space Station	**-293.5**	**-425.4**	**-455.0**	**-332.2**	**-371.1**	**-152.6**	**2,143.1**
Programmatic Content	6.8	-13.3	--	--	--	--	2,143.1
Programmatic Transfers	--	--	0.5	131.1	77.5	303.5	--
Institutional Adjustments	-300.3	-412.1	-455.5	-463.3	-448.6	-456.1	--
Space and Flight Support (SFS)	**1.1**	**-99.4**	**188.5**	**230.1**	**255.1**	**264.4**	**645.4**
Programmatic Content	56.4	0.6	10.0	--	--	--	645.4
Programmatic Transfers	--	--	276.6	297.4	320.2	330.1	--
Institutional Adjustments	-55.3	-100.0	-98.1	-67.3	-65.1	-65.7	--

Explanation of Mission Directorate Changes

Space Operations

Space Shuttle

Programmatic Content:

Reduction of Transition and Retirement to fund other critical Agency priorities.

Programmatic Transfers:

Transferred budget and content to Corporate G&A for Safety and Mission Assurance fee for services and Agency IT services.

Institutional Adjustments:

Reflects the Agency reallocation of indirect costs which includes Corporate G&A, CM&O, and Institutional Investments.

International Space Station

Programmatic Transfers:

Transfers funding from Explorations Systems Mission Directorate (ESMD) to International Space Station Cargo Crew Services and transfers budget and content for Agency IT services to Corporate G&A.

Institutional Adjustments:

Reflects the Agency reallocation of indirect costs which includes Corporate G&A, CM&O, and Institutional Investments.

Space and Flight Support (SFS)

Programmatic Content:

A $10M budget increase in FY 2009 is to support the Delta II launch pad costs borne by NASA to support its missions. Reduced unneeded funds for Launch Services Program - Alpha Magnetic Spectrometer and transferred funds to Space Communications and Navigation Program reserves.

Programmatic Transfers:

Transferred funds and content from ESMD and SMD for Space Communications Constellation Integration, the Deep Space Network (DSN), and Near Earth Network (NEN) to the Space Communications and Navigation (SCaN) Program as part of Agency consolidation of Space Communications activities.

Institutional Adjustments:

Reflects the Agency reallocation of indirect costs which includes Corporate G&A, CM&O, and Institutional Investments.

Mission Directorate:	Space Operations
Theme:	Space Shuttle

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**3,315.3**	**3,266.7**	**2,981.7**	**2,983.7**	**95.7**	**--**	**--**
Space Shuttle Program	3,315.3	3,266.7	2,981.7	2,983.7	95.7	--	--
FY 2008 President's Budget Request	**4,017.6**	**4,007.5**	**3,650.9**	**3,634.4**	**116.2**	**--**	**--**
Space Shuttle Program	4,017.6	4,007.5	3,650.9	3,634.4	116.2	--	--
Total Change from FY 2008 Request	**-702.3**	**-740.8**	**-669.1**	**-650.8**	**-20.5**	**0.0**	**0.0**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-702.3**	**-740.8**	**-669.1**	**-650.8**	**-20.5**	**--**	**--**
Space Shuttle Program	**-702.3**	**-740.8**	**-669.1**	**-650.8**	**-20.5**	**--**	**--**
Programmatic Content	-17.6	-2.8	-6.2	-3.7	--	--	--
Programmatic Transfers	--	--	-1.7	-1.8	--	--	--
Institutional Adjustments	-684.7	-738.0	-661.2	-645.3	-20.5	--	--

Explanation of Program Changes

Space Shuttle Program

A net reduction to the Space Shuttle Program reflects removal of indirect costs, reduction of Transition and Retirement (T&R) and transfer of Safety and Mission Assurance fee for services and Agency IT services to Corporate General and Administrative.

Mission Directorate:	Space Operations
Theme:	Space Shuttle

Theme Overview

The Space Shuttle Theme ensures that the Space Shuttle is prepared to safely complete those missions that require the Shuttle's unique ability to carry crews and heavy payloads to low Earth orbit and, once there, to execute extremely complex and intricate assembly and servicing operations. All Space Shuttle missions will be completed by the end of FY 2010 and the Space Shuttle will be retired after nearly 30 years of service. At that time, many of the people with critical skills needed to support exploration, facilities, and hardware from the Space Shuttle Program (SSP) will be transitioned to a new generation of vehicles currently being developed by the Constellation Systems Program, ensuring both cost-effective operations and continued success of NASA's program of space exploration.

The SSP's highest priority is to safely complete the mission manifest by the end of FY 2010. Working through project, program, Mission Directorate, and Agency-level processes, SSP will also play a key role in coordinating the smooth transition of those Space Shuttle assets and capabilities needed for exploration to the next generation of space exploration systems without compromising the safety of ongoing flight operations.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

NASA's primary objective is to advance U.S. national scientific, security, and economic interests by ensuring the success of the Nation's exploration goals as enunciated in the Vision for Space Exploration. The next step in the Vision for Space Exploration is to complete assembly of the ISS in a manner that meets NASA's exploration research needs and international commitments. Enabling the Hubble Space Telescope to continue to return world-class science is also a high priority for the Nation's science community. The Space Shuttle is uniquely qualified to carry out both of these missions. While accomplishing these missions, Space Shuttle transition activities will be undertaken in a manner that, where necessary, safeguards the long-term viability of key U.S. technical capabilities.

Relevance to the NASA Mission and Strategic Goals:

The Space Shuttle supports NASA's Mission by providing a unique capability.

The Space Shuttle Theme supports NASA's achievement of Strategic Goal 1.

Relevance to education and public benefits:

The Space Shuttle provides long-term benefits to the public by enabling the completion of the International Space Station and serving as a platform for servicing the Hubble Space Telescope. The SSP also remains a highly visible activity that promotes education in math, science, and engineering-careers that are critical to U.S. security and the future of U.S. economic competitiveness.

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 1	**Fly the Shuttle as safely as possible until its retirement, not later than 2010.**					
Outcome 1.1	**Assure the safety and integrity of the Space Shuttle workforce, systems and processes, while flying the manifest.**		**Green**	**Green**	**Yellow**	**Green**
APG 9SSP1	Achieve zero Type-A (damage to property at least $1 million or death) or Type-B (damage to property at least $250 thousand or permanent disability or hospitalization of three or more persons) mishaps in FY 2009.	Space Shuttle Program				Green
APG 9SSP2	Complete 100 percent of all mission objectives for all Space Shuttle missions in FY 2009 as specified in the Flight Requirements Document for each mission.	Space Shuttle Program				Green
Outcome 1.2	**By September 30, 2010, retire the Space Shuttle.**		**None**	**None**	**None**	**Green**
APG 9SSP3	A 13 percent reduction in Space Shuttle annual value of Shuttle production contracts for Orbiter, External Tank, Solid Rocket Boosters, Reusable Solid Rocket Motor, Space Shuttle Main Engine and Launch & Landing, while maintaining safe flight.	Space Shuttle Program				None
APG 9SSP4	Reduce to twenty the number of dedicated Space Shuttle Kennedy Space Center (blocks of) facilities, while maintaining safe flight.	Space Shuttle Program				None

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Space Shuttle Theme					
APG 9SSP5	Annually reduce the Space Shuttle sustaining engineering workforce for flight hardware and software, while maintaining safe flight.				Green
APG 9SSP6	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green

Performance Achievement Highlights:

- The Space Shuttle Program successfully completed three missions--STS-116, STS-117, and STS-118--and accomplished all primary mission objectives. The program achieved its Annual Performance Goals despite events that could have caused setbacks: significant damage to the external tank of STS-117 caused by a hailstorm at the Kennedy Space Center, while the Shuttle was on the pad awaiting launch; and the threat posed by Hurricane Dean to operations at the Johnson Space Center during the STS-118 mission.

- In November 2006, NASA published the Human Space Flight Transition Plan, which outlines the Agency's approach to safely managing the remaining manifested Space Shuttle flights, completing ISS assembly, and developing new human space flight transportation systems under the Constellation Systems Program. Through joint budget development, workforce sharing, and joint review boards, including the Transition Control Board and the Joint Integrated Control Board, the Space Shuttle and Constellation Systems programs identified a number of assets for transfer or disposition. In the area of joint utilization, Shuttle and Constellation Systems are coordinating use of Launch Complex 39-B at the Kennedy Space Center to support the Ares I-X test flight and launch-on-need support for the Hubble Space Telescope servicing mission (STS-125), the Vehicle Assembly Building at the Kennedy Space Center for Ares I-X and Space Shuttle processing, and the Michoud Assembly Facility in Louisiana for Shuttle external tank production and Orion and Ares I upper stage production. NASA also began close-out activities for Shuttle capabilities no longer needed for mission execution or Constellation Systems development, including facilities for producing Space Shuttle main engine components and facilities at the White Sands Test Facility used for testing orbiter maneuvering system rocket engines.

For more information, see Strategic Goal 1 in the FY 2007 Annual Performance Report, included in this budget.

Quality

Program Assessment Rating Tool (PART):

The Space Shuttle Theme received FY 2005 PART rating of "Adequate", as an update to its original FY 2003 rating of "Results Not Demonstrated." The original rating was received while the Space Shuttle was still on its path to a return to flight in the aftermath of the Columbia accident. The reasons for the updated rating include a well-defined purpose and system design, benefiting from strong strategic planning. To perform beyond an "Adequate" rating, improvements are required in the areas of program management and program results. The Space Shuttle Program is taking steps to improve programmatic and financial management, and identify the program benefits from several successful missions, including return to ISS assembly in September 2006.

Since the program's review, NASA completed three actions required to improve the performance status of the program:

1) Returned the Space Shuttle safely to flight and restarted its assembly of the ISS;
2) Completed plans to retire the Shuttle by 2010, when it has finished its role in assembling the ISS; and
3) Developed outcome-oriented short and long-term measures for the SSP.

NASA has begun, but has not completed, the following actions to improve the performance status of the program:

1) Developing outcome-oriented measures to assess the effectiveness of the transition between the Space Shuttle and Constellation Systems programs; and
2) Use the Space Shuttle to safely complete assembly of the International Space Station.

These performance improvement areas were added in FY 2006 and continue to stretch the program to greater levels of results. In FY 2009, the program will continue to track (through metrics) the sharing of facilities, property, and capabilities no longer needed for the safe completion of the Shuttle manifest, and to coordinate those activities across the Space Shuttle, International Space Station, and Constellation Systems programs. Between July 2005 and December 2007, the Space Shuttle Program has returned to flight and successfully completed seven flights to the International Space Station.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	NASA Advisory Council	10/2007	Provides independent guidance for the NASA Administrator.	02/2008
Other	ASAP	10/2007	Provides independent assessments of safety to the NASA Administrator.	02/2008
Other	Program Implementation Review	-	Provides an independent review of ongoing ISS and SSP operations.	06/2008

Mission Directorate:	Space Operations
Theme:	Space Shuttle
Program:	Space Shuttle Program

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	3,315.3	3,266.7	2,981.7	2,983.7	95.7	0	0
Program Integration	511.4	470.3	489.6	614.8	95.7	0	0
Flight and Ground Operations	1,066.7	1,121.8	1,031.2	955.9	0	0	0
Flight Hardware	1,717.2	1,674.6	1,460.9	1,413.0	0	0	0
Hurricane Recovery	20.0	0	0	0	0	0	0
FY 2008 President's Budget Request	4,017.6	4,007.5	3,650.9	3,634.4	116.2	0	0
Program Integration	758.4	575.9	557.8	572.9	116.2	0	0
Flight and Ground Operations	1,255.0	1,373.7	1,277.9	1,313.6	0	0	0
Flight Hardware	2,004.2	2,057.9	1,815.1	1,748.0	0	0	0
Changes from FY 2008 Request	-702.3	-740.8	-669.1	-650.8	-20.5	0.0	0.0

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Program Overview

The FY 2009 budget reflects the continuation of International Space Station (ISS) assembly flights. The budget also takes into account continued and extensive disposition of Space Shuttle Program (SSP) assets that are no longer needed for mission execution. Those assets that are needed to support the development or operation of future exploration systems like the Ares I Crew Launch Vehicle are being preserved. Assets that are not needed are being dispositioned appropriately. Wherever feasible, existing processes and institutional structures are being employed or slightly modified to support the transition effort.

For more information, please see http://www.nasa.gov/mission_pages/shuttle/main/index.html.

Program Relevance

For FY 2009, the SSP manifest calls for completing at least five ISS assembly flights. The ISS assembly flights include the launch of the last major power element (the S6 truss segment and solar arrays) and other significant infrastructure and international partner hardware. These flights are a major step towards fulfilling U.S. commitments to NASA's International Partners.

This program supports Outcomes 1.1 and 1.2.

Mission Directorate:	Space Operations
Theme:	Space Shuttle
Program:	Space Shuttle Program

Plans for FY 2009

There are a number of significant activities planned for SSP in FY 2009. The Space Shuttle is manifested to fly a total of five missions to the ISS. At the same time, NASA and the Space Shuttle have a number of major transition milestones set for FY 2009, including the first flight test of Ares I hardware (Ares I-X) and the potential retirement of Space Shuttle Atlantis.

Project Descriptions and Explanation of Changes

The pages that follow provide a detailed description of the tightly-coupled project activities of the Space Shuttle program that support the mission manifest for FY 2009. The table below provides a detailed look at the planned budget for each of these projects for FY 2007 to FY 2011.

RY ($ millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
TOTAL SPACE SHUTTLE	**3,315.3**	**3,266.7**	**2,981.7**	**2,983.7**	**95.7**
FLIGHT AND GROUND OPERATIONS	**1,066.7**	**1,121.8**	**1,031.2**	**955.9**	**0.0**
Launch and Landing (KSC)	746.3	780.4	705.5	632.5	
Landing Operations (DFRC)	3.0	3.1	4.0	4.0	
Mission Operations	214.5	236.5	221.4	220.8	
Flight Crew Operations	87.6	87.6	86.3	83.0	
Space and Life Sciences	11.2	12.6	12.1	13.1	
Flight/Ground Operations Transition & Retirement	4.2	1.6	2.0	2.4	
FLIGHT HARDWARE	**1,717.2**	**1,674.6**	**1,460.9**	**1,413.0**	**0.0**
Orbiter	620.3	504.8	459.1	638.4	
EVA	0.2	0.2	0.2	0.2	
External Tank	298.7	313.2	253.6	169.2	
Reusable Solid Rocket Motors	326.0	369.0	301.6	114.9	
Space Shuttle Main Engine	264.5	240.0	193.8	178.0	
Solid Rocket Boosters	165.2	154.1	136.8	98.2	
SSC Test Support	25.6	33.2	30.0	24.7	
Flight Hardware Transition & Retirement	16.7	60.1	85.8	189.4	
PROGRAM INTEGRATION	**511.4**	**470.3**	**489.6**	**614.8**	**95.7**
Systems Engineering and Integration	90.1	86.7	74.0	77.4	
Safety and Mission Assurance	25.1	30.6	54.8	42.2	
Flight Software	111.1	112.4	100.9	107.4	
Flight Operations and Integration	58.0	52.2	54.8	55.0	
Management Integration and Planning	34.9	31.1	26.7	26.7	
Business Management	66.8	66.5	62.1	64.1	
Propulsion Systems Engineering & Integration	18.5	19.5	16.6	18.0	
Space Shuttle Propulsion Systems Integration	15.5	20.6	19.3	20.7	
Construction of Facilities	20.1				
Safety and Sustainability	3.4	1.7			
Mission Directorate Support	29.7	8.6	12.2	12.2	
Contract Administration	26.5	26.0	25.5	23.4	
Closed Accounts	8.9	1.0	1.0	1.0	
Program Integration Transition & Retirement	2.7	1.4	1.5	1.7	
Severance and Retention		12.0	40.3	165.0	95.7
HURRICANE RECOVERY	**20.0**				
Hurricane Recovery	20.0				

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013.

Project Descriptions and Explanation of Changes

Program Integration

The Program Integration budget includes the following: funds for flight software; system engineering, flight operations, and management integration; safety and mission assurance; business management; propulsion system integration; construction of facilities; safety and sustainability; and all Shuttle support accounts that are performed for the Space Shuttle Program. Program Integration includes payload integration into the Space Shuttle and systems integration of the flight hardware elements through all phases of flight. It provides for the engineering analysis needed to ensure that payloads are safe and meet Space Shuttle interface requirements. Finally, Program Integration includes the necessary mechanical, aerodynamic and avionics engineering tasks to ensure that the launch vehicle can be safely launched, fly a safe ascent trajectory, achieve planned performance and descend to a safe landing.

Changes: A net reduction to the Space Shuttle Program reflects changes to indirect costs. For Program Integration there are no changes in scope or direct costs.

Flight and Ground Operations

Flight Operations assures the successful accomplishment of pre-flight planning, crew training, operations control activities, flight crew operations support, aircraft maintenance and operations, and life sciences operations support for each mission to efficiently and effectively meet our customer requirements. Flight operations funding also provides for the maintenance and operation of critical mission support facilities including the Mission Control Center, Integrated Training Facility, Integrated Planning System, the Software Production Facility, and the aircraft fleet used for training.

Ground Operations provides final integration and checkout of all hardware elements for launch. It also includes coordination with other government agencies and foreign entities for Shuttle landing capabilities. The major launch site operational facilities at the Kennedy Space Center (KSC) include three Orbiter Processing Facilities, two launch pads, the Vehicle Assembly Building, the Launch Control Center and three Mobile Launcher Platforms. Ground operations support capability includes launch countdown and landing for Shuttle missions. Ground support for Shuttle landing includes both the KSC and Edwards Airforce Base runways and multiple contingency landing sites in the United States and other countries. Ground Operations also includes the maintenance and operations of ground infrastructure to support launch and landing. The Orbiters are normally in the hardware processing flow along with External Tanks, Space Shuttle Main Engines, and Solid Rocket Booster components to support several missions.

Changes: A net reduction to the Space Shuttle Program reflects changes to indirect costs. For Flight and Ground Operations there are no changes in scope or direct costs.

Flight Hardware

Space Shuttle Flight Hardware ensures the vehicle hardware and software are designed, developed, manufactured, and tested for safe and reliable transportation. Five major flight elements make up the Space Shuttle system: the Orbiter, the Space Shuttle Main Engines (SSME), the External Tank (ET), the Reusable Solid Rocket Motors (RSRM), and the Solid Rocket Boosters (SRB).

Changes: A net reduction to the Space Shuttle Program reflects changes to indirect costs, and transfer of Safety and Mission Assurance fee for services and Agency IT services to the Agency Management and Operations Theme.

Orbiter

The Orbiter, the winged vehicle that carries the payload and a crew of up to seven astronauts, is the principal element of the Space Shuttle system. Each Orbiter measures 122 feet long, 57 feet high, with a wingspan of 78 feet, and can carry approximately 35,000 to 41,000 pounds of payload to the International Space Station depending on the configuration of the Space Shuttle, rendezvous altitude, and other mission-specific requirements. There are three reusable Orbiters in the fleet: Discovery OV-103, Atlantis OV-104, and Endeavour OV-105. NASA plans to retire Space Shuttle Atlantis potentially in FY 2009, and the remaining two Orbiters by FY 2010. The flight schedule continues to support the ISS assembly sequence as well as the Hubble Space Telescope servicing mission scheduled to fly in FY 2008.

Space Shuttle Main Engine

The Space Shuttle Main Engines (SSME) were developed in the 1970s and are the most efficient liquid-fueled rocket engines ever built. Each Block II main engine can produce 418,000 pounds of thrust at sea level. The main engines are throttle-able, reusable, and have a high degree of redundancy. Three main engines are mounted in a triangular configuration at the aft end of the Orbiter and provide about 29 percent of the total thrust at liftoff. Critical SSME engineering skills are being maintained to ensure safe mission flyout, and sufficient SSME component spares are being stockpiled to support the program through FY 2010.

External Tank

The External Tank (ET) is the largest and heaviest (approximately 1.7 million pounds when fully loaded with liquid oxygen fuel and liquid hydrogen) element of the Space Shuttle system. The ET serves two functions: to carry the fuel and oxidizer that feeds the main engines during ascent, and to act as the structural "backbone" to which the Orbiter and Solid Rocket Boosters are attached. Because the liquid hydrogen and liquid oxygen need to be stored at temperatures of hundreds of degrees below zero, the ET is covered with foam insulation to keep the propellants cold on the launch pad and during ascent and prevent formation of ice from atmospheric condensation. After the main engines are shut down at an altitude of about 70 miles above Earth, the ET is jettisoned, reenters the atmosphere at high velocity, and breaks up harmlessly over a remote ocean area.

There are sufficient stocks of both aluminum lithium for the main structural elements and most components to support flights up to Shuttle retirement in FY 2010. Meanwhile, the ET project office continues to work closely with the Constellation program to ensure a smooth transition of materials, tooling, critical skills, and shop floor space at the Michoud Assembly Facility in Mississippi from ET production to Orion and Ares I development.

Reusable Solid Rocket Boosters

Two Reusable Solid Rocket Boosters (RSRBs) provide the main thrust that lifts the Space Shuttle off the launch pad up to an altitude of about 150,000 feet. Each RSRB is composed of three major subassemblies: a forward nose cone, a four-segment Reusable Solid Rocket Motor (RSRM), and an aft nozzle. The RSRBs for the Space Shuttle are the largest ever flown, and are designed for reuse. Each is 149 feet long, 12 feet in diameter, and weighs approximately 1.3 million pounds when loaded with fuel. The sea-level thrust of each booster is approximately 3.3 million pounds. They are fired after the thrust level of the three main engines is verified during the first few seconds of the ignition sequence. Together, the two RSRBs provide about 71 percent of the total thrust at liftoff.

Each Ares I crew launch vehicle will have a first stage powered by an RSRB using five RSRM segments derived from those currently used by the Space Shuttle, while the heavy-lift Ares V will use two five-segment boosters mounted alongside a core stage similar to the way the RSRBs are attached to the ET on the Space Shuttle. Using Shuttle-derived booster technology in Constellation Systems Program vehicles promotes continuity and cost savings in both hardware production and operations.

Transition and Retirement

NASA continues to ensure a smooth transition from the Space Shuttle to the next generation of Constellation Systems Program vehicles, including the Orion Crew Exploration Vehicle (CEV) and Ares I Crew Launch Vehicle (CLV). Appropriate Space Shuttle flight and ground hardware, technology, people and practices are being identified for transfer, retirement, or reassignment. NASA's Human Space Flight Transition Plan is guided by four fundamental principles: (1) the Space Shuttle fleet will be retired by the end of FY 2010; (2) the Space Shuttle Program's emphasis is on safety and mission success; (3) Space Shuttle transition will support Constellation Systems development objectives without interfering with Space Shuttle safety and mission success; and (4) the Space Shuttle will complete assembly of the International Space Station (ISS) and conduct a fifth servicing mission to the Hubble Space Telescope by the end of FY 2010 using as few flights as possible. The goals of Human Space Flight Transition are to: (1) evolve from current operations to future operations; (2) evolve the workforce, ensuring that NASA has the right levels and mix of skills for both Shuttle/ISS Programs and Constellation Systems; (3) achieve multi-program objectives at the best value to the Agency; and (4) conduct an efficient and safe closeout of the Space Shuttle Program through the transfer of assets needed for follow-on programs and decommissioning and disposing of the rest.

NASA has already taken a number of important steps to ensure a smooth transition. In FY 2009, NASA will focus on plans for transition of the necessary human spaceflight government and industry workforce from Shuttle to Constellation Systems, plans for the disposition of Shuttle equipment no longer needed after Shuttle missions are completed, and disposition of Shuttle facilities not needed after the last Shuttle mission. In addition to developing the Transition Plan, NASA has identified Space Shuttle assets that are no longer needed for mission execution and that can be used in Exploration Systems development. These assets will be transferred to Constellation Systems as they are released from the Space Shuttle Program as Space Shuttle missions are completed. Most of the major equipment and facilities that will be transferred will do so after the last Space Shuttle missions in 2010, but some transfers began as early 2005. These include flight equipment such as Solid Rocket Booster casings, skirts and fairings; materials such as aluminum-lithium metal used to fabricate spacecraft structures; and facilities such as Engine Testing Stands, Launch Control Firing Rooms, and vehicle assembly and launch complexes and their support equipment.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Safely complete manifest and retire by FY 2010.	The Space Shuttle Program	The manifest has five launches planned in FY 2009.

Implementation Schedule

Project	Schedule by Fiscal Year															Phase Dates		
	Prior	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	Beg	End
Program Integration																Tech Form Dev Ops Res	Dec-04	Sep-10
Flight and Ground Operations																Tech Form Dev Ops Res	Dec-04	Sep-10
Flight Hardware																Tech Form Dev Ops Res	Dec-04	Sep-10

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Space Shuttle Program Manager reports to the Associate Administrator for Space Operations at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Program Integration	Johnson Space Center	Johnson Space Center	n/a
Flight and Ground Operations	Kennedy Space Center	Kennedy Space Center and Johnson Space Center	n/a
Flight Hardware	Johnson Space Center	Johnson Space Center and Marshall Space Flight Center	n/a

Acquisition Strategy

The Space Program Operations Contract (SPOC) prime contractor is United Space Alliance. Other prime contractors providing flight hardware are ATK Thiokol (Reusable Solid Rocket Motor), Lockheed Martin (External Tank), and Pratt & Whitney Rocketdyne (Space Shuttle Main Engines).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	NASA Advisory Council	10/2007	Provides independent guidance for the NASA Administrator.	02/2008
Other	ASAP	10/2007	Provides independent assessments of safety to the NASA Administrator.	02/2008
Other	Program Implementation Review	-	Provides an independent review of ongoing ISS and SSP operations.	06/2008

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Safely complete manifest by FY 2010	Assembly of the ISS is dependent on the Space Shuttle, which will be retired by 2010.	Shuttle hardware could support two contingency flights if those flights are essential to continue ISS operations and can be safely flown before the end of FY 2010.

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**1,469.0**	**1,813.2**	**2,060.2**	**2,277.0**	**2,176.4**	**2,448.2**	**2,143.1**
International Space Station Program	1,469.0	1,813.2	2,060.2	2,277.0	2,176.4	2,448.2	2,143.1
FY 2008 President's Budget Request	**1,762.6**	**2,238.6**	**2,515.1**	**2,609.2**	**2,547.5**	**2,600.8**	**--**
International Space Station Program	1,762.6	2,238.6	2,515.1	2,609.2	2,547.5	2,600.8	--
Total Change from FY 2008 Request	**-293.5**	**-425.4**	**-455.0**	**-332.2**	**-371.1**	**-152.6**	**2,143.1**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-293.5**	**-425.4**	**-455.0**	**-332.2**	**-371.1**	**-152.6**	**2,143.1**
International Space Station Program	**-293.5**	**-425.4**	**-455.0**	**-332.2**	**-371.1**	**-152.6**	**2,143.1**
Programmatic Content	6.8	-13.3	--	--	--	--	2,143.1
Programmatic Transfers	--	--	0.5	131.1	77.5	303.5	--
Institutional Adjustments	-300.3	-412.1	-455.5	-463.3	-448.6	-456.1	--

Explanation of Program Changes

International Space Station Program

Transfers funding from Explorations Systems Mission Directorate (ESMD) to International Space Station Cargo Crew Services; and the removal of indirect costs.

Mission Directorate:	Space Operations
Theme:	International Space Station

Theme Overview

Missions to the International Space Station (ISS) are yielding information about the impacts of long-duration space exploration on humans. NASA and the International Partners are using this information to set the standards for longer missions to the Moon and Mars. Techniques demonstrated in robotics, assembly, and maintainability on the ISS will guide development of next-generation space vehicles that will fly farther, faster, and for longer duration.

The FY 2009 budget request provides funding for ISS launch processing activities, vehicle on-orbit assembly with a crew of six, and continuation of NASA-funded research payload and experiment deliveries to orbit. The FY 2009 budget includes funding for the delivery and operation of the habitability modifications for a crew of six, the purchasing of additional spares (some to be stowed on ISS for use during the post-Shuttle period), and development of the ExPRESS Logistics Carriers (ELC) to transport and stow critical ISS components and spares on-orbit. NASA's plan to complete the ISS will meet the commitment to the International Partners and utilize the ISS as a vital part of the Vision for Space Exploration. A key element in the future of the ISS Program is the purchase of alternate cargo and crew transportation services for the post-Shuttle era. Funding for the development of the Commercial Orbital Transportation Services (COTS) Project is in the Constellation Systems Theme to better exploit potential synergies with exploration systems. Funding for the purchase of crew and cargo transportation services was increased to better anticipate future costs through efficiencies identified in ISS Operations and from funds transferred from the Exploration Systems Mission Directorate. The total available funding for the purchase of cargo transportation services is $2.6 billion over five years.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The ISS serves as a platform for research activities that will prepare human explorers to travel beyond low Earth orbit. Research aboard the ISS is critical to:

- Understand the effects of space environments on the human body;
- Develop techniques for mitigating these hazards;
- Minimize the logistical burden of supporting humans far from Earth;
- Address remote medical emergencies; and
- Demonstrate enabling technologies for human exploration.

The ISS Program represents an unprecedented level of international cooperation. The ISS International Partnership is composed of NASA, the Russian Federal Space Agency (Roskosmos), the Canadian Space Agency (CSA), the European Space Agency (ESA), and the Japan Aerospace Exploration Agency (JAXA). International participation in the program has significantly enhanced the capabilities of the ISS.

Relevance to the NASA Mission and Strategic Goals:

This Theme supports Strategic Goal 2 of NASA's Strategic Plan: Complete the International Space Station in a manner consistent with NASA's International Partner commitments and the needs of human exploration. The ISS Theme supports the fundamental plan of the Vision for Space Exploration "to advance U.S. scientific, security, and economic interest through a robust space exploration program," by completing assembly of the ISS by the end of the decade, focusing U.S. research and use of the ISS on supporting space exploration goals, and conducting ISS activities in a manner consistent with international commitments.

Relevance to education and public benefits:

The benefits of ISS research cross all areas of American life, including health, medicine, economics, entrepreneurship, quality of life, research/knowledge gathering, education, and bridging cultural differences. Specific examples include new uses of ultrasound technology, embedded Web technology to allow remote monitoring and control of devices through a computer and Web browser, and work to help researchers understand and mitigate muscle, balance, and bone problems. Research performed on the ISS will contribute to a broader understanding of injury and disease in support of Earth-based medical applications. The ISS, an exploration research and technology test bed, will be used to develop and demonstrate, among other things, closed loop life support systems and remote medical care capabilities. Both technologies can be used to benefit people here on Earth. For example, water recycling technology is being used to provide potable water to places devastated by natural disasters. NASA will also demonstrate technologies on the ISS necessary for future space systems such as thermal control, environmental control, and power generation.

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 2	**Complete the International Space Station in a manner consistent with NASA's International partner commitments and the needs of human exploration.**					
Outcome 2.1	**By 2010, complete assembly of the U.S. On-orbit Segment; launch International Partner elements and sparing items required to be launched by the Shuttle; and provide on-orbit resources for research to support U.S. human space exploration.**		**None**	**Green**	**Green**	**Green**
APG 9ISS1	Based on the actual Space Shuttle flight rate, number of remaining Shuttle flights, and the discussions with the International Partners, update the agreed-to ISS assembly sequence and transportation plan as necessary.	International Space Station Program				Green
APG 9ISS2	Accomplish a minimum of 90 percent of the on-orbit research objectives as established one month prior to a given increment.	International Space Station Program				Green
APG 9ISS3	Per the final configuration agreed to by the International Partners, fly the ISS elements and logistics baselined for FY2009.	International Space Station Program				Green
APG 9ISS4	Provide increased ISS capability by assembling the remaining two Japanese Exploration Agency (JAXA) elements, the Exposed Facility (EF) and the Experiment Logistics Module-Exposed Section (ELM-ES), and the NASA EXPRESS Logistics Carriers (ELC) as baselined in FY 2009.	International Space Station Program				Green
Outcome 2.2	**By 2009, provide the on-orbit capability to support an ISS crew of six crewmembers.**		**None**	**None**	**None**	**Green**
APG 9ISS5	Install and make flight ready the following delivered ISS systems for 6 member crew capability in FY 2009: three crew quarters, Galley, Water Recovery System (WRS racks 1 and 2), second Treadmill with Vibration Isolation (TVIS2), and Waste Collection/Hygiene Compartment (WHC).	International Space Station Program				Green
APG 9ISS6	In concert with the International Partners, assure a continuous crew presence on the ISS.	International Space Station Program				Green

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
International Space Station Theme					
APG 9ISS7	Achieve an Annual Cost Performance Index (CPI), the ratio of the value of the work accomplished versus the actual cost of the work accomplished, of greater than or equal to one.				None
APG 9ISS8	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green

Performance Achievement Highlights:

- With support from Shuttle flights STS-116 (ISS construction mission 12A.1), STS-117 (13A), and STS-118 (13A.1), NASA continued work on the ISS solar array and truss sections, preparing the ISS for arrival of new major elements in FY 2008. In July 2007, astronaut Clay Anderson successfully activated the Oxygen Generation System (OGS), part of the ISS's Environmental Control and Life Support System (ECLSS) located in the Destiny Laboratory. An addition to the Elekron system located in the Russian Zvezda module, the OGS is critical to supporting future six-crewmember operations.

- NASA is on track to support six-crewmember operations in FY 2009. ISS crew successfully activated the OGS. A team at Kennedy Space Center modified Harmony (Node 2) to receive a second treadmill, which will provide needed exercise facilities for a larger crew. Harmony was launched successfully in fall 2007 and is integrated onto the ISS. NASA also is preparing other habitability hardware for launch in FY 2008: the Water Recovery System, a treadmill with Vibration Isolation System, extra crew quarters, the Waste Collection/Hygiene Compartment, the Total Organic Carbon Analyzer, and galley. NASA also made progress in developing plans for training, crew composition and rotation, and Russian Soyuz launch timetable associated with effectively maintaining and using a six-crewmember complement.

For more information, see Strategic Goal 2 in the FY 2007 Annual Performance Report, included in this budget.

Quality

Program Assessment Rating Tool (PART):

The International Space Station Program received an FY 2004 PART rating of "Moderately Effective." The assessment found that the program had greatly improved its management, particularly in the area of cost control and had effectively managed its budget reserves. Further concern was expressed that the ISS was extremely dependent on the Space Shuttle. The original rating was due to delays in meeting the goals of the ISS Program in the aftermath of the Columbia accident. The ISS program continues to address the concern of dependency on the Space Shuttle. The program will receive a full PART review in calendar year 2008.

NASA is taking the following actions to improve the performance of the program:
1) Developing alternatives to the Space Shuttle for resupplying the International Space Station; and
2) Holding program managers accountable for meeting cost, schedule, and performance goals.

In FY 2007, NASA continued progress in both of these areas for improvement. The ISS is currently addressing several risks that may be encountered in operating the ISS after the Shuttle is retired: the uncertainty in the availability of the cargo transportation vehicles under development, the uncertainty in the costs of those vehicles, and the long lead-time required for procuring the vehicles. Careful risk management is required for planning human spaceflight missions, and this includes continuing the Commercial Orbital Transportation Services (COTS) Project which funds demonstrations of resupply. Preparations have begun for follow-on procurements of U.S. commercial transportation services as the primary source of resupplying the ISS after Shuttle retirement. A mixed fleet approach will consider alternatives such as the European Space Agency Automated Transfer Vehicle and the Japan Aerospace Exploration Agency H-II Transfer Vehicle if U.S. commercial services are unavailable. To address program manager accountability, the ISS deployed Earned Value Management (EVM) practices at lower levels to improve performance monitoring and control with the same success as demonstrated when using EVM at higher levels.

The ISS will receive a full PART review in FY 2008.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	Independent Safety Task Force	12/2006	Discover and assess possible ISS vulnerabilities that may impact vehicle health, compromise crew health, or necessitate premature abandonment. Final report was released February 2007.	N/A
Other	ISS Advisory Committee	09/2007	Assess ISS operational readiness to support new crew, assess Russian flight team preparednesss to accommodate the Expedition 15 mission, and assess health and flight readiness of Expedition 15 crew.	03/2008
Other	NASA Advisory Council	10/2007	Provides independent guidance for the NASA Administrator.	02/2008
Other	ASAP	10/2007	Provides independent assessments of safety to the NASA Administrator.	02/2008
Other	Program Implementation Review	-	Provides an independent review of ongoing ISS and SSP operations	06/2008

Mission Directorate:	Space Operations
Theme:	International Space Station
Program:	International Space Station Program

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**1,469.0**	**1,813.2**	**2,060.2**	**2,277.0**	**2,176.4**	**2,448.2**	**2,143.1**
ISS Operations	**1,469.0**	**1,713.1**	**1,755.4**	**1,750.2**	**1,754.2**	**1,697.2**	**1,528.5**
ISS Cargo Crew Services	**0**	**100.1**	**304.8**	**526.8**	**422.2**	**751.0**	**614.6**
FY 2008 President's Budget Request	**1,762.6**	**2,238.6**	**2,515.1**	**2,609.2**	**2,547.5**	**2,600.8**	**0**
ISS Operations	**1,762.6**	**2,116.0**	**2,142.9**	**2,128.0**	**2,143.1**	**2,084.2**	**0**
ISS Cargo Crew Services	**0**	**122.6**	**372.2**	**481.3**	**404.4**	**516.6**	**0**
Changes from FY 2008 Request	**-293.5**	**-425.4**	**-455.0**	**-332.2**	**-371.1**	**-152.6**	**2,143.1**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Program Overview

The International Space Station (ISS) is a complex of research laboratories in low Earth orbit (LEO) in which NASA and international astronauts conduct scientific and technological investigations in a space environment. The objective of the ISS is to support scientific research for human space exploration and other activities requiring the unique attributes of humans in space. Consistent with the Vision for Space Exploration, ISS research is focused on science and technology development that will prepare human explorers to travel beyond LEO.

NASA is seeking partnerships with other government agencies and the commercial sector to utilize a portion of the ISS as a national lab, as designated by the NASA Authorization Act of 2005. NASA's plan for the ISS National Laboratory, the National Lab Report, was submitted to Congress in May 2007. Approximately 50 percent of planned U.S. utilization resources on ISS could be available for non-NASA use. Firm interest in ISS use has been demonstrated in the areas of education, human health-related research and defense sciences research. The NIH-NASA Memorandum of Understanding for "Cooperation in Space-Related Health Research" signed on September 12, 2007, could be the first in a series of Memorandum of Understandings with US government agencies that have expressed interest in access to the ISS for research and development purposes. In addition, NASA issued an announcement of "Opportunity for Use of the ISS by Non-Government Entities for R&D and Industrial Processing Purposes" on August 14, 2007, and is planning on entering into Space Act Agreements as a result.

In June and August 2007, ISS assembly continued with the attachment of the S3/S4 (Flight 13A) and S5 (Flight 13A.1) Trusses, respectively. ISS crews are supported by re-supply and crew rotation using the Space Shuttle, and Russian Progress and Soyuz vehicles. More detailed information may be found at http://www.nasa.gov/mission_pages/station/main/index.html.

Mission Directorate:	Space Operations
Theme:	International Space Station
Program:	International Space Station Program

Program Relevance

The ISS is an exploration research and technology test bed. NASA will use the ISS to develop and demonstrate, among other things, closed loop life support systems, and remote medical care capabilities. Both of these technologies can be used to benefit people here on Earth; for example, water recycling technology used on the ISS is being used to provide potable water to places devastated by natural disasters. NASA will also demonstrate technologies on the ISS necessary for future space systems such as thermal control, environmental control, and power generation.

This program supports Outcomes 2.1, "By 2010, complete assembly of the U.S. On-orbit Segment; launch international partner elements and sparing items required to be launched by the Shuttle; and provide on-orbit resources for research to support U.S. human space exploration," and Outcome 2.2, "By 2009, provide the on-orbit capability to support an ISS crew of six crewmembers."

Plans For FY 2009

In FY 2009, NASA will continue ISS assembly and complete the truss and solar array assembly with delivery of the S6 truss structure on Flight 15A. The final Japanese Aerospace Exploration Agency's (JAXA) segments, Exposed Facility (EF) and the Experiment Logistics Module-Exposed Section (ELM-ES) will be delivered on Flight 2J/A. Flight 17A will deliver a Multi-Purpose Logistics Module (MPLM). Flight ULF3 is scheduled for the delivery of the ExPRESS Logistics Carriers 1 and 2 (ELC). ISS will continue processing activities, ground testing, and integration of flight hardware for future missions, while operating and monitoring the health of the vehicle systems, and conducting operations on 30 to 40 research experiments. Ground training is ongoing for future flight crews, and ISS will continue to conduct ISS-based EVAs for ISS maintenance, science, and assembly.

Mission Directorate:	Space Operations
Theme:	International Space Station
Program:	International Space Station Program

Project Descriptions and Explanation of Changes

Operations

The ISS Operations budget is accomplished through several key activities: Program Integration, Multi-User System Support (MUSS), Avionics and flight software, and Launch and Mission Operations.

In November 2009, NASA will launch the final Truss Assembly S6 on Flight 15A. In March 2009, NASA will launch both the Japanese Aerospace Exploration Agency's (JAXA) Exposed Facility (EF) and the Experiment Logistics Module-Exposed Section (ELM-ES). In May 2009, Flight 17A will deliver a Multi-Purpose Logistics Module (MPLM), resupplying the ISS. In August 2009, Flight ULF3 is scheduled for the delivery of the ExPRESS Logistics Carriers 1 and 2 (ELC).

MUSS manages all payload operations activities, primarily research payloads. With the completed delivery of the International Partner elements and the establishment of six-person crew capability, ISS research opportunities will be expanded to conduct research in life sciences, materials sciences, fluid physics, as well as its primary focus to serve as a test bed for future exploration missions in a weightless environment.

Prior to launch, NASA and the International Partners, as part of the Launch and Mission Operations activity, will complete building, conduct testing, and perform integration of each U.S. and international element into the Shuttle orbiter at the Kennedy Space Center for launch to orbit. For FY 2009 NASA will perform those activities for the S6 Truss and the Multi-Purpose Logistics Module (MPLM) on Flight ULF3, scheduled for launch in August 2009. Mission Operations are the cadre of people responsible for monitoring ISS and its crew.

ISS program reserves are held in the Operations budget. The FY 2008 program reserves were reduced to accommodate ISS Cargo Crew Services increases and appropriation reductions.

ISS Cargo Crew Services

The purchase of ISS Cargo Crew Services was transferred from Exploration Systems Mission Directorate (ESMD) to SOMD in the FY 2008 budget. The development of this capability, the Commercial Crew and Cargo Program, remains within ESMD. The FY 2008 Continuing Resolutions required that ESMD continue to fund this project until appropriations were received. This resulted in a decrease to planned SOMD requirements and an increase in the ESMD requirements. However, overall NASA expenditures for ISS Cargo Crew Services increased due to the Russian agreement signed in FY 2007 to purchase Soyuz and Progress flights through 2011. This increase was funded out of ISS program reserves held within the Operations budget.

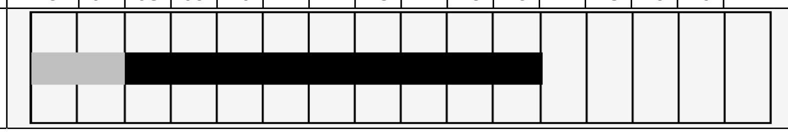
The ISS Cargo Crew Services budget consists of International Partner and commercial purchases. In the near-term, International Partner purchases are required because no U.S. alternatives exist to the Space Shuttle. In the long-term, NASA would prefer to use U.S. commercial space transportation providers, both to ensure domestic sources and to expend taxpayer dollars domestically.   The commercial cargo services acquisition is currently in the pre-formal acquisition phase. A draft and formal Request for Proposal (RFP) is expected during FY 2008. NASA currently has agreements with Russia to purchase Soyuz and Progress flights. In the future, NASA may also purchase Japanese H-II Transfer Vehicle (HTV) or European Automated Transfer Vehicle (ATV) flights for cargo delivery in the post-Shuttle timeframe.

Mission Directorate:	Space Operations
Theme:	International Space Station
Program:	International Space Station Program

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
ISS Assembly complete by 2010	International Space Station (ISS)	No change

Implementation Schedule

Project	Schedule by Fiscal Year	Phase Dates	Beg	End
	Prior 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21		Beg	End
ISS		Tech		
		Form		
		Dev	Oct-93	Sep-07
		Ops	Oct-07	Sep-16
		Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The ISS Program Manager reports to the Associate Administrator for Space Operations at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
On-orbit assembly and operations	NASA Johnson Space Center	NASA Johnson Space Center	Russian Federal Space Agency, European Space Agency, Japan Aerospace Exploration Agency, Canadian Space Agency, and Italian Space Agency (ASI).

Acquisition Strategy

After the Shuttle retires in FY 2010, the ISS Program intends to use alternative cargo transportation services from the commercial industry. In August 2006, NASA selected Space Exploration Technologies Corporation of El Segundo, California, and Rocketplane-Kistler of Oklahoma City, Oklahoma, to develop and demonstrate Commercial Orbital Transportation Services (COTS) that could open new markets and pave the way for contracts to launch and deliver cargo to the ISS. NASA and the two companies signed Space Act Agreements (SAAs) that established milestones and objective criteria to assess their progress throughout Phase 1 of the competition. Funding for COTS is in the Constellation Systems Theme to better exploit potential synergies with exploration systems.

In the summer of 2007, NASA also entered into non-funded SAAs with five additional U.S. companies. NASA is planning to purchase cargo delivery services in full and open competition in Phase 2. In August 2007, NASA issued a Request For Information (RFI) to obtain industry data on ISS commercial resupply opportunities and for future acquisition planning for other payloads in orbit. The primary purpose of this RFI is to collect information on key parameters that would help NASA refine and mature the acquisition plan for procuring safe, cost effective, and reliable ISS logistics re-supply services. (Reference Solicitation Number: NNJ07ISSBG.)

The ISS Program is developing an acquisition strategy that addresses completion of assembly and sustains the United States Orbital Segment. The current NAS 15-10000 contract has been extended, by exercising planned options, to run through September 30, 2008. Given the delay in the assembly of the ISS caused by the Columbia accident, NASA is considering extension of the contract two years through September 30, 2010. This will ensure a stable contract environment through completion of assembly and Shuttle retirement.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	Independent Safety Task Force	12/2006	Discover and assess possible ISS vulnerabilities that may impact vehicle health, compromise crew health, or necessitate premature abandonment. Final report released February 2007.	N/A
Other	ISS Advisory Committee	09/2007	Assess ISS operational readiness to support new crew, assess Russian flight team preparedness to accomplish the Expedition 15 mission, and assess health and flight readiness of Expedition 15 crew.	03/2008
Other	NASA Advisory Council	10/2007	Provides independent guidance for the NASA Administrator.	02/2008
Other	ASAP	10/2007	Provides independent assessments of safety to the NASA Administrator.	02/2008
Other	Program Implementation Review	-	Provides an independent review of ongoing ISS and SSP operations.	06/2008

Mission Directorate:	Space Operations
Theme:	International Space Station
Program:	International Space Station Program

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
USOS Cargo Transportation Shortfall - 2010 through 2015	Given Shuttle retirement in 2010 and current ISS transportation reqirements, there is approximately 61.3 metric ton USOS cargo transportation still required from 2010 through 2015.	Program continues to work upmass requirements. Additional options to mitigate the risk are addressed in an August 2007 NASA Request For Information (RFI) to obtain industry data on ISS commercial resupply parameters.
Russian Segment (RS) capability to provide adequate MMOD protection	Inadequate Micro-Meteroid/Orbital Debris (MMOD) shielding on the Russian Segment can lead to greater potential for MMOD penetration and depress contingencies	In FY2007, the ISS installed conformal panels on the SM during an EVA to mitigate the MMOD risk to the RS. Additionally, NASA has reached tentative agreement with Rocket Space Corporation-Energia, which is currently being finalized and documented, regarding implementation of Service Module deployable MMOD shields, and detailed study of Soyuz and Progress MMOD shielding enhancements.
ExPRESS Logistics Carrier (ELC) Development Cost and Schedule	Given the results of the Phase 2 Avionics CDR, the Goddard engineering support contract transition and the inherently aggressive development schedule, there is a possibility of cost and schedule increase.	NASA is closely monitoring ELC development cost and schedule. A detailed mitigation strategy is in development.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**329.2**	**446.3**	**732.8**	**612.1**	**628.0**	**641.7**	**645.4**
Space Communications and Navigation	191.3	303.9	582.9	475.2	491.3	504.8	508.5
Launch Services	83.4	91.7	99.6	84.0	83.4	83.8	83.8
Rocket Propulsion Testing	46.4	41.9	41.8	44.3	44.7	44.6	44.6
Crew Health & Safety	8.1	8.7	8.6	8.6	8.5	8.5	8.5
FY 2008 President's Budget Request	**328.1**	**545.7**	**544.3**	**382.0**	**372.9**	**377.2**	**--**
Space Communications and Navigation	170.5	371.4	373.4	215.5	206.2	210.4	--
Launch Services	101.5	112.3	109.4	102.3	102.1	102.4	--
Rocket Propulsion Testing	46.2	51.3	51.0	53.8	54.2	54.1	--
Crew Health & Safety	9.9	10.6	10.5	10.4	10.4	10.4	--
Total Change from FY 2008 Request	**1.1**	**-99.4**	**188.5**	**230.1**	**255.1**	**264.5**	**645.4**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**1.1**	**-99.4**	**188.5**	**230.1**	**255.1**	**264.5**	**645.4**
Space Communications and Navigation	**20.8**	**-67.3**	**209.4**	**259.9**	**285.2**	**294.5**	**508.5**
Programmatic Content	49.3	0.4	--	0.1	0.7	0.7	508.5
Programmatic Transfers	--	--	276.7	297.4	320.3	330.2	--
Institutional Adjustments	-28.5	-67.7	-67.3	-37.6	-35.8	-36.4	--
Launch Services	**-18.1**	**-20.6**	**-9.8**	**-18.3**	**-18.7**	**-18.7**	**83.8**
Programmatic Content	-0.8	0.1	10.0	-0.1	-0.7	-0.7	83.8
Institutional Adjustments	-17.3	-20.7	-19.8	-18.2	-18.0	-18.0	--
Rocket Propulsion Testing	**0.2**	**-9.5**	**-9.2**	**-9.6**	**-9.6**	**-9.5**	**44.6**
Programmatic Content	8.1	--	--	--	--	--	44.6
Institutional Adjustments	-7.9	-9.5	-9.2	-9.6	-9.6	-9.5	--
Crew Health & Safety	**-1.8**	**-2.0**	**-1.9**	**-1.9**	**-1.8**	**-1.8**	**8.5**
Programmatic Content	-0.2	--	--	--	--	--	8.5
Institutional Adjustments	-1.6	-2.0	-1.9	-1.9	-1.8	-1.8	--

Note: As a result of the centralization of Space Communication and Navigation infrastructure and network activities under SOMD starting in FY 2009 the budget for ECANS now SCIP was transferred from ESMD and the budgets for DSN and GN now NEN were transferred from SMD into the Space Communications and Navigation (SCaN)Program.

Explanation of Program Changes

Space Communications and Navigation

The management of all NASA Space Communications and Navigation activities was centralized within the Space Operations Mission Directorate. The centralization includes several existing networks: Deep Space Network, Space Network, Near Earth Network formerly Ground Network, NASA Integrated Services Network, and Space Communications Constellation Integration Project formerly the Exploration Communications and Navigation System and supporting functions. The budgets for these projects have been transferred from the Science Mission Directorate and the Exploration Systems Mission Directorate budgets to the Space Operations Mission Directorate's Space Communications and Navigation Program budget.

Launch Services

The FY 2007 budget decrease reduced the number of Technical Task Agreements. The $10M budget increase in FY 2009 is to support the Delta II launch pad costs borne by NASA to support its missions. The FY 2010 and outyears decreased due to re-examination of post launch, operational support for the Alpha Magnetic Spectrometer.

Rocket Propulsion Testing

Increase in FY 2007 to support testing in the B-2 Test Chamber at Plumbrook and core capability support to test stands at Stennis Space Center. Decrease in FY 2008 and outyears for removal of indirect costs.

Crew Health & Safety

Decrease in FY 2007 for environmental monitoring, and in FY 2008 and outyears for removal of indirect costs.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)

Theme Overview

NASA's Space Communications and Navigation (SCaN) Program provides communications and navigation services to the Agency's flight missions and supplies terrestrial communications needs. SCaN supports NASA Mission Directorates and external organizations by providing space communications and data systems services that are responsive to the mission needs. These services include utilization of commercial providers to the extent that is feasible and cost effective. SCaN also performs sustaining and replenishment efforts necessary to maintain the infrastructure, such as the acquisition of TDRS replenishment spacecraft. SCaN includes infusion of communications and data systems technology and standards to provide mission enabling, efficient, and effective services. All NASA space communications and navigation infrastructure, network activities, and budgets have been centralized within SCaN. The SCaN Program is managed within the Space Operations Mission Directorate (SOMD) at NASA Headquarters.

NASA has assigned responsibility for understanding the full range of civil space launch needs to the SOMD Launch Services Program (LSP). LSP, which works closely with other government agencies and the launch industry, seeks to ensure that the most safe, reliable, on-time, and cost-effective commercial launch opportunities are available on a wide range of launch systems. The LSP budget also supports integration activities for the Alpha Magnetic Spectrometer scientific instrument, a 16-nation international particle physics and astrophysics experiment planned for the ISS that will look for dark matter, anti-matter, and strange matter.

The Rocket Propulsion Testing (RPT) Program reviews, approves, and provides direction on rocket propulsion test assignments, capital asset improvements, test facility modernization and refurbishments, integration for multi-site test activities, identification and protection of core capabilities, and the advancement and development of test technologies.

The care of the NASA Astronaut Corps is the responsibility of space medical operations at the Johnson Space Center. A portion of the responsibilities for that care is managed within the Crew Health and Safety (CHS) Program. CHS enables: healthy and productive crew during all phases of space flight missions; implementation of a comprehensive health care program for astronauts; and the prevention and mitigation of negative long-term health consequences of spaceflight.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)

Relevance

Relevance to national priorities, relevant fields, and customer needs:

SFS provides the enabling capabilities required to advance space exploration and expand scientific knowledge of Earth and the universe. Without these capabilities NASA could not perform many of its missions.

Relevance to the NASA Mission and Strategic Goals:

The Space and Flight Support (SFS) Theme supports NASA's Vision for Space Exploration by providing unique operational capabilities for space communications and navigation, launch services, and rocket tests, as well as managing the health care of the Astronaut Corps. The services provided are critical for enabling the conduct of space exploration, aeronautical research, and biological and physical research and are provided to a wide range of customers, including NASA scientists and engineers, other federal agencies, universities, foreign governments, and industry interests.

The Space and Flight Support Theme supports the following Goals in the 2006 NASA Strategic Plan:

Goal 5: Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.

Goal 6: Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.

Relevance to education and public benefits:

The benefits of SFS to education and public benefits include: the relay of scientific data from space to Earth; the safe launching of expendable launch vehicles necessary for research; the assurance that rocket systems have been adequately tested; and the testing and implementation of various human health and illness prevention measures. A space program properly supported by this Theme will produce research data that can be used to generate new scientific knowledge through the study of heliophysics, astrophyisics, solar system exploration, Earth science, biological and physical research, and more. These activities benefit both the general public and the education community.

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 3	**Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.**					
Sub Goal 3F	**Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration.**					
Outcome 3F.4	**By 2012, identify and develop tools, methods, and technologies for assessing, improving and maintaining the overall health of the astronaut corps, for mission lengths up to 180 days in microgravity or 1/6 G.**					
APG 9SFS1	Publish volume 5 of the Spacecraft Maximum Allowable Concentrations (SMACs) and volume 3 of the Spacecraft Water Exposure Guidelines (SWEGs).	Crew Health & Safety				None
APG 9SFS2	Thirty-seven percent of current and former astronaut medical requirements data will be captured in a comprehensive medical data management infrastructure.	Crew Health & Safety				None
APG 9SFS3	Capture 100% of medical and environmental data required by Medical Operations in queriable form.	Crew Health & Safety				None
Strategic Goal 4	**Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.**					
Outcome 4.1	**No later than 2015, and as early as 2010, transport three crewmembers to the International Space Station and return them safely to Earth, demonstrating an operational capability to support human exploration missions.**		**Green**	**Green**	**Green**	**Yellow**
APG 9SFS3	In FY 2009, maintain agency rocket propulsion test core competencies (both infrastructure and critical skills) at appropriate levels to meet Constellation testing requirements and integrate these with other NASA programs, commercial partners, and DoDrequirements and capabilities.	Rocket Propulsion Testing				None
APG 9SFS4	Coordinate rocket propulsion test activities to support Constellation rocket propulsion testing milestones by providing an agency level Rocket Propulsion Test Plan.	Rocket Propulsion Testing				None
Strategic Goal 5	**Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.**					
Outcome 5.1	**Develop and demonstrate a means for NASA to purchase launch services from emerging launch providers.**		**Green**	**Green**	**Green**	**Green**
APG 9SFS5	Establish a contractual mechanism or agreement to provide technical exchanges between NASA's Launch Services Program and emerging launch vehicles/providers to enhance early launch success.	Launch Services				Green

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 6	**Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.**					
Outcome 6.4	**Implement the space communications and navigation architecture responsive to science and exploration mission requirements.**		**Green**	**Green**	**Green**	**Green**
APG 9SFS6	Complete TDRS Replenishment Preliminary Design Review (PDR).	Space Communications and Navigation				New
APG 9SFS7	Re-compete the Space Network, Near Earth Network and NISN operations and maintenance contracts to provide uninterrupted support of those networks.	Space Communications and Navigation				Green
APG 9SFS8	Complete a consolidated network modernization plan for all SCaN networks to meet existing and future science and exploration mission requirements.	Space Communications and Navigation				Green

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Space and Flight Support (SFS) Theme					
APG 9SFS10	Achieve at least 99% Space Network proficiency for delivery of Space Communications services.				Green
APG 9SFS11	Complete all development projects within 110% of the cost and schedule baseline.				White
APG 9SFS12	Ratio of Launch Services program cost per mission to average spacecraft cost, reduced to 6.3 percent.				None

Performance Achievement Highlights:

- LSP completed an Agency strategic review of medium-sized expendable launch vehicle options in which the program recommended that NASA give significant attention to enabling the emerging commercial launch service providers in becoming certified for NASA use. The program also coordinated an Agency review of NASA Policy Document 8610.7, "Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions," to evaluate the feasibility of changes to Agency policy that would enable the use of emerging launch service providers sooner.

- In 2006, the Space Communications Program developed a plan for updating NASA's space communications and navigation architecture, as directed in the NASA Authorization Act of 2005. NASA delivered the report to the House Committee on Science and Technology on July 25, 2007.

- The Space Communications Program is working with the Space Operations Mission Directorate, the Exploration Systems Mission Directorate and the Science Mission Directorate to ensure that communication and navigation needs are met. As part of this effort, the program partners with the commercial sector to obtain and maintain reliable technologies at competitive prices: the Communication Navigation and Networking Reconfigurable Testbed (CoNNeCT), which is investigating reprogrammable (software-defined) radio technology for use during space exploration missions, is a joint government and commercial development project; NASA is working with industry partners on the Tracking and Data Relay Satellite (TDRS) Continuation Project; and the Near Earth Network acquires over 60 percent of tracking services on a commercial fee-for-service basis.

For more information, see Strategic Goals 5 and 6 in the FY 2007 Annual Performance Report, included in this budget.

Quality

Program Assessment Rating Tool (PART):

The Space and Flight Support (SFS) Theme's 2007 PART rating of "Moderately Effective" is an improvement over its original FY 2004 PART rating of "Adequate." The SFS Theme continues to meet existing NASA needs such as reliable communication and navigation services for space missions, safe and cost-effective access to space on commercial launch vehicles, and rocket testing for current and future programs. Steps that were taken to improve included the increased use of independent assessments and the development of relevant performance measures that will provide the indication if program outcomes are being met.

Since the program's review, NASA has completed one action required to improve the performance of the program:
1) Develop better measures that will help to drive program improvement.

There are remaining performance improvement areas as identified that NASA is taking action toward:
1) Compare efficiency data against established targets and benchmark these results to similar services available in private industry or other emerging providers to ensure best value to the government;
2) Develop a plan to assess the most cost-effective method to sustain necessary program capabilities post-Shuttle retirement and tracks their performance during this period of possible reduced demand; and
3) For the time between Shuttle retirement and human lunar operations, identify and track changing Space Communication requirements for human and robotic exploration that may impact program budget or performance.

The Space Network target for percent of planned data delivery achieved has increased from 98 percent to 99 percent and the actuals are meeting or exceeding the target. Improvements are also being identified through independent review of all the major program elements to evaluate effectiveness and relevance. The Launch Services and Space Communications and Navigation Programs contracted with NAPA and NRC, respectively, to perform these independent reviews in FY 2006 and FY 2007. The completed report has been received and the programs have initiated processes to address areas that require improvement.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	National Research Council	01/2006	SOMD Space Communications Independent Evaluation by National Research Council was completed in September 2006 with final report delivered the first quarter of CY 2007.	n/a
Performance	National Academy of Public Adm	09/2006	Independent assessment on LSP's performance.	n/a

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	191.3	303.9	582.9	475.2	491.3	504.8	508.5
Space Communications Networks	59.9	90.7	363.5	385.5	409.8	420.2	423.7
Space Communications Support	66.4	63.9	65.4	63.7	62.5	62.0	71.4
TDRS Replenishment	65.0	149.3	154.0	26.0	19.0	22.6	13.4
FY 2008 President's Budget Request	170.5	371.4	373.4	215.5	206.2	210.4	0
TDRS Continuation	0	182.5	186.2	29.7	21.0	25.7	0
Space Communications and Navigation	170.5	188.9	187.2	185.8	185.2	184.7	0
Changes from FY 2008 Request	20.8	-67.4	209.5	259.7	285.1	294.4	508.5

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

Program Overview

Space Communications and Navigation (SCaN) services are vital to the Nation's space programs. While often less visible, they are as critical as the payloads and the launch systems that carry flight missions to their destinations.

SCaN provides the enabling communications services to NASA's human and robotic flight missions to accomplish their mission objectives. NASA uses an integrated infrastructure to provide these essential links. The responsibility of this infrastructure is vested with the Space Operations Mission Directorate's SCaN Program Office. This integrated approach to SCaN services significantly reduces operational and development costs.

Two key challenges for the SCaN Program Office are projecting and capturing future mission communications needs, and determining how to meet these requirements. SCaN provides communications for these missions by incorporating effective and efficient state-of-the-art technology while stimulating and encouraging development of commercial sources. The budget for SCaN is based upon operational needs of flight missions, technology initiatives, and other cross cutting support (e.g., management and use of the electromagnetic spectrum and interoperable data standards) necessary to meet future mission requirements. The SCaN Program Office is also developing an integrated space communication and navigation architecture aligned with NASA's Vision for Space Exploration and other science mission requirements.

The SCaN Program serves NASA Mission Directorates, the managers of the approved space flight missions (both NASA-only and partnerships), NASA institutional facilities, and non-NASA organizations requiring services from the NASA Space Communication assets. Non-NASA organizations include other U.S. Government agencies, commercial companies, and foreign space agencies. To maintain services, additional spacecraft are being acquired through a contract awarded in December 2007 to procure two new TDRS replenishment satellites (K & L) for deployment in 2012 and 2013, respectively.

For more information, please see https://www.spacecomm.nasa.gov/spacecomm/.

Program Relevance

The SCaN Program is responsible for providing communications and navigation services to NASA's flight missions and for the Agency's terrestrial mission and administrative communications. These services include activities that support the planning, systems engineering, design, development, operation, and analysis of communications networks and of related network control and planning systems. SCaN provides flight missions with services such as transmitting data to and from a space vehicle, deriving data from transmitted signals, and distributing data to mission organizations. SCaN services may include the processing, storage, and transmission of spacecraft, payload, instrument, ground system, and network data for supported flight missions. The administrative communications services provided by the SCaN Program include voice, video, email, and data transport.

SCaN supports Outcome 6.4: Implement the Space Communications and Navigation architecture responsive to science and exploration requirements. The SCaN Program insures reliable space communication and navigation that enable future Lunar and Mars missions, as well as robotic exploration.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

Plans For FY 2009

- Successfully provide Space Communications and Navigaton (SCaN) support to all missions.

- Complete network ground station modernization plans.

- Conduct Tracking and Data Relay System (TDRS-K/L) Preliminary Design Review.

- Conduct TDRS-K/L Non-Advocacy Review.

- Participate in Orion Crew Exploration Vehicle (CEV) Preliminary Design Review to define the Lunar/SCaN requirement.

- Define Lunar capability requirements.

- Complete the recompetition of the Space Network/Near Earth Network, and NISN follow on contracts.

- Continue to advance cross support opportunities with international space agencies.

- Deliver the software Defined Radio Test Bed payload to the Space Transportation System (STS) for launch in 2010.

- Continue demonstration of new technology candidates for network implementation (e.g., multiple access combining, high-rate data compression).

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

Project Descriptions and Explanation of Changes

Space Communications Networks

The management of all NASA Space Communications and Navigation activities was centralized within the Space Operations Mission Directorate. The centralization consolidated the management of several existing networks within the Space Communications Network project: Deep Space Network, Space Network, Near Earth Network (formerly Ground Network), NASA Integrated Services Network, and Space Communications Constellation Integration Project (formerly the Exploration Communications and Navigation System), and supporting functions. The budgets and content for these projects have been transferred from the Science Mission Directorate and the Exploration Systems Mission Directorate budgets to the Space Operations Mission Directorate's Space Communications and Navigation Program budget.

- Deep Space Network: Deep Space Network's globally distributed terrestrial communications stations predominantly support missions operating at distances beyond geosynchronous orbit. There are three stations that support this effort: Spain, Austrailia and California. This network is managed for NASA by the Jet Propulsion Laboratory. The budget and content for this project were transferred from the Science Mission Directorate.

- Near Earth Network: Formerly known as the Ground Network, the Near Earth Network globally distributes tracking stations supporting near Earth spacecraft needing periodic contact. The antenna locations are primarily at high latitude locations such as Norway and Alaska. Additional antennas are located at Wallops Island, Virginia, and Merritt Island, Florida. This project was transferred from the Science Mission Directorate and is managed by NASA at Goddard Space Flight Center.

- NASA Integrated Services Network: This network has commercial service backbones providing point-to-point terrestrial signal transport services and routing network services. This project is managed for NASA by Marshall Space Flight Center.

- Space Network: The Space Network's geosynchronous relay satellites predominantly support low Earth orbit missions with global coverage. This network is managed for NASA by the Goddard Space Flight Center. Ground stations for the project are located at White Sands, New Mexico, and at Guam.

Space Communications Support

- Managing cross-cutting communication functions for external coordination of Spectrum, Standards, Technology, and Systems Planning functions that enable NASA's space communications networks;

- Initiating and managing communications and navigation technology initiatives to reduce cost;

- Developing an architecture to support exploration and science missions;

- Managing access to communications radio frequencies in order to conduct space/ground based transmissions; and

- Conducting proof-of-concept analysis for space-based search and rescue system to improve distress alert and location capability.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

Tracking and Data Relay Satellite System (TDRSS) Replenishment

The TDRS Continuation Project was renamed during this FY 2009 President's Budget to reflect an acceleration of the NASA contribution to meet partner agreements. The contract was awarded in December 2007, maintaining the original plans as requested in the FY 2008 President's Budget. NASA and its partners will procure two new TDRS (K/L) for deployment in 2012.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Achieve less than 3% of lost operating time on NISN available services.	NASA Integrated Services Network, NISN	no change
Achieve at least 98% Space Network proficiency for delivery of Space Communications services.	Space Network, Deep Space Network, and Near Earth Network	no change

Implementation Schedule

Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

Project	Phase	Beg	End
Space Communications and Navigation Operations	Tech		
	Form		
	Dev		
	Ops	Oct-05	Oct-20
	Res		
Space Communications and Navigation Non Operations, TDRS Replenishment	Tech		
	Form	Oct-06	Sep-09
	Dev	Oct-09	Sep-12
	Ops		
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Deputy Associate Administrator for Space Communications and Navigation (SCaN) reports to the Associate Administrator for Space Operations at NASA Headquarters. SCaN projects are managed by managers located at Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
SCaN Constellation Integration Project	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center, Glenn Research Center, Jet Propulsion Laboratory	
Near Earth Network	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center	
NASA Integrated Services Network	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center, Marshall Space Flight Center	
Space Communications Project	Space Communications Program Office - NASA Headquarters	Glenn Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Johnson Space Center	
TDRS Replenishment	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center, Kennedy Space Center	Non-NASA Partner Agency
Deep Space Network	Space Communications and Navigation Program Office - NASA Headquarters	Jet Propulsion Laboratory	
Space Network	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center	Other Government Agencies

Acquisition Strategy

The TDRS Replenishment Project is a joint partnership between NASA and other Government Agencies. A cost sharing arrangement with non-NASA users has been negotiated. To meet the 2012/2013 launch schedule, the prime contract for spacecraft development was awarded in December 2007.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	National Research Council	01/2006	SOMD Space Communications Independent Evaluation by National Research Council (NRC) was completed in September 2006 with the final report delivered the first quarter of CY 2007. This report validated the need to centralize management of all NASA space communications, formalized in a detailed program plan.	n/a

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
TDRS K/L Obsolescence Risk Management	Aging spacecraft requires replacement hardware by 2013. The mission load is predicted to exceed current capacity and will need additional spacecraft to provide the needed capacity.	The project procured replacement spacecraft in early FY 2008.
Space Network Obsolescence Risk Management	Aging equipment and obsolescence is increasing the risk of a break in service. Maintenance costs are increasing and diverting budget from lower-priority necessary tasking.	The Space Network will continue to monitor and pursue revenue sources.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation
Project In Formulation:	TDRS Replenishment

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009
FY 2009 President's Budget Request	**65.0**	**149.3**	**154.0**
FY 2008 President's Budget Request	**--**	**182.5**	**186.2**
Total Change from 2008 President's Budget Request	**65.0**	**-33.2**	**-32.2**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Project Purpose

The existing fleet of the Tracking and Data Relay Satellite System (TDRSS) supports tracking, data, voice, and video services to the International Space Station (ISS), space and Earth science missions, as well as other government agency users. The total mission load is predicted to increase, which will require additional satellites to be added to the fleet.

The existing fleet is aging and reliability analysis predicts a shortage of flight assets to support NASA missions and the user community by 2011. As a result, NASA began in FY 2007 the acquisition of two additional spacecraft, TDRS-K and TDRS-L, to be launched in 2012 and 2013 respectively. By adding these two spacecraft to the TDRSS fleet, continuity of service will be insured for NASA and other Government Agency user missions through approximately 2016.

The TDRS Replenishment Project supports the Agency's goal to establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations. It accomplishes this by implementing the space communications and navigation architecture responsive to Science and Exploration mission requirements and implementing technology initiatives consistent with approved baseline space communications and navigations architecture.

Project Preliminary Parameters

The TDRS system consists of in-orbit telecommunications satellites stationed at geosynchronous altitude and associated ground stations located at White Sands, New Mexico and Guam. This system of satellites and ground stations comprises the Space Network that provides mission services for near -Earth user satellites and orbiting resources, with many near-Earth spacecraft being totally dependent upon it for performance. The TDRSS constellation includes the first-generation satellites (TDRS 1-6), the replacement satellite (TDRS 7), and the second-generation satellites (TDRS 8, 9, and 10).

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation
Project In Formulation:	TDRS Replenishment

Estimated Project Deliverables

The TDRS-K and TDRS-L spacecraft will be fully compatible with and capable of functioning as part of the TDRS System as implemented and operated by the White Sands Complex (WSC) and Guam ground terminals. Requirements will include: design, development, fabrication, integration, test, on-orbit delivery, and launch services. Launch dates for TDRS-K and TDRS-L will be in 2012 and 2013 respectively. The spacecraft are required to have an operational life of 11 years. The basic requirement will also include modification of the WSC Space-to-Ground Link Terminals to provide compatibility with the new spacecraft, while preserving compatibility with the existing TDRS fleet.

Project Element	Provider	Description	FY 2008 PB Request	FY 2009 PB Request
TDRS Replenishment	NASA	Aging hardware replacement	NASA commited $450M through FY 2013.	$450M

Estimated Project Schedule

Milestone Name	Formulation Agreement Estimate	FY 2008 PB Request	FY 2009 PB Request
Formulation			
Release Request For Procurement, RFP	Quarter 2, FY 2007	N/A	N/A
Prime Contract Award	Quarter 1, FY 2008	$150M	$154M
Preliminary Design Review, PDR	Quarter 2, FY 2008	N/A	N/A
Non-Advocacy Review	Quarter 2, FY 2008	N/A	N/A

Project Management

The Deputy Associate Administrator for Space Communications and Navigation reports to the Associate Administrator for Space Operations at NASA Headquarters.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
TDRS Replenishment	Space Communications and Navigation (SCAN) Office	Headquarters SCaN Program Office	GSFC, KSC, and Non-NASA Agencies

Acquisition Strategy

The Acquisition Strategy for this procurement uses a Firm Fixed Price with Incentive Fee contract.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation
Project In Formulation:	TDRS Replenishment

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
TDRS-K and TDRS-L Obsolescence Risk Management	Aging spacecraft requires replacement hardware by 2013. The mission load is predicted to exceed current capacity and will need additional spacecraft to provide enough capacity.	The project has awarded a Firm Fixed Price with Incentive Fee contract as of December 2007.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Launch Services

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**83.4**	**91.7**	**99.6**	**84.0**	**83.4**	**83.8**	**83.8**
Launch Services	**83.4**	**91.7**	**99.6**	**84.0**	**83.4**	**83.8**	**83.8**
FY 2008 President's Budget Request	**101.5**	**112.3**	**109.4**	**102.3**	**102.1**	**102.4**	**0**
Launch Services	**101.5**	**112.3**	**109.4**	**102.3**	**102.1**	**102.4**	**0**
Changes from FY 2008 Request	**-18.1**	**-20.6**	**-9.8**	**-18.2**	**-18.7**	**-18.7**	**83.8**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Program Overview

Assuring reliable and cost-effective access to space for missions is critical to achieving the Vision for Space Exploration. NASA has assigned responsibility for understanding the full range of civil space launch needs to the Space Operations Mission Directorate Launch Services Program. The Launch Services Program, which works closely with other government agencies and the launch industry, seeks to ensure that the most safe, reliable, on-time, cost-effective commercial launch opportunities are available on a wide range of launch systems. A key challenge for the program is understanding the launch needs of the different civil government customers. These customers seek to: understand Earth processes, including the use of weather satellites; explore the solar system with planetary probes, Mars rovers, and orbiters; understand the universe primarily through the use of space-based telescopes; and enhance life on Earth by understanding the Earth-Sun system using various scientific missions. The program purchases fixed-price launch services from domestic suppliers and provides oversight to ensure that these valuable, one-of-a-kind missions safely leave Earth to explore the universe beyond. The program works with customers from universities, industry, government agencies, and international partners from the earliest phase of a mission. The funding provides the capability for NASA to maintain critical skills that provide technical management of launch services on the full fleet of existing and new launch systems. For more information, please see http://www.nasa.gov/centers/kennedy/launchingrockets/index.html.

The Launch Services Program budget also supports integration activities for the Alpha Magnetic Spectrometer scientific instrument comprised of a 16-nation international particle physics and astrophysics experiment planned for the ISS that will look for dark matter, anti-matter, and strange matter. This experiment is sponsored by the Department of Energy and funded largely by International Partners.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Launch Services

Program Relevance

The Launch Services Program (LSP) is responsible for enabling access to space for NASA and other select government missions. LSP is responsible for a wide range of activities critical to fulfilling the Vision for Space Exploration. LSP provides safe, reliable, cost-effective, and on-time commercial launch services for NASA and NASA-sponsored payloads using expendable launch vehicles (ELVs). The program increases the opportunity for mission success by reducing launch risk through a technical oversight approach that includes a combination of specified approvals and targeted insight. LSP is also responsible for NASA oversight of launch operations and countdown management and provides added quality and mission assurance in lieu of the requirement for the launch service provider to obtain a commercial launch license.

This program supports Outcome 5.1.

Plans For FY 2009

There are numerous planned launches for FY 2009: Orbiting Carbon Observatory (OCO), Glory, Kepler, Lunar Reconnaissance Orbiter/Lunar Crater Observation Sensing Satellite (LRO/LCROSS), National Oceanic and Atmospheric Administration-N Prime (NOAA-N'), Solar Dynamics Observatory (SDO), NPOESS Preparatory Project (NPP), Geostationary Operational Environmental Satellite (GOES-P), Mars Science Lab (MSL), and Aquarius. Kepler, NOAA-N', NPP, and Aquarius will be launched on Delta II rockets, and GOES-P will be launched on a Delta IV. LRO/LCROSS, SDO, and MSL will be on an Atlas V, while OCO and Glory will be launched on a Taurus XL. In addition to the processing, mission analysis, and spacecraft integration and launch services of the above missions, LSP plans the continued advanced planning and trade studies for launching future missions that will extend scientific knowledge and exploration capabilities, such as a mission to Jupiter, a wide-field infrared telescope, the next-generation Mars rover, and a mission to collect data of Earth's continental surfaces. LSP conducts advanced planning to support the evolving launch requirements for Moon and Mars exploration, and is working to increase the number of current launch providers available to our customers.

Project Descriptions and Explanation of Changes

Launch Services Program

The primary elements of the Launch Services Program (LSP) are described below:

LSP provides the acquisition of commercial services using primarily domestic launch vehicles and associated standard services and mission unique options. These services are contracted through LSP at the Kennedy Space Center. LSP provides: acquisition and management of all program-related services; program-level financial management including the integration and insight of the launch services tasks across multiple Centers; and management of all program resource requirements. LSP provides the Contracting Officer Technical Representative (COTR) function for launch service contracts, and support services contracts, ensuring consistency and best practices are followed. LSP assures NASA retains the technical, management, and acquisition skills necessary to meet customer demand by providing the necessary resources required to meet the Agency's various needs.

LSP provides mission integration, technical, and launch management functions. Manifesting and scheduling of payload launches are accomplished through the auspices of the Flight Planning Board. Through this process all space access requirements and priorities are assessed to develop flight planning manifests that best meet the requirements and capabilities of the Agency. LSP acquires launch services to meet the full range of customer requirements. These requirements range from finding space for small payloads to the launch of dedicated payloads on a range of launch vehicles. LSP also provides technical management of the launch service, including planning, execution, and support for flight project customer requirements. This element of the program provides for planning and implementation of mission-specific integration activities, coordination and approval of mission-unique launch vehicle hardware/software development, and provision of payload-processing accommodations. Additionally, LSP offers management of the launch campaign/countdown including coordination with other government agencies and the commercial sector.

LSP provides engineering services and analysis for launch vehicle certification at levels of detail commensurate with the mission risk tolerance. The program maximizes the mission success of commercially developed expendable launch services by employing a technical oversight approach that includes a combination of specified approvals and targeted insight. This element also provides for the coordination of mission-specific and fleet-wide launch vehicle analyses, hardware changes, and production oversight, assessments, and out-of-family anomaly resolution.

The FY 2007 budget decreased the number of Technical Task Agreements. The $10M budget increase in FY 2009 is to support Delta II launch pad costs borne by NASA to support its missions. Funding in FY 2010 and the outyears is decreased due to a re-examination of post-launch operational support for the Alpha Magnetic Spectrometer.

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
The Launch Services Program is planning for 30 missions by 2013	SMD - 24 Missions, ESMD - 2 Missions, SOMD - 2 Missions, and DOD - 2 Missions	1 mission slipped into FY 09

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Launch Services

Program Management

The Launch Services Program Manager reports to the Assistant Associate Administrator for Launch Services, Space Operations Mission Directorate at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Launch Services Acquisition and Management	Launch Services Program, Kennedy Space Center	Kennedy Space Center	Air Force, National Reconnaissance Office
Engine Assembly and Test	Launch Services Program, Kennedy Space Center	Stennis Space Center	Air Force, National Reconnaissance Office
Mission Planning and Integration	Launch Services Program, Kennedy Space Center	Kennedy Space Center	Science Mission Directorate, Exploration Systems Mission Directorate, Missile Defense Agency, NOAA
Vehicle Production Insight	Launch Services Program, Kennedy Space Center	Marshall Space Flight Center	Air Force, National Reconnaissance Office

Acquisition Strategy

Under the NASA Launch Services (NLS) contracts with Boeing, Lockheed Martin, and Orbital Sciences, the program acquires services associated with launches of Delta, Atlas, Pegasus, and Taurus launch vehicles. Services are provided on a Firm-Fixed-Price/IDIQ basis, and missions can be ordered under these contracts through June 2010. Missions not presently under contract are competed among existing NLS contractors through use of a Launch Service Task Order mechanism. In addition to the NLS contracts, four active missions remain under the Small Expendable Launch Vehicle Services contract with Orbital Sciences.

The NLS solicitation contains an On-Ramp provision that permits technology infusion or improvements. New offerors may seek an NLS contract during On-Ramp open seasons that occur each year in February and August. The NLS contracts enable ordering of standard and non-standard services, as well as special studies and mission-unique modifications.

Integrated launch services are provided by the Analex Corp. through a hybrid fixed-price/cost contract which contains options to continue performance through September 2011. Payload processing for East Coast missions is provided by Astrotech Space Operations. West Coast payload processing is provided after a competitive selection by either Astrotech or Spaceport Systems International.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO Assessment	10/2006	This was a Non-Advocate Review (NAR) of LSP to present information to Agency decision-making councils. The IPAO Review Team found that LSP is a highly successful program compliant with Agency direction, policy and directives. The review further illustrated that LSP's 100 percent launch success record, together with sound cost management, demonstrates exceptional performance.	2008
Performance	National Academy of Public Adm	9/2006	The NAPA Study Team found that LSP's performance at integrating the spacecraft with the launch vehicle and managing the launch process is excellent. The LSP has a thorough and disciplined approach to mission assurance and the acquisition and contracting processes to attain mission success. However, the team also found numerous areas needing improvement to accommodate the increasing costs of launch services and the Program's ability to keep costs down.	none
Performance	NASA Human Capital Study	10/2006	This independent assessment on KSC implementations of NASA's full cost and workforce planning found that it is critical for the Agency to develop processes that ensure it has the right people, with the right skills, at the right time, in the right place.	none

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Delta II Production Line	RISK: Future availability of launch services in the medium performance class is uncertain.	NASA will phase out the use of the Delta II launch vehicle around the end of the decade and subsequently move traffic to existing intermediate class Evolved Expendable Launch Vehicles (EELV). NASA is evaluating incentives to encourage emerging launch providers in the medium class.
Limited number of domestic providers of services to support scheduled launch missions.	RISK: There are a very limited number of domestic providers to support scheduled missions.	Through acquisition strategy, the program will maximize the number of bidders for the various missions supported by the Launch Services Program.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Rocket Propulsion Testing

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	46.4	41.9	41.8	44.3	44.7	44.6	44.6
Rocket Propulsion Testing	46.4	41.9	41.8	44.3	44.7	44.6	44.6
FY 2008 President's Budget Request	46.2	51.3	51.0	53.8	54.2	54.1	0
Rocket Propulsion Testing	46.2	51.3	51.0	53.8	54.2	54.1	0
Changes from FY 2008 Request	0.2	-9.5	-9.2	-9.6	-9.6	-9.5	44.6

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Program Overview

As the principal implementing authority for NASA's rocket propulsion testing, the Rocket Propulsion Test (RPT) Program reviews, approves, and provides direction on rocket propulsion test assignments, capital asset improvements, test facility modernizations and refurbishments, integration for multi-site test activities, identification and protection of core capabilities, and the advancement and development of test technologies.

RPT employs a collaborative approach to ensure rocket propulsion test activities are conducted in a manner that minimizes cost, ensures safety, provides credible schedules, achieves all technical objectives, and leverages the lessons learned. RPT reduces propulsion test costs through the safe and efficient utilization of rocket propulsion test facilities in support of NASA programs, commercial partners, and the Department of Defense, while eliminating unwarranted duplication. RPT sustains and improves Agency-wide rocket propulsion test core capabilities (both infrastructure and critical skills) and ensures appropriate levels of capability and competency are maintained.

The program strategy is to fund and maintain a core competency of skilled test and engineering crews and test stand facilities; consolidate and streamline NASA's rocket test infrastructure; establish and maintain world-class test facilities; modernize test facility equipment; provide non-project specific equipment and supplies; and develop effective facility/infrastructure maintenance strategies and performance. RPT supports several Agency Strategic Goals: Strategic Goal 1, Fly the Shuttle as safely as possible until its retirement, not later than 2010; Strategic Goal 4, Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement; and Strategic Goal 6, Establish a lunar return program having the maximum possible utility for later mission to Mars and other destinations.

Further information on the RPT Program can be found at: https://rockettest.ssc.nasa.gov/.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Rocket Propulsion Testing

Program Relevance

Test capabilities will continue to support safe operation of the Space Shuttle, implementation of the Vision for Space Exploration, and use by other Department of Defense and commercial programs. Capabilities include rocket propulsion test facilities, associated infrastructure and systems, and the core skilled workforce necessary to operate and maintain these assets. These capabilities are critical for the testing of existing and new rocket propulsion systems used by the Shuttle, Constellation Systems, and other programs for their safe and successful operation, and in general, for the Nation's access to space.

This program supports Outcome 4.1.

Plans For FY 2009

Test facility management, maintenance, sustaining engineering, operations, and facility modernization projects required to keep the test-related facilities in the appropriate state of operational readiness will continue to be funded. Established testing requirements for the exploration program will be used to identify excess and "at-risk" test facilities and will support decisions relative to test asset consolidation initiatives. RPT's inventory of 32 test stands, ranging from active to mothballed facilities, will continue to be maintained at various states of operational readiness as required. Propulsion test technology development will also be continued.

The RPT Program will also continue to assist in the rocket propulsion testing requirements definition for low Earth orbit and in-space propulsion systems and related technologies.

Project Descriptions and Explanation of Changes

RPT

RPT represents the single point interface for NASA's rocket propulsion test facilities located at: Stennis Space Center (SSC), Marshall Space Flight Center (MSFC), Johnson Space Center-White Sands Test Facility (JSC-WSTF), and Glenn Research Center-Plum Brook Station (GRC-PBS). These facilities have a replacement value of greater than $2 billion. The RPT sustains and improves Agency-wide rocket propulsion test core competencies (both infrastructure and critical skills), ensures appropriate levels of capability and competency are maintained, and eliminates unwarranted duplication. The program strategy is to fund and maintain core competencies of skilled test and engineering crews and test stand facilities; consolidate and streamline NASA's rocket test infrastructure; establish and maintain world-class test facilities; modernize test facility equipment; provide non-project specific equipment and supplies; and develop effective facility/infrastructure maintenance strategies and performance. The RPT budget does not include resources to support the marginal costs of testing (e.g., direct labor, propellants, materials, program-unique facility modifications, etc.) since these activities are funded by programs as a direct cost when they utilize the RPT test stands. When NASA, DoD, and commercial partners use the RPT-supported test stands, they are responsible for program-specific facility modifications in addition to the active testing of the program-specific test article.

There were no changes in scope, schedule, or direct costs for FY 2008 and beyond.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Rocket Propulsion Testing

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Support continued commercial testing of RS-68 engine.	Pratt Whitney Rocketdyne/Air Force	no change
Support continued testing of SSME, Shuttle Reaction Control System, and SRB Technology testing.	Space Shuttle Program	no change
Support Advanced Propulsion System Test Bed, J-2X, & ESMD Propulsion System technology development.	Constellation Program	no change

Program Management

The Rocket Propulsion Testing Program Manager reports to the Assistant Associate Administrator for Launch Services, Space Operations Mission Directorate at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Technical Services and Support	Stennis Space Center	Jacobs-Sverdrup, Mississippi Space Services, Plum Brook Operations Support Group	Rocket Propulsion Test Management Board Members: Stennis Space Center, Marshall Space Flight Center, Johnson Space Center, White Sands Test Facility, Glenn Research Center's Plum Brook Station, Kennedy Space Center (associate member), and Glenn Research Center (associate member). National Rocket Propulsion Test Management Board Department of Defense Members: Air Force Research Lab, Arnold Engineering Development Center, Redstone Technical Test Center, and Naval Air Warfare Center.

Acquisition Strategy

The Test Operations Contract (TOC) will be completing the first year of its second two-year option contract period which will begin in September 2008.

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Facility infrastructure	RPT's 40 year old facilities require extensive maintenance to extend their functional performance life for several decades.	RPT is strategically investing limited maintenance funding for critical projects on the facilities required by test projects. The RPT will employ an approach that includes multi-year phasing of significant projects and funding project design packages to develop improved cost and schedule data. RPT will determine and undertake the most vulnerable system issues in priority order.
Uncertainty of Exploration Systems requirements for RPT test facilities	Since the Constellation Systems Program is still early in the design, development, test, and evaluation process, testing requirements for RPT facilities are evolving, most specifically those requirements associated with the Crew Exploration Vehicle.	RPT will continue evaluating ESMD's requirements, assessing impacts, and identifying resources to achieve test schedules. RPT formed an alliance with the Constellation Systems Program Propulsion Test Integration Group to provide review of test schedules, and to make appropriate test assignments. RPT will coordinate across NASA and the Federal Government to make test facility investments.
Critical skills	RPT must retain the critical test facility engineering and operations skills held by the test site workforce during the transition period between the Space Shuttle phase-out and the Constellation Systems Program phase-in.	RPT will monitor Constellation's developing requirements, and the effects of Shuttle's plans on the RPT workforce. The information derived from this analysis will be used to identify the specific propulsion test skills needed to perform the Agency's requirements. RPT will manage NASA's present resources to maintain the core competencies needed to implement the Vision for Space Exploration.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Crew Health & Safety

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	8.1	8.7	8.6	8.6	8.5	8.5	8.5
Crew Health and Safety	8.1	8.7	8.6	8.6	8.5	8.5	8.5
FY 2008 President's Budget Request	9.9	10.6	10.5	10.4	10.4	10.4	0
Crew Health & Safety	9.9	10.6	10.5	10.4	10.4	10.4	0
Changes from FY 2008 Request	-1.8	-1.9	-1.9	-1.9	-1.8	-1.8	8.5

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Program Overview

The health care of the NASA Astronaut Corps is the responsibility of Space Medical Operations at the Johnson Space Center. A portion of the responsibilities is managed within the Crew Health and Safety (CHS) Program. CHS enables the following: healthy and productive crew during all phases of spaceflight missions and on the ground; implementation of a comprehensive health care program for astronauts; and the prevention and mitigation of negative long-term health consequences of space flight. The program works towards these goals by providing the means to capture and analyze the evidence base essential to identify health risks and apply this information to operational medicine. CHS also develops, assesses, and refines standards for clinical and physiological testing, in-flight health and performance, and environmental monitoring. Requirements for the medical care system are continually assessed and refined, modifications and enhancements identified, and development of capabilities undertaken when needed.

Program Relevance

CHS provides enhancements to the health care provision environment d and manages aspects of health care for the Astronaut Corps, both while in space and on the ground. CHS contributes to the medical and health certification of astronauts before flight and the provision of care throughout their careers. CHS also medically supports the ISS, Shuttle, and Orion activities, in areas such as planning, training, and medical operations support.

This program supports Outcome 3F.4.

Plans For FY 2009

CHS will continue to help develop and refine a standardized battery of clinical and physiological tests for all crewmembers. Refinement of evidence-based information continues with the intent of applying this information to operational medicine. Crew Health Surveillance special projects will focus on developing and refining medical standards. This is critical to meet the needs of exploration timelines. Similarly, real-time mission evaluation will help define and deliver medical operations hardware for current programs and meet the needs of known architectures. The Longitudinal Study of Astronaut Health will be enhanced with respect to data archiving and mining. This is crucial to being able to provide health information for current and future operational medical response, as well as for countermeasures development. Remote Medical Diagnostic and Informatics will design, implement, and maintain a comprehensive data management infrastructure. Modules for real-time collection of medically relevant mission data will continue to be added to the Mission Medical Information System this year. Additional tools will be implemented as operational needs and priorities are identified. NASA will continue adding all forms of clinical data to the Computerized Medical Information System, which is an electronic medical record used for real-time documentation of clinical care at the point of care. Finally, CHS will continue to develop and maintain environmental standards for all space exploration platforms.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Crew Health & Safety

Project Descriptions and Explanation of Changes

Clinical Status Evaluation

Clinical Status Evaluation develops a standardized battery of clinical and physiological tests performed on all long-duration crewmembers for use in health-risk and operations-impact analysis.

Crew Health Surveillance

Crew Health Surveillance supports development and interpretation of operational health-related data from space flight. It also provides clinical team support for implementation and evaluation of medical requirements and for rapid response to clinical contingencies.

Real-Time Mission Evaluation

Real-Time Mission Evaluation supports the definition and implementation of medical care system requirements for all mission types in conjunction with medical operations efforts.

Longitudinal Study of Astronaut Health

Longitudinal Study of Astronaut Health archives astronaut medical record information in database form and performs data analyses to support clinical care and long-term health assessments of the Astronaut Corps using evidence-based medicine methodology.

Remote Medical Diagnostic and Informatics

Remote Medical Diagnostic and Informatics designs, implements, and maintains a comprehensive data management infrastructure to support the objectives of the Space Medicine Program.

Computerized Medical Information System

Computerized Medical Information System develops electronic medical records for real-time documentation of clinical care at the point of care and provides a foundation for the long-term goal of delivering medical information electronically to flight surgeons.

Clinical Care Capability Development Project

Clinical Care Capability Development Project designs, develops, and implements a comprehensive health-care system for spaceflight to include health monitoring, prevention, and intervention for all mission phases commensurate with medical operations guidelines.

Environmental Monitoring

Environmental Monitoring develops and maintains environmental standards. It prepares and defends documents presented to the National Research Council (NRC) during committee meetings, surveys all available literature on the compounds in question, and determines recommended exposure levels based upon NRC recommended methods. It also supports JSC's environmental laboratories.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Crew Health & Safety

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Analysis of Fitness-for-Duty Standards	Clinical Status Evaluation	no change
Data Reports	LSAH	no change
Database for Medical Requirements Data	Remote Medical Diagnostic & Informatics	no change
Medical Hardware Certification Process Revision	Clinical Care Capability Development	no change
Electronic Medical Record System	Computerized Medical Information System	no change
Environmental Standards	Environmental Monitoring	no change

Program Management

The Crew Health and Safety Program Manager reports to the Deputy Associate Administrator for Program Integration within Space Operations at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Clinical Status Evaluation	JSC	JSC/Wyle	N/A
Crew Health Surveillance	JSC	JSC/Wyle	JSC/Wyle
Real-Time Mission Evaluation	JSC	JSC/Wyle	N/A
Longitudinal Study of Astronaut Health	JSC	JSC/Wyle	N/A
Remote Medical Diagnostic & Informatics	JSC	JSC/Wyle	N/A
Computerized Medical Information System	JSC	JSC/Wyle	N/A
Clinical Care Capability Development Project	JSC	JSC/Wyle	N/A
Environmental Monitoring	JSC	JSC/Wyle	N/A

Acquisition Strategy

No major acquisitions planned.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Crew Health & Safety

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	Institute of Medicine (IOM)	01/2003	NASA requested help from IOM in "assessing the Longitudinal Study of Astronaut Health (LSAH) study and making any necessary midcourse corrections." Outcome: IOM's report, Review of NASA's LSAH Study, makes recommendations for improving the validity of the LSAH as a database for monitoring the health of astronauts and for research on the effects of space on humans.	TBD
Other	LSAH CPHS	03/2007	Review the LSAH study for compliance with Human Subjects Study rules. Outcome: Approval renewed.	TBD
Other	Astronaut Healthcare Sys. Rev.	07/2007	Astronaut Healthcare System, an independent reviewer, assessed the medical and behavioral healthcare systems delivered to the Astronaut Corps. Recommendations included making improvements in the secure access to patient data and develop privacy policies and procedures that ensure that individual astronaut electronic medical records are viewable only on a strict need-to-know basis by those clinicians who are directly involved in relevant aspects of their care.	TBD

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
JSC Watch Item 1043/Resource Availability for Space Medicine Systems Information Tech Enhancements	Given the constrained resources for space medicine IT, there is a possibility that the improvement of medical capabilities will be impacted. The process must become more efficient by creating new databases and systems tools that solve deficiencies and to enable management, review, analysis, and reporting of all crew member medical data.	The plan is to incrementally implement improvements as funding allows with a target resolution date of FY11. Leveraging with the ESMD Human Research Program has begun to improve this timeline.
JSC IRMA 1044 Resource availability for implementing IOM recommendations for LSAH	The Institute of Medicine part of the National Academies, conducted a review of the Longitudinal Study of Astronaut Health project at the direction of NASA/HQ. Their findings recommend improving the quality of data collection.	The plan is to incrementally implement improvements as funding allows. Some enhancements to surveillance have already been implemented (equalization of testing between astronaut subjects and comparison subjects).

Overview

The Office of Education (referred to as Education) partners with academia, professional associations, industry, and other agencies to provide teachers and faculty with experiences that capitalize on the excitement of NASA's missions and provides meaningful, content-rich educational programs to inspire students at all levels to pursue careers in fields related to Science, Technology, Engineering, and Mathematics (STEM). Education's programs strive to reach and connect with youth, and to excite and inspire them into becoming the next generation of scientists, inventors, technicians, and explorers.

NASA will continue pursuing following three major goals:
1. Strengthen the Nation's future workforce by identifying and developing programs to reinforce the critical skills and capabilities needed to achieve the Vision for Space Exploration. The program will contribute to the development of the Nation's STEM workforce through a portfolio of initiatives for students at all levels, especially underserved and underrepresented communities.

2. Attract and retain students in STEM disciplines and encourage their pursuit of higher education in disciplines critical to NASA's scientific and technical needs.

3. Engage Americans in NASA's mission by building strategic partnerships and linkages between STEM formal and informal education providers.

Education will continue to implement rigorous standards and evaluation for education activities funded by Headquarters, Centers and Mission Directorates. Education is an active member of the National Science and Technology Council (NSTC) Education Subcommittee and Evaluation Subgroup, and draws from this association approaches to identify rigorous evaluation methodologies for determining the effectiveness of programs, and to implement the recommendations of the Academic Competitiveness Council.

For the FY 2009 budget, Education used a defined process to create a balanced portfolio of investments to address the NASA Strategic Plan, recommendations from the National Research Council (NRC), and education community priorities.

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**115.9**	**146.8**	**115.6**	**126.1**	**123.8**	**123.8**	**123.8**
Education	115.9	146.8	115.6	126.1	123.8	123.8	123.8
FY 2008 President's Budget Request	**167.4**	**153.7**	**152.8**	**152.7**	**149.8**	**149.6**	**--**
Education	167.4	153.7	152.8	152.7	149.8	149.6	--
Total Change from FY 2008 President's Budget Request	**-51.5**	**-7.0**	**-37.2**	**-26.6**	**-26.0**	**-25.8**	**123.8**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual column, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Budget Changes

Budget Authority ($ millions)	Actual FY 2007	Enacted FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-51.5**	**-7.0**	**-37.2**	**-26.6**	**-26.0**	**-25.8**	**123.8**
Education	**-51.5**	**-7.0**	**-37.2**	**-26.6**	**-26.0**	**-25.8**	**123.8**
Programmatic Content	-27.6	26.3	-10.0	--	--	--	123.8
Institutional Adjustments	-23.9	-33.3	-27.2	-26.6	-26.0	-25.8	--

Explanation of Mission Directorate Changes

Education

Education

Programmatic Content:

In FY 2008 budget (enacted), Education received an increase in funding of $26.3M, representing four Congressionally directed initiatives that NASA does not intend to continue in FY 2009 (Competitive Educational Grant Program; Global Climate Change Education; Science Center, Museum, Planetarium Grants; and NASA Visitor Centers) and an increase to three existing programs Space Grant, Experimental Program to Stimulate Competitive Research (EPSCoR), and Classroom of the Future.

In the 2009 Budget, Education was reduced $10 million. Under the standards established by the U.S. Office of Management and Budget (OMB) for the President's Management Agenda (PMA) Performance Improvement Initiative, NASA and OMB conducted a Program Assessment Rating Tool (PART) evaluation in 2007. The Education Mission received an evaluation rating of "Results Not Demonstrated". The PART process highlighted several on-going issues that NASA had recognized, and had expended effort to address but had not completed all the relevant actions. The main highlighted issue was an underdeveloped performance management system that would provide a demonstration of results through consistent monitoring and tracking toward a recognized set of performance metrics, mapped to objectives, and clear baselines from which to measure performance. In light of this rating, funding was removed from the Education programs to apply to higher NASA priorities.

In order to maintain an ideal portfolio identified by the Education Coordinating Committee (ECC), the Office of Education balanced Congressional priorities (ESPCoR, Space Grant, Motivating Undergraduates in Science and Technology Project (MUST)) with the recommendations from the NRC, and the Agency's three framework outcomes. The $10M reduction was distributed across the portfolio to avoid major impact to any one program. Reductions were distributed as follows: Elementary and Secondary Education (reduction of $5.9M); EPSCoR (reduction of $1.7M); and Minority University and Research Program (MUREP) (reduction of $2.4M).

Institutional Adjustments:

FY 2008, NASA incurred a general reduction of $2.2 million and an indirect reduction of $31.1 million.

Mission Directorate: Education
Theme: Education

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**115.9**	**146.8**	**115.6**	**126.1**	**123.8**	**123.8**	**123.8**
Education	115.9	146.8	115.6	126.1	123.8	123.8	123.8
FY 2008 President's Budget Request	**167.4**	**153.7**	**152.8**	**152.7**	**149.8**	**149.6**	**--**
Education	167.4	153.7	152.8	152.7	149.8	149.6	--
Total Change from FY 2008 Request	**-51.5**	**-7.0**	**-37.2**	**-26.6**	**-26.0**	**-25.8**	**123.8**

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual Column, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 Column, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-51.5**	**-7.0**	**-37.2**	**-26.6**	**-26.0**	**-25.8**	**123.8**
Education	**-51.5**	**-7.0**	**-37.2**	**-26.6**	**-26.0**	**-25.8**	**123.8**
Programmatic Content	-27.0	26.3	-10.0	--	--	--	123.8
Institutional Adjustments	-24.5	-33.3	-27.2	-26.6	-26.0	-25.8	--

Explanation of Program Changes

Education

The NASA Office of Education initial FY 2007 Budgetary Reductions were based on realignment of funds within the Agency to support Space Exploration. Additional realignments occurred after a directive was received from Congress to increase the Education Budget by $27 million.

In FY 2008 budget (enacted), Education received an increase in funding of $26.3M, representing four Congressionally directed initiatives that NASA does not intend to continue in FY 2009(Competitive Educational Grant Program; Global Climate Change Education; Science Center, Museum, Planetarium Grants; and NASA Visitor Centers) and an increase to three existing programs Space Grant, EPSCoR, and Classroom of the Future.

In the 2009 Budget, Education was reduced $10 million. Under the standards established by the Office of Management and Budget (OMB) for the President's Management Agenda (PMA) Performance Improvement Initiative, NASA and OMB conducted a Program Assessment Rating Tool (PART) evaluation in 2007. The Education Mission received an evaluation rating of "Results Not Demonstrated." The PART process highlighted several on-going issues that NASA had recognized, and had expended effort to address but had not completed all the relevant actions. The main highlighted issue was an underdeveloped performance management system that would provide a demonstration of results through consistent monitoring and tracking toward a recognized set of performance metrics, mapped to objectives, and clear baselines from which to measure performance. In light of this rating, funding was removed from the Education Programs to apply to higher NASA priorities.

In order to maintain an ideal portfolio identified by the Education Coordinating Committee (ECC), the Office of Education balanced Congressional priorities (EPSCoR, Space Grant, MUST) with the recommendations from the NRC, and the Agency's three framework outcomes. The $10M reduction was distributed across the portfolio to avoid major impact to any one program. Reductions were distributed as follows: Elementary and Secondary (E&S) Education (reduction of $5.9M); EPSCoR (reduction of $1.7M); and Minority University Research and Education Program (MUREP)(reduction of $2.4M).

Theme Overview

Education's Strategic Portfolio Framework is built around four categories of involvement: inspire, engage, educate, and employ. This Strategic Portfolio Framework will guide the planning, implementation, assessment and validation of the portfolio of programs toward achieving its Outcomes, as identified in NASA's Strategic Performance Plan (the Outcomes have changed some since the Strategic Plan). Education's programs focus on different populations within this framework: educators within the K-12 and higher education communities; the informal education community; and students.

Many of the programs are cross-cutting in nature and design. Educator-focused programs often include student components, and there is often synergy and leverage between formal and informal education activities.

Mission Directorate:	Education
Theme:	Education

Relevance

Relevance to national priorities, relevant fields, and customer needs:

To ensure the next-generation workforce is fully prepared for challenging scientific and technical careers, the Nation must maintain its commitment to excellence in science, technology, engineering, and mathematics (STEM) education. The May 2005 National Academies report, "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future," proposed broad recommendations to enhance the science and technology enterprise, including increasing America's talent pool by vastly improving K-12 science and mathematics education. A 2007 review of NASA's Education Program by the National Academies concluded that NASA should continue to engage in education activities at the K-12 level, designing its K-12 activities to capitalize on the primary strengths and resources found in the Mission Directorates. NASA is taking a leading role to inspire student interest in STEM, as few other organizations can, through its unique Mission, workforce, facilities, and research and technology innovations. NASA is also taking a leading role to make an impact in engaging underserved and underrepresented communities in STEM.

Relevance to the NASA Mission and Strategic Goals:

The NASA Education Strategic Coordination Framework a portfolio approach is designed to attract and retain students in ongoing science and technology activities that will facilitate their entry as members of a highly skilled and diverse workforce. Education investments are an important component to establishing a NASA affinity with students and institutions to help ensure workforce availability in needed disciplines.

Education will support efforts to retain STEM educators by increasing long-term professional development opportunities, implementing a bridge project that will: link K-12 and undergraduate student programs within the STEM pipeline; supporting underrepresented students in pursuing STEM careers, and coordinating with other agencies and state collaborative efforts; and evaluate the effectiveness and impacts of its education programs and projects.

Education supports all of NASA's Strategic Goals in its capacity-building activities for a future workforce, and as part of an integrated Agency-wide approach to human capital management.

Relevance to education and public benefits:

As NASA implements its Vision for Space Exploration, which will carry humans back to the Moon, to Mars, and beyond, Education's programs are helping to lay the groundwork. Education will promote learning activities as an integral component NASA's of major missions and research to convey the excitement of involvement in science and technology. Through partnerships with industry and university engineers and scientists, K-12 STEM educators will be leveraging investments by strengthening student affinity towards and success within STEM studies. Improving the STEM capabilities of the Nation's workforce, regardless of career choice, is of great relevance to the public.

Mission Directorate:	Education
Theme:	Education

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal	**Supports Multiple Agency Goals**					
Outcome ED-1	**Contribute to the development of the Science, Technology, Engineering and Math (STEM) workforce in disciplines needed to achieve NASA's strategic goals, through a portfolio of investments.**		**None**	**Green**	**Green**	**Green**
APG 9ED1	Support the development of 60 new or revised courses targeted at the STEM skills needed by NASA.					None
APG 9ED2	Serve 132 institutions in designated EPSCoR states.					None
APG 9ED3	Engage 8,500 underrepresented and underserved students in NASA higher education programs.					None
APG 9ED4	Increase the percentage of higher education program participants who have participated in NASA elementary or secondary programs by an additional ten percent above the FY 2007 baseline of eighteen percent.					None
APG 9ED5	Achieve thirty five percent of student participants in FY 2009 NASA higher education programs, will be employed by NASA, aerospace contractors, universities, and other educational institutions.					None
APG 9ED6	Achieve thirty five percent of undergraduate students in FY 2009 NASA higher education programs, move on to advanced education in NASA-related disciplines.					None
Outcome ED-2	**Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers and faculty.**		**None**	**Green**	**None**	**Green**
APG 9ED10	Achieve fifty percent or greater level of interest in science and technology careers among elementary and secondary students participating in NASA education programs.					None
APG 9ED7	Increase the percentage of elementary and secondary educators, who receive NASA content-based STEM resources materials or participate in short-duration activities that use these materials in the classroom by four percent above the FY 2007 baseline of fifty five percent.					None
APG 9ED8	Increase the number of elementary and secondary student participants in NASA instructional and enrichment activities by 10% above the FY 2007 baseline of 408,774.					None
APG 9ED9	Assure seventy percent of elementary and secondary educators who participate in NASA training programs use NASA resources in their classroom instruction, an increase in the FY 2007 baseline of sixty two percent.					None

Mission Directorate:	Education
Theme:	Education

Outcome ED-3	**Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission.**		**None**	**None**	**None**	**Green**
APG 9ED11	Assure that at least 350 museums and science centers across the country actively engage the public through NASA content.					None
APG 9ED12	Assure that twenty percent of the 460 museums and science centers that participate in NASA networks, use NASA resources in programs and exhibits.					None

Uniform and Efficiency Measures:

	Description	Multi-year Outcome ratings			
Measure #		**FY 04**	**FY 05**	**FY 06**	**FY 07**
Education Theme					
APG 9ED13	Reduce the dollar invested per number of people reached via e-education technologies from FY 2008 amounts.				None
APG 9ED14	Reduce the cost per K-12 program participant over FY2007 amounts by 1%.				None

Mission Directorate:	Education
Theme:	Education

Performance Achievement Highlights:

The following highlights and major activities of FY 2007, listed by project, helped to support Education's Outcomes:

Elementary & Secondary Education
- The Science, Engineering, and Mathematics Aerospace Academy (SEMAA) was recognized by the Ash Institute's Excellence in Government Project as one of the top 17 federal programs in the Nation. A Congressional Recognition Award for Excellence was also given to SEMAA. NASA's SEMAA project supports education Outcomes through a results-driven process that has impacted thousands of youth interested in developing STEM talents.
- A major restructuring of Flight Projects was completed.
- Completed consolidation of projects to increase efficiency and effectiveness in project support.

Higher Education
- Internship / Fellowship Protocol Guidelines were established to help provide equality, efficiency, and balance in the funding, selection and placement of interns within the NASA pipeline, mapping of applicants to NASA competencies, academic preparation, skills, and experiences, and designing of articulation agreements.

Informal Education
- NASA continued partnership efforts in Informal Education.
- NASA Explorer Institute continued to establish linkages that promoted new relationships resulting in creative and improved STEM education in all learning environments.

Minority University Research and Education Project
- Education, in collaboration with the Office of Diversity and Equal Opportunity and the Office of Human Capital Management, provided joint funding for a National Academies study, "U.S. Competitiveness: Underrepresented Groups and the Expansion of the Science and Engineering Pipeline." This study will analyze the rate of change and challenges the Nation currently faces in developing a strong and diverse workforce, identify best practices and the characteristics that make them effective and sustainable, and develop a prioritized list of policy and funding action items with milestones and cost estimates that will lead to a science and engineering workforce that mirrors the Nation's diverse population.
- The project conducted analysis of critical issues affecting under-represented populations and STEM.

e-Education
-A new Kids' Club Web Site was unveiled, featuring animated educational activities for children in grades K-4.
- Twelve visually impaired/blind high school students participated in an innovative program called Rocket On, made possible through a partnership between NASA and the National Federation of the Blind.

Quality

Program Assessment Rating Tool (PART):

In FY 2007, NASA's Education Theme received a PART rating of "Results Not Demonstrated." Many positive attributes were cited and the conclusion was that the Theme attracts students to science and technology careers at NASA. On the other hand, it was cited that NASA lacked complete data on the effectiveness of its Education programs. The Theme did not have sufficient data to document the extent to which participants had taken jobs with NASA or related fields. It did not report on a complete set of performance measures that reflected the desired program Outcomes.

The Office of Education was assigned several program improvements actions specifically:
- Collect performance data consistently and annually for all program activities, reporting performance against a program's established metrics and targets, and using results to improve performance;
- Conduct independent evaluations to assess the Theme's effectiveness and efficiency against the Theme's established metrics and performance goals and applying resources based on the results;
- Offer opportunities not addressed by other agencies, which are unique in their use of NASA's resources and benefits to NASA's Mission, and collaborating with other agencies where appropriate; avoid duplication with other NASA education programs;
- Fill NASA's workforce needs using a stronger effort to consider eligible program participants and facilitate their entry into positions at NASA;
- Establish baselines for all performance metrics; and
- Fully execute the new Education Investment Framework, per the implementation plan, to complete the strategic alignment of the Education portfolio that best supports the Agency strategic direction and the Vision for Space Exploration.

The Office of Education has worked hard in the past six months to assure that its performance measurement is based on relevant data and has clear baselines for its various projects. A process is under development for external independent evaluations to be conducted on a rotating basis across the Office of Education's projects. In 2008, the program will continue to refine its measures and evaluation processes to aid decisions on investments, which assure the alignment and contribution to Education's goals.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	TBD	FY 2005	Determine the extent to which the objectives and intended outcomes of higher education student support programs have achieved their objectives and intended outcomes. Programs to be reviewed: Graduate Student Researchers Program (GSRP); Jenkins Predoctoral Fellowship Program (JPFP); Undergraduate Student Research Program (USRP.) Results will be used to improve the programs and to inform the portfolio review process.	FY 2009
All	TBD	FY 2007	An RCT-based evaluation will be conducted to determine the extent to which intervention programs positively or negatively compare to control groups which do not participate in the program. Evaluations will be conducted for: Aerospace Education Service Project (AESP) and Flight Projects.	FY 2009

Mission Directorate:	Education
Theme:	Education
Program:	Education

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	115.9	146.8	115.6	126.1	123.8	123.8	123.8
Elementary and Secondary Education	35.1	23.8	32.1	38.1	35.8	35.8	35.7
Competitive Educational Grant Program	0	11.6	0	0	0	0	0
E-Education	3.6	5.8	6.8	6.7	6.7	6.7	6.8
MUREP	24.7	27.5	28.1	30.7	30.7	30.7	30.7
Higher Education	8.1	9.0	9.5	10.1	10.1	10.1	10.1
EPSCoR	12.8	12.8	8.3	10.0	10.0	10.0	10.0
NASA Space Grant	29.9	35.7	28.7	28.4	28.4	28.4	28.4
Global Climate Change Education	0	7.0	0	0	0	0	0
Informal Education	1.6	0	2.0	2.1	2.1	2.1	2.1
Science Museums and Planetarium Grants	0	7.8	0	0	0	0	0
NASA Visitor Centers	0	5.8	0	0	0	0	0
FY 2008 President's Budget Request	167.4	153.7	152.8	152.7	149.8	149.6	0
Education	167.4	153.7	152.8	152.7	149.8	149.6	0
Changes from FY 2008 Request	-51.5	-7.0	-37.2	-26.6	-26.0	-25.8	123.8

Note: FY 2009 President's Budget Request is in Direct Dollars and represents the July 2007 Operating Plan for the 2007 Actual column, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is in Full Cost and represents the as-delivered February 5, 2007 Budget Estimate Book. Due to the change from reporting full-cost to direct, NASA's program budgets will appear to have declined.

Program Overview

Education will continue to invest in the support of educators who play a key role in preparing, inspiring, exciting, encouraging, and nurturing the youth who will manage and lead the laboratories and research centers of tomorrow.

Education's portfolio of projects are designed to balance services to its target populations - educators within the K-12 and higher education communities; the informal education community; and students - within its Strategic Portfolio Framework categories of inspire, engage, educate and employ.

The Education Program will continue to develop and implement rigorous standards and evaluations for its education activities to determine the effectiveness of its portfolio elements and inform strategic investment decisions.

Mission Directorate:	Education
Theme:	Education
Program:	Education

Program Relevance

Education is the critical connector between NASA's scientists and engineers and the education community. Education translates NASA's missions into educational materials, services, and opportunities for its ultimate delivery to students as well as learners of all ages.

Education's collaboration with NASA Mission Directorates and Centers has assisted teachers and faculty in promoting scientific and technical literacy, and attracting and retaining students in STEM disciplines and STEM careers. Education works with other federal agencies engaged in educational activities, along with public and private partners to leverage the effectiveness and reach of its efforts.

The Education Program's re-aligned and restructured projects support NASA Outcomes ED-1, ED-2, and ED-3.

Plans For FY 2009

The Higher Education and MUREP Projects will continue competitive NASA Research Announcements (NRA), Cooperative Agreement Notices (CANs), and other procurement vehicles, and multi-year grants awarded to institutions, faculty, and students in Agency-relevant research. These projects will focus on strengthening the academic and research infrastructure of Minority Institutions (MI) attracting and preparing students in STEM disciplines, and supporting their completion of undergraduate and graduate degrees, with an ultimate goal of entering careers at NASA or in the Nation's scientific and technical workforce.

NASA Elementary and Secondary Education Project will continue to implement a systemic restructuring and reallocation of budgets to realize efficiencies and cost savings. A business model that includes cost-sharing, sunrise-sunset provisions to funded projects, and insertion of standard processes, tools, and reporting will continue to be implemented. Adjustments can be expected to occur in FY 2009 as a result of realignment, rebalancing and reorganization of several sub-projects.

The e-Education Project will sustain efforts in FY 2009 to: implement studies of key e-Education research questions and technical requirements; develop an R&D roadmap for the next three to five years; pursue partnerships; leverage technology infrastructures to deliver exploration-related content; implement a meta-tagging process for the Education Program to improve access to NASA multi-media content; identify assessment results that provide objective evidence of benefit to targeted audiences.

The Informal Education Project will focus on NASA Explorer Institutes (NEI), its priority initiative. Four categories of NEI projects will be considered for funding in FY 2009 including: Professional Development Workshops; STEM Learning Tools and Products; Infrastructure Development; and Partnerships for Sustainability.

For FY 2009 in general, Education's focus is to accelerate the delivery of its products and services in support of its Outcomes.

Project Descriptions and Explanation of Changes

Elementary and Secondary Education

The Elementary and Secondary Education Project provides K-12 educators with tools, experiences, and opportunities to further their education and participate in unique NASA learning experiences to enhance their knowledge of STEM and inspire students to pursue STEM careers. The project supports the role of educational institutions, which provide the framework to unite students, families, and educators for educational improvement.

Changes: FY 2009 reduction of $5.9 million. Due to Education's score of Results Not Demonstrated on the OMB's PART rating tool, Education funding was reduced by $10M. The Program took into considerations the recommendations provided by the National Academies (NRC) study "NASA's Elementary and Secondary Education Program: Review and Critique". Within the Program the following projects were selected: Flight Projects (reduction of $0.83M); NES (reduction of $4.15M); and SEMAA (reduction of $0.89M).

Competitive Educational Grant Program

The Competitive Educational Grant Program awards grants to public schools and non-profit organizations on a competitive basis. The grants are awarded to help introduce young people to the exciting world of space and engineering, thereby opening the door to future involvement in scientific or higher technology jobs.

Changes: Unrequested (Congressionally Directed) initiative NASA does not intend to continue into FY 2009, based on Omnibus Appropriations Act (P.L.110-161)

e-Education

The e-Education Project sustains the research and development of technology applications, products, and services, and the implementation of technology-enriched infrastructure. These activities are focused on facilitating appropriate and effective technology-based applications to enhance the educational process for formal and informal education.

Changes: None

Minority University Research and Education Project (MUREP)

The Minority University Research and Education Project (MUREP) serves under-represented populations through a wide variety of initiatives. Multi-year grants are awarded to engage minority institutions, faculty and students in research pertinent to NASA missions. The project focuses on retaining underrepresented and underserved students in a STEM discipline through completion of undergraduate or graduate degrees and entry into the scientific and technical workforce.

Changes: FY 2009 reduction of $2.4 million. Due to Education's score of Results Not Demonstrated on the OMB's PART rating tool, Education funding was reduced by $10M. Within this Program, the NASA Administrators Fellowship Project (NAFP) is reduced by $2.4M. NAFP provides the smallest contribution towards the achievement of Outcome 1.

Higher Education

The Higher Education Project focuses on supporting institutions of higher education in strengthening their research capabilities and providing opportunities that attract and prepare increasing numbers of students for NASA-related careers. The research conducted by the institutions will contribute to the research needs of NASA's Mission Directorates. The student projects serve as a major link in the student pipeline helping to "build, sustain, and effectively deploy the skilled, knowledgeable, diverse, and high performing workforce needed to meet the current and emerging needs of government and its citizens."

Changes: None

Experimental Program to Stimulate Competitive Research (EPSCoR)

The NASA Experimental Program to Stimulate Competitive Research (EPSCoR) provides states of modest research infrastructure with funding to develop a more competitive research base within their state and member academic institutions. A total of seven Federal agencies conduct EPSCoR programs. The goal of NASA EPSCoR is to develop academic research activities that are long-term, self-sustaining, and nationally competitive for non-EPSCoR research awards. There are 26 jurisdictions or states, including Alabama, Alaska, Arkansas, Delaware, Hawaii, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, New Hampshire, New Mexico, North Dakota, Oklahoma, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, West Virginia, Wyoming, and the Commonwealth of Puerto Rico, eligible to participate in the NASA EPSCoR program.

Changes: FY 2009 reduction of $1.7 million. Due to Education's score of Results Not Demonstrated on the OMB's PART rating tool, Education funding was reduced by $10M. The reduction was distributed across all Outcomes to avoid major impact to any one area. Within Higher Education, the impacted program is EPSCoR with a reduction of $1.7M.

NASA Space Grant

The National Space Grant College and Fellowship Program, also known as Space Grant, is a national network of colleges and universities. These institutions are working to expand opportunities for Americans to understand and participate in NASA's aeronautics and space projects by supporting and enhancing science and engineering education, research and public outreach efforts. The Space Grant national network includes over 850 affiliates from universities, colleges, industry, museums, science centers, and state and local agencies. These affiliates belong to one of 52 consortia that fund fellowships and scholarships for students pursuing careers in science, mathematics, engineering and technology, or STEM, as well as curriculum enhancement and faculty development. Member colleges and universities also administer pre-college and public service education projects in their states.

Changes: None

Global Climate Change Education

The Global Climate Change Education Project is a competitive program to educate students on global climate change as recommended by the National Academies' Earth Decadal Survey.

Changes: Unrequested (Congressionally Directed) initiative NASA does not intend to continue into FY 2009, based on Omnibus Appropriations Act (P.L.110-161)

Mission Directorate:	Education
Theme:	Education
Program:	Education

Informal Education

The Informal Education Project inspires learning, particularly by students, informal educators, and the general public by promoting the use of NASA-specific science, technology, engineering or math (STEM), in order to expand the nation's future STEM workforce. The project provides funding for activities that support the development of STEM literacy materials/handouts that are standards based, fosters networks and alliances of the NASA Centers with private and public informal learning providers; and promotes partnerships between informal and formal educational institutions.

Changes: None

Science Museums and Planetarium Grants

The Science Museums and Planetarium Grants program is a completive program authorized by section 616 of P.L. 109-155 for science museums and planetariums to enhance programs related to space exploration, aeronautics, space science or microgravity.

Changes: Unrequested (Congressionally Directed) initiative NASA does not intend to continue into FY 2009, based on Omnibus Appropriations Act (P.L.110-161)

Visitor Centers

The Visitor Centers Project is for the development of educational activities at NASA's field centers, as proposed by the Senate. Funding is provided to each Center's official visitor center for development of educational activities, as well as exhibits, in science, technology, engineering, and mathematics.

Changes: Unrequested (Congressionally Directed) initiative NASA does not intend to continue into FY 2009, based on Omnibus Appropriations Act (P.L.110-161)

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Enable eligible jurisdictions to compete successfully for NASA research & technology opportunities	Experimental Project to Stimulate Competitive Research (EPSCoR)	Project value reduced $1.7M
Promote a network of state-based consortia to promote NASA's interests throughout the country	National Space Grant College and Fellowship Project (Space Grant)	No change in project value
Place undergraduate students at NASA centers for 10-week internship or 15-week semester internship	Undergraduate Student Research Project (USRP)	No change in project value
Support graduate students pursuing master or doctoral degrees in disciplines relevant to NASA	Graduate Student Researchers Project (GSRP)	No change in project value
Achieve broad-based competitive aerospace research capability among the Nation's minority instit	University Research Centers (URCs)	No change in project value
Produce leadership for building capacity at MIs and prepare students to compete in STEM workforce	NASA Science and Technology Institute for Minority Institutions (NSTI-MI)	No change in project value
Respond to need of 2 & 4 year minority institutions to strengthen STEM curricula related to NASA	Curriculum Improvement Partnership Award for Integration of Research (CIPAIR)	No change in project value
Enhance professional development of NASA employees and STEM faculty of minority service institutions	NASA Administrator's Fellowship Project (NAFP)	Project value reduced $2.4M
Create opportunity for minority, women, & individuals with disabilities to pursue graduate education	Harriet G. Jenkins Predoctoral Fellowship Project (JPFP)	No change in project value
Enhance the education infrastructure at the Nation's 35 Tribal Colleges and Universities	Tribal Colleges (TCUs)	No change in project value
Target & support underserved populations in diverse geographic locations; bring together educators, administrators, students (in classroom grades 4-9) and families in sustained STEM involvement with NASA's education programs across United States	Elementary & Secondary Education Program-NASA Explorer Schools (NES)	Project value reduced $4.2M
Plan for 100 undergraduates across nine centers and JPL	Motivating Undergraduates in Science & Technology (MUST)	No change in project value
Target & support underserved populations in diverse geographic locations; bring together educators, administrators, students (in classroom grades 4-9) and families in sustained STEM involvement with NASA's education programs across United States	Elementary & Secondary Education Program	Program value reduced $5.9 M
Technical direction for 24 SEMAA sites, host student tours/presentations, and national conference	Science, Engineering, Mathematics & Aerospace Academy (SEMAA)	No change in project value
Nationwide infrastructure for customized professional development	Aerospace Education Services Project (AESP)	No change in project value
STEM pathways for eligible U.S. citizens with emphasis on underrepresented & underserved groups	Interdisciplinary National Science Project Incorporating Research & Education Experience (INSPIRE)	No change in project value

Opportunities for K-12 students to gain hands-on experience as payload investigators using NASA fligh	Education Flight Projects	No change in project value
Serve schools in every state and add up to 50 new teams	NASA Explorer Schools (NES)	No change in project value
Advance technologies that support well-educated and highly skilled workforce	NASA Learning Technologies (NLT)	No change in project value
Implement additional options for accessing Web-based learning services from the Education Portal	NASA Educational Technology Services (NETS)	No change in project value
Evaluate new technologies available commercially for applications in educational environments	NASA-sponsored Classroom of the Future (COTF)	No change in project value
Partnerships/alliances for students/citizens to become participants in NASA R&T and Space Exploration	NASA Explorer Institutes (NEI)	No change in project value
Train students with disabilities and underrepresented/underserved 6-16 students through MSI (replaced by #10 above)	Small Projects	No change in project value
Harness the collective resources of NASA, institutions of higher education, science centers, museums, primary & secondary schools to bridge the education gap for historically underserved and underrepresented K-12 youth in STEM	Elementary & Secondary Education Program - SEMMA	Project value reduced $0.9M
Provides students with unique opportunity to talk (amateur radio) directly with Astronauts on ISS while they orbit Earth and enable thousands of students to photograph & examine (ISS EarthKAM) Earth from the unique perspective of space	Elementary & Secondary Education Program - Education Flight Projects	Project value reduced 0.8M

Mission Directorate:	Education
Theme:	Education
Program:	Education

Program Management

The Assistant Administrator for Education is responsible to the NASA Administrator for NASA's education portfolio and serves as NASA Education Officer. Reports directly to Chief of Strategic Communication, and manages all education responsibilities.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Informal Education Project	NASA HQ Office of Education	JPL, NASA Centers	Arizona State University and ArtReach International, AMES-The Navajo Nation; National Park Service, University of California -Berkeley, and Ideum, GSFC; College of Charleston, S.C., U.S. Space and Rocket Center, Ala.; Girl Scouts U.S.A.; Houston Museum of Natural Science, Rice University and Starlight Productions, JSC; Denver Museum of Nature and Science; Morehead Planetarium and Science Center; University of Alabama -Huntsville, National Association of Rocketry, and 4-H; Lunar Planetary Institute, Texas, Haltom City Public Library, Texas, and Librarians from Pennsylvania, Delaware and Maryland; and American Museum of National History, Over 200 Museums.
e-Education Project	NASA HQ Office of Education	NASA Centers	NSF, Dept. of Education, DoD, Dept. of Energy, Office Max, Lorain, County Joint Vocational School
Elementary & Secondary Education Project	NASA HQ Office of Education	NASA Centers	Educational organizations and institutions provide professional development opportunities and in-kind contributions to NES schools; OSU; Network of Educator Astronaut Teachers, AOL, Univ CA-San Diego, AMSAT, ARISS International Team
Minority University Research and Education Project	NASA HQ Office of Education	NASA Centers	
Higher Education Project	NASA HQ Office of Education	NASA HQ, NASA Centers	Fifty-two university-based Space Grant Consortia in all 50 states, Puerto Rico and District of Columbia require 100 percent matching funds on non-fellowship awards. Twenty-five selected juristictions and a total of seven federal agencies.

Mission Directorate:	Education
Theme:	Education
Program:	Education

Acquisition Strategy

The Education Program will continue to facilitate its programs and projects through competitive NASA Research Announcements, Cooperative Agreement Notices and other procurement vehicles, and multi-year competitive grant awards to institutions, faculty and students in Agency-relevant research. Below are projects with agreements to perform work under these various mechanisms.

Informal Education Project: External grant awardee
e-Education Project: External grant awardees, UNITeS Contract
Elementary & Secondary Education Project: NASSMC, NSTA, U.S. Space & Rocket Center, external grant awardee
Minority University Research and Education Project: External grant awardees
Higher Education Project: External grant awardees

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	TBD	FY 2005	To determine the extent to which the objectives and intended outcomes of higher education student support programs have achieved their objectives and intended outcomes. Assess: Graduate Student Researchers Program (GSRP); Jenkins Pre-doctoral Fellowship Program (JPFP); Undergraduate Student Research Program (USRP). Results will be used to improve the program and to inform the portfolio review process.	FY 2009
All	TBD	FY 2007	An RCT-based evaluation will be conducted to determine the extent to which interventions positively or negatively compare to control groups not participating in the program. Assess: Aerospace Education Service Project (AESP); Flight Projects.	FY 2009

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Affiliation Risk	The primary risk is loss of affiliation with students, teachers, faculty, education administrators, and institutions at all educational levels. Without strong affiliation, there is reduced potential for students to enter into the scientific and technical disciplines needed at NASA and in the Nation's workforce.	Education Program will monitor and mitigate program & project risks through continual evaluation of program & project performance and relevance, adjusting the portfolio to ensure an appropriate mix.

Overview

Cross-Agency Support provides a focus for managing technical capability and agency mission support functions. This budget area consists of three themes: Center Management and Operations (CM&O), Agency Management and Operations, and Institutional Investments (II). Cross-Agency Support is not directly identified or aligned to a specific program or project requirement but is necessary to ensure the efficient and effective operation and administration of NASA.

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**2,949.9**	**3,242.9**	**3,299.9**	**3,323.9**	**3,363.7**	**3,436.1**	**3,511.3**
Center Management and Operations	1,754.9	2,013.0	2,045.6	2,046.7	2,088.0	2,155.3	2,211.6
Agency Management and Operations	971.2	830.2	945.6	945.5	939.8	950.5	961.3
Institutional Investments	223.8	319.7	308.7	331.7	335.9	330.4	338.3
Congressionally Directed Items	--	80.0	--	--	--	--	--
FY 2008 President's Budget Request	**2,962.8**	**3,285.5**	**3,263.6**	**3,290.5**	**3,345.8**	**3,419.2**	**--**
Center Management and Operations	1,733.0	2,013.0	2,014.7	2,031.5	2,078.2	2,141.4	--
Corporate General and Administrative	741.1	678.7	679.1	673.9	680.1	695.7	--
Advanced Business Systems (IEMP)	80.8	84.1	56.8	58.9	55.7	55.7	--
Innovative Partnerships Program	178.6	162.0	161.8	164.7	165.2	165.3	--
Strategic Capabilities Assets Program	18.3	28.0	28.0	29.8	30.7	30.7	--
Institutional Investments	211.0	319.7	323.2	331.7	335.9	330.4	--
Total Change from FY 2008 President's Budget Request	**-12.9**	**-42.6**	**36.3**	**33.4**	**17.9**	**16.9**	**3,511.3**

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. The FY 2008 President's Budget Request is shown in direct dollars.

Budget Changes

Budget Authority ($ millions)	Actual FY 2007	Enacted FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-12.9**	**-42.6**	**36.3**	**33.4**	**17.9**	**16.9**	**3,511.3**
Center Management and Operations	**21.9**	**--**	**30.9**	**15.2**	**9.8**	**13.8**	**2,211.6**
Programmatic Content	21.9	--	30.9	15.2	9.8	13.8	2,211.6
Agency Management and Operations	**-47.6**	**-122.6**	**19.9**	**18.2**	**8.1**	**3.1**	**961.4**
Programmatic Content	-47.6	-122.6	19.9	18.2	8.1	3.1	961.4
Institutional Investments	**12.8**	**--**	**-14.5**	**--**	**--**	**--**	**338.3**
Programmatic Content	12.8	--	3.3	--	--	--	338.3
Programmatic Transfers	--	--	-17.8	--	--	--	--
Congressionally Directed Items	**--**	**80.0**	**--**	**--**	**--**	**--**	**--**
Programmatic Content	--	80.0	--	--	--	--	--

Explanation of Mission Directorate Changes

Cross-Agency Support

Center Management and Operations

Programmatic Content:

Programmatic Content increased to fund rising center operational costs, including utility costs, and costs for required maintenance of IT and facility infrastructure.

Public Affairs funding at the Centers reduced to hold funding at FY 2008 levels.

Agency Management and Operations

Programmatic Content:

Programmatic content reductions in FY 2008 reflect decreases from public Law 110-161 to Innovative Partnerships Program, Advanced Business Systems, Agency Management, Safety and Mission Success, and Strategic Capability Assets Program.

Institutional Investments

Programmatic Content:

In FY 2009 increased Environmental Compliance Restoration by $3.3 Million.

Programmatic Transfers:

Programmatic transfers includes transfer of content to Agency Management and Operations for Strategic Information Technology (IT) Infrastrucure Investments in Agency IT Services. In FY 2009, program transfers included $14.5 million of IT Investments.

Congressionally Directed Items

Programmatic Content:

Congressionally Directed items based on Public Law 110-161.

Budget Distribution Detail

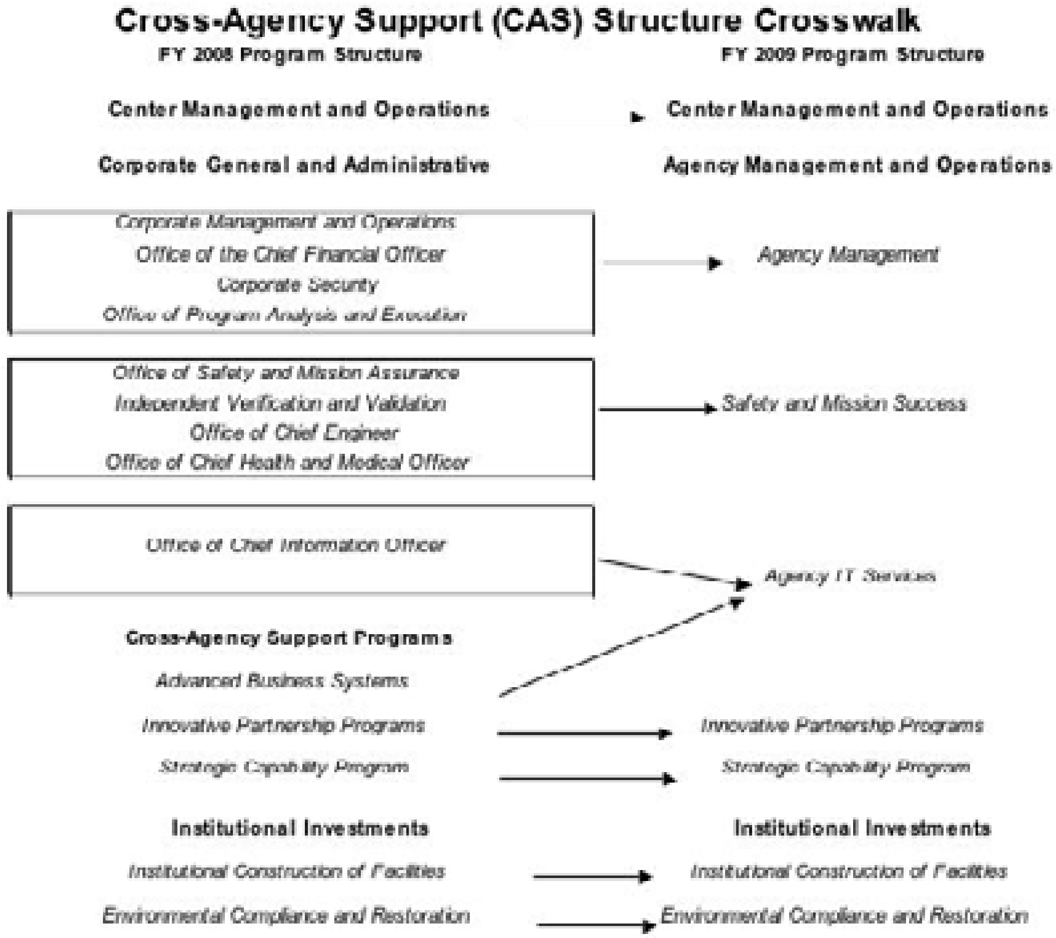
NASA implemented full cost management, to include budgeting and execution, in FY 2004 to strengthen the Agency's understanding of the true costs of projects and provide NASA management with better insight into the efficient use of resources. After three years of full cost implementation, NASA conducted a review to determine the effects on Agency operations. The primary finding from that review was that indirect allocations were more complex than necessary, and that the indirect allocation approach created disadvantages for NASA's smaller research Centers.

NASA addressed the issues of Center impact in its FY 2008 President's Budget Request by applying a single Agency-wide rate for Center Management and Operations (CM&O) for all nine Federal Centers based on project direct budget (The indirect costs for NASA's Jet Propulsion Laboratory are included in its contract rates as a Federally-Funded Research and Development Center).

The FY 2008 Omnibus Appropriations Act (P.L. 110-161) directs NASA to modify the Agency's appropriations account structure in FY 2009 from three accounts (Science, Aeronautics, and Exploration, Exploration Capabilities, and Inspector General) to seven accounts (Space Operations, Exploration Systems, Science, Aeronautics, Education, Cross Agency Support, and Inspector General). The FY2009 President's Budget Request is presented in the new seven-account structure.

To enable execution across NASA's 10 Centers under this new appropriations account structure, it is necessary for NASA to fund its indirect activities directly, instead of receiving allocations from each of the different appropriation accounts. Direct project funding continues to include the full cost of resources to execute projects--procurement, labor, travel, and test and fabrication services. Center Management and Operations, Corporate G&A, and Institutional Investments funding are budgeted in the Cross Agency Support appropriations account. The FY 2009 President's budget summary for each appropriations account is provided in direct dollars for FY 2007 and out. For comparison purposes, an Agency budget summary is also provided in its full cost equivalent in the front of this document.

The Cross-Agency Support, Theme, and Program Budget Tables compare the FY 2009 President's Budget Request in direct dollars to the FY 2008 President's Budget Request in direct dollars.


Cross-Agency Support (CAS) Structure Crosswalk
FY 2008 Program Structure
FY 2009 Program Structure
Center Management and Operations
Center Management and Operations
Corporate General and Administrative
Agency Management and Operations
Corporate Management and Operations
Office of the Chief Financial Officer
Corporate Security
Office of Program Analysis and Execution
Agency Management
Office of Safety and Mission Assurance
Independent Verification and Validation
Office of Chief Engineer
Office of Chief Health and Medical Officer
Safety and Mission Success
Office of Chief Information Officer
Agency IT Services
Cross-Agency Support Programs
Advanced Business Systems
Innovative Partnership Programs
Innovative Partnership Programs
Strategic Capability Program
Strategic Capability Program
Institutional Investments
Institutional Investments
Institutional Construction of Facilities
Institutional Construction of Facilities
Environmental Compliance and Restoration
Environmental Compliance and Restoration

Mission Directorate:	Cross-Agency Support
Theme:	Center Management and Operations

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	1,754.9	2,013.0	2,045.6	2,046.7	2,088.0	2,155.3	2,211.6
Center Management and Operations	1,754.9	2,013.0	2,045.6	2,046.7	2,088.0	2,155.3	2,211.6
FY 2008 President's Budget Request	1,733.0	2,013.0	2,014.7	2,031.5	2,078.2	2,141.4	--
Center Management and Operations	1,733.0	2,013.0	2,014.7	2,031.5	2,078.2	2,141.4	--
Total Change from FY 2008 Request	**21.9**	**0.0**	**30.9**	**15.2**	**9.8**	**13.9**	**2,211.6**

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. The FY 2008 President's Budget Request is shown in direct dollars.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**21.9**	**--**	**30.9**	**15.2**	**9.8**	**13.9**	**2,211.6**
Center Management and Operations	**21.9**	**--**	**30.9**	**15.2**	**9.8**	**13.9**	**2,211.6**
Programmatic Content	21.9	--	30.9	15.2	9.8	13.9	2,211.6

Explanation of Program Changes

Center Management and Operations

The FY 2009 budget includes an increase to fund Center operational costs, including utility costs, and to increase funding for required maintenance of Center IT and facility infrastructure.

Theme Overview

Center Management and Operations (CM&O) provides for the management and operation of each of the Agency's nine Centers. It provides for basic Center operations, as well as for the costs associated with ensuring that the Centers provide the unique technical capability required to execute the Agency's programs and projects.

The Supporting Data section in the back of this document provides additional data on the Centers to address the 2008 Omnibus Appropriations Act (Public Law 110-161).

Mission Directorate:	Cross-Agency Support
Theme:	Center Management and Operations

Relevance

Relevance to the NASA Mission and Strategic Goals:

NASA's Centers are essential for completion of the Agency's Mission. Center Management and Operations (CM&O) provides for costs that cannot be directly identified or tied to a specific program or project requirement, but are necessary for efficient and effective administration and operation of the NASA Centers. CM&O ensures that NASA's nine Centers provide the infrastructure and technical capability required to support the Agency's Mission.

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal	**Supports Multiple Agency Goals**					
Outcome CMO-1	**Under development for release in 2010.**					**New**
APG 9CMO1	Under development for release in 2010.					New

Mission Directorate:	Cross-Agency Support
Theme:	Center Management and Operations
Program:	Center Management and Operations

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	1,754.9	2,013.0	2,045.6	2,046.7	2,088.0	2,155.3	2,211.6
Facility Services	419.2	465.3	486.1	492.5	485.9	503.4	512.9
Environmental Management	20.1	27.9	28.3	28.8	29.7	30.5	31.3
Institutional Administration	611.6	573.0	591.0	595.3	606.4	624.7	641.2
Safety and Mission Assurance	28.1	41.9	43.5	44.8	46.5	47.8	49.5
SMA Technical Authority	13.9	25.5	25.4	26.0	26.7	27.5	28.4
Science & Engineering	0	200.4	206.4	207.1	214.6	221.4	228.4
Center Investments Account	164.9	92.5	81.3	72.3	81.2	87.3	93.1
Test Services	0	16.9	16.9	16.8	17.1	17.5	18.1
Information Services	226.6	258.2	255.7	252.6	257.2	262.9	267.2
Security Program	94.0	113.1	110.8	111.7	115.4	118.8	121.3
Fabrication	0	9.8	7.0	5.1	5.5	5.7	5.7
Other Personnel Costs	65.0	74.2	76.1	71.4	73.2	74.4	77.2
Technical Excellence	111.6	114.4	117.0	122.1	128.5	133.2	137.5
FY 2008 President's Budget Request	1,733.0	2,013.0	2,014.7	2,031.5	2,078.2	2,141.4	0
Center Management and Operations	1,733.0	2,013.0	2,014.7	2,031.5	2,078.2	2,141.4	0
Changes from FY 2008 Request	21.9	0.0	30.9	15.2	9.8	13.9	2,211.6

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. The FY 2008 President's Budget Request is shown in direct dollars.

Mission Directorate:	Cross-Agency Support
Theme:	Center Management and Operations
Program:	Center Management and Operations

Program Overview

Center Management & Operations (CM&O) funds the activities required to manage, maintain, and operate NASA's nine Centers.

Basic management and operation activities included in CM&O are referred to as City Management costs and include Institutional Administration, Environmental Management, Facility Services, Information Technology Services, Security Program, Safety and Mission Assurance, and Other Personnel Costs.

Maintaining and managing NASA's unique Technical Capability is a critical component of the CM&O budget. Costs associated with these activities enable Centers to efficiently provide the engineering, mission safety, scientific, and other technical skills and resources required to support the Agency's mission. Technical Capability includes Technical Excellence, Safety and Mission Assurance Technical Authority, Science and Engineering Support, Fabrication, Testing Services, and Center Investments.

Program Relevance

NASA's Centers are essential for completion of the Agency's mission. Center Management and Operations provides the costs that cannot be directly identified or tied to a specific program or project requirement, but are necessary for efficient and effective administration and operation of the NASA Centers.

Plans For FY 2009

The request for FY 2009 provides for ongoing operations, maintenance, and management of NASA's nine Centers. The funds ensure that the Centers have the infrastructure and technical capability required to perform NASA's mission.

Mission Directorate:	Cross-Agency Support
Theme:	Center Management and Operations
Program:	Center Management and Operations

Project Descriptions and Explanation of Changes

Facility Services

Facility services include activities required to support center facilities and infrastructure operations and maintenance. It includes utility costs, grounds maintenance, and Center-wide building and central plant operations. A large component of Facility Services is the maintenance and repair of the Center facilities, roads, utility systems, and other infrastructure required to support the Agency's Mission.

Changes: Added funding at all Centers for increased operational, facilities maintenance, and utility costs.

Environmental Management

Environmental Management provides for the ongoing Center activities required to comply with environmental federal, state, and local laws, regulations, and executive orders.

Institutional Administration

Institutional Administration includes all of the activities required to support the basic operations and management at each NASA Center. It includes operations of the senior Center management and other Center organizations, including human resources, procurement, financial management, equal opportunity, public affairs, and legal support. Additionally Institutional Administration provides for Center-wide services such as shipping and receiving, property and inventory management, occupational health, and publishing.

Changes: Reduced activities at all Centers to fund higher priority activities within CM&O in facilities and Information Services.

Safety and Mission Assurance

Safety and Mission Assurance provides for institutional operational safety activities to support the development, implementation and oversight of Center safety, reliability, and quality assurance. Included are construction safety, mishap prevention, safety training, and other industrial and institutional safety activities.

Safety and Mission Assurance Technical Authority

Safety and Mission Assurance (S&MA) Technical Authority funds the safety management required to render independent authoritative decisions on safety and mission assurance requirements relating to the design or operation of a program or project.

Changes: Programmatic transfer of S&MA Technical Authority content from Mission Directorates in accordance with Agency governance.

Science and Engineering Support

This project provides the science and engineering support and technical resources needed to sustain core scientific and engineering competencies for mission use.

Center Investments

Center Investments funds the activities required to maintain and develop the core technical capabilities of a Center.

Testing Services

Testing Services provides the testing support and technical resources required to sustain core test and laboratory competencies for mission use. It includes management, administrative support, and equipment.

Information Services

Information Technology (IT) services provides the IT infrastructure and tools required for each Center. It includes IT management and security, and provides desktop computing and applications services and support to Center personnel.

Changes: Added funding at all Centers for IT Infrastructure.

Security Program

Security and Program Protection provides the basic and specialized protective services necessary for each Center to comply with regulations and Center-specific needs associated with the protection and accountability of people, property, and information. It includes physical security, law enforcement, information assurance, personnel security, emergency management, and emergency services such as fire fighting and airfield crash/rescue.

Changes: Realigned content from other CM&O activities for consistency across all Centers.

Fabrication

This project provides the fabrication support and technical resources needed to sustain core fabrication competencies for mission use, including maintenance of fabrication tools and equipment.

Other Personnel Costs

Other Personnel Costs provides for recruiting and retention costs, employment suitability background investigations, lump sum payments, awards, training, worker's compensation, and other associated costs.

Technical Excellence

Technical Excellence funds the engineering management required to render independent judgment and decision-making on matters related to program and project technical requirements.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**971.2**	**830.2**	**945.6**	**945.5**	**939.8**	**950.5**	**961.3**
Agency Management	363.2	361.5	414.6	422.5	430.6	438.8	447.3
Safety and Mission Success	174.1	161.6	163.4	165.4	167.3	169.3	171.3
Agency IT Services	173.2	133.1	163.9	145.9	133.1	133.5	133.9
Innovative Partnerships Program	189.2	146.8	175.7	181.9	178.0	178.1	178.1
Strategic Capabilities Assets Program	71.5	27.2	28.0	29.8	30.7	30.7	30.7
FY 2008 President's Budget Request	**1,018.8**	**952.8**	**925.7**	**927.3**	**931.7**	**947.4**	**--**
Corporate General and Administrative	741.1	678.7	679.1	673.9	680.1	695.7	--
Agency IT Services	80.8	84.1	56.8	58.9	55.7	55.7	--
Innovative Partnerships Program	178.6	162.0	161.8	164.7	165.2	165.3	--
Strategic Capabilities Assets Program	18.3	28.0	28.0	29.8	30.7	30.7	--
Total Change from FY 2008 Request	**-47.6**	**-122.6**	**19.9**	**18.2**	**8.1**	**3.1**	**961.3**

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. The FY 2008 President's Budget Request is shown in direct dollars.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-47.6**	**-122.6**	**19.9**	**18.2**	**8.1**	**3.1**	**961.3**
Agency Management	**-117.1**	**-55.2**	**-5.0**	**1.6**	**6.1**	**4.4**	**447.3**
Programmatic Content	-117.1	-55.2	-5.0	1.6	6.1	4.4	447.3
Safety and Mission Success	**-12.9**	**-24.2**	**-20.9**	**-12.1**	**-11.3**	**-12.8**	**171.3**
Programmatic Content	-12.9	-24.2	-20.9	-12.1	-11.3	-12.8	171.3
Agency IT Services	**18.6**	**-27.2**	**31.9**	**11.5**	**0.4**	**-1.3**	**133.9**
Programmatic Content	18.6	-27.2	31.9	11.5	0.4	-1.3	133.9
Innovative Partnerships Program	**10.6**	**-15.2**	**13.9**	**17.2**	**12.9**	**12.8**	**178.1**
Programmatic Content	10.6	-15.2	13.9	17.2	12.9	12.8	178.1
Strategic Capabilities Assets Program	**53.2**	**-0.8**	**--**	**--**	**--**	**--**	**30.7**
Programmatic Content	53.2	-0.8	--	--	--	--	30.7

Explanation of Program Changes

Agency Management

Activities reduced in FY 2009 and re-prioritized to enable critical funding of center-based activities in Center Management & Operations.

Safety and Mission Success

Activities reduced and re-prioritized to enable critical funding of center-based activities in Center Management & Operations.

Agency IT Services

The FY 2009 budget includes an increase for IT Infrastructure investments to consolidate network and increase IT security investments to consistent levels across the NASA Centers.

Innovative Partnerships Program

The changes in IPP from FY 2008 to FY 2009 are in SBIR/STTR due to revisions in estimates of Extramural R&D which is used as the basis for SBIR/STTR funding, and in restoring funding which was significantly reduced in the FY 2008 omnibus for technology transfer and partnership development.

Theme Overview

Agency Management and Operations provides for the management and oversight of Agency missions and functions and for the performance of many Agency-wide activities.

This Theme funds Agency Management, Safety and Mission Success, Agency Information Technology Services, Innovative Partnerships Program, and Strategic Capabilities Assets Program. Refer to the Program Sections for additional detail.

Relevance

Relevance to the NASA Mission and Strategic Goals:

The activities within Agency Management and Operations provide the critical support required to enable NASA's mission. The management of the Agency's unique test facilities and technical capability, including independent engineering and safety oversight provided in AMO are essential to NASA's success. Additionally, AMO provides ongoing management support, technology alternatives for NASA programs and projects, and IT operations to benefit all Mission Directorates.

Relevance to education and public benefits:

Through the Innovative Partnership Program (IPP), AMO provides technology transfer out of NASA for commercial and other socio-economic benefit to the Nation. In addition, IPP facilitates protection of the government's rights in NASA's inventions, as mandated by legislation. IPP implements NASA's SBIR and STTR programs with the primary objective of providing the high-technology small business sector with an opportunity to develop technology for NASA.

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal	**Supports Multiple Agency Goals**					
Outcome IEM-1	**By 2012, implement Agency business systems that provide timely, consistent and reliable business information for management decisions.**		**None**	**None**	**None**	**Green**
APG 9IEM1	Implement all reports into the Human Capital Information Environment and stabilize the project and environment.	Agency IT Services				None
APG 9IEM2	Implement the federal eTravel initiative to provide a standardized, comprehensive tool to support online booking, travel planning, travel expense reimbursement, payment processing, credit card reconciliation, and management reporting for NASA.	Agency IT Services				None
Outcome IEM-2	**Increase efficiency by implementing new business systems and reengineering Agency business processes.**		**None**	**None**	**Green**	**Green**
APG 9IEM3	Reduce the number of quarterly corrective adjustments to financial statements from the 2006 baseline of 5948 steps to the 2009 goal of 2509 steps (a 58% reduction).	Agency IT Services				Green
APG 9IEM4	Improve the timeliness of the funds distribution process (time from receipt of apportionment to distribution of funds to Centers) from 65 days to the 2009 goal of 12 days.	Agency IT Services				None
APG 9IEM5	Achieve cost savings, expected to increase annually with a 2009 goal of $19.3M, resulting from the integration of financial and asset management systems, a reduction in the number of redundant property, plant and equipment (PP&E) systems and process improvements that enable NASA to better manage PP&E assets.	Agency IT Services				None
Outcome IPP-1	**Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and projects.**		**Blue**	**Green**	**Green**	**Green**
APG 9IPP1	Develop twelve technology-related significant partnerships that create value for NASA's programs and projects. Track both quantitative dollar value and qualitative benefits to NASA (e.g. reduced volume or mass, improved safety).	Innovative Partnerships Program				Green
APG 9IPP2	Complete thirty technology transfer agreements with the commercial and academic community through such mechanisms as licenses, software use agreements, facility use agreements, and Space Act Agreements.	Innovative Partnerships Program				Green
APG 9IPP3	Fully implement a new system for managing NASA's technology transfer and partnership information, that is more user friendly and less costly than the current NASA Technology Transfer System (NTTS).	Innovative Partnerships Program				None

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations

Performance

Performance Commitments, Current Ratings and Outcome Trends:

Measure #	Description	Contributing Program (s)	FY 04	FY 05	FY 06	FY 07
APG 9IPP4	Infuse technologies from the IPP portfolio into NASA's programs and projects, with at least twelve documented infusion successes.	Innovative Partnerships Program				None
Outcome SC-1	**Establish and maintain selected Agency level shared capabilities, across multiple classes of assets (e.g., wind tunnels, vacuum chambers, etc.), to ensure that they will continue to be available to support the missions that require them.**		**None**	**None**	**None**	**Green**
APG 9SC1	Prioritize funding requirements and select classes of assets for inclusion in the Shared Capability Assets Program.	Strategic Capabilities Assets Program				Green
APG 9SC2	Identify re-investment/re-capitalization opportunities within and among classes of assets and execute the approved changes (e.g., reallocate funds, upgrade facilities, etc.).	Strategic Capabilities Assets Program				Green
APG 9SC3	Assets identified in FY 2008 that no longer have requirements for use by NASA will be dispositioned (decision made on whether to place on standby, be mothballed, be demolished, etc.).	Strategic Capabilities Assets Program				None
Strategic Goal 5	**Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.**					
Outcome 5.1	**Develop and demonstrate a means for NASA to purchase launch services from emerging launch providers.**		**Green**	**Green**	**Green**	**Green**
APG 9IPP5	Demonstrate the purchase of services from the emerging commercial space sector for microgravity research and training.	Innovative Partnerships Program				New
Outcome 5.3	**By 2012, complete one or more prize competitions for independently designed, developed, launched, and operated missions related to space science or space exploration.**		**None**	**None**	**None**	**Green**
APG 9IPP6	Demonstrate benefits of prize competitions by awarding at least one prize and communicating the resulting technology advancements.	Innovative Partnerships Program				Green

Uniform and Efficiency Measures:

Measure #	Description	FY 04	FY 05	FY 06	FY 07
Agency Management and Operations Theme					
APG 9IEM8	Complete all development projects within 110% of the cost and schedule baseline.				None
APG 9IEM9	Reduce the number of financial processing steps/time to perform year end closing from the 2005 baseline of 120 steps to the 2008 goal of 20 steps (an 83% reduction).				None

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations

Uniform and Efficiency Measures:

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9IPP7	For technology partnerships, leverage IPP funding by bringing at least an additional $1.80 (one dollar and eighty cents) for each $1 (one dollar) of IPP funds.				None

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency Management

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**363.2**	**361.5**	**414.6**	**422.5**	**430.6**	**438.8**	**447.3**
Agency Management	**363.2**	**361.5**	**414.6**	**422.5**	**430.6**	**438.8**	**447.3**
FY 2008 President's Budget Request	**480.3**	**416.7**	**419.6**	**420.9**	**424.5**	**434.4**	**0**
Agency Management	**480.3**	**416.7**	**419.6**	**420.9**	**424.5**	**434.4**	**0**
Changes from FY 2008 Request	**-117.1**	**-55.2**	**-5.0**	**1.6**	**6.1**	**4.4**	**447.3**

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. The FY 2008 President's Budget Request is shown in direct dollars.

Program Overview

The Agency Management Program sponsors and supports an executive-based, Agency-level functional and administrative management agenda. It delivers policies, controls, and oversight across a range of functional and administrative management service areas. The program provides for independent technical assessments of Agency programs. It delivers strategic planning services. It assesses and evaluates NASA program and mission performance. It sponsors and directs the Institutions and Management agenda in procurement, human capital, real property and infrastructure, security and program protection, diversity, equal opportunity, and small business. The Agency Management Program also provides for the operational costs of Headquarters as an installation. It provides for the salaries, benefits, and travel requirements of the Headquarters workforce, and it provides resources necessary to operate the Headquarters installation. The Agency Management Program delivers training programs for the Headquarters workforce and it supports executive training across the Agency.

Program Relevance

The Agency Management Program establishes and sustains the human capital and real capital infrastructure that enable the Agency to carry out its programs and missions. It is a critical source of independent, non-advocate review and assessment of Agency research and technology activities, and it provides an important voice for influencing Agency strategic goals and objectives. The Agency Management Program also finances and sustains the salaries, travel, and physical infrastructure necessary to operate the Headquarters installation.

Plans For FY 2009

Deliver policies, controls, and oversight across a range of functional and administrative management service areas. Provide independent technical assessments and strategic planning service. Direct the activities in procurement, finance, human capital, real property and infrastructure, security and program protection, diversity, equal opportunity, and small business.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency Management

Project Descriptions and Explanation of Changes

Corporate Management & Operations / Agency Operations

Headquarters personnel salaries, benefits, travel, training, and operational costs such as rents, IT support, payroll information services, and facility services.

Changes: Activities reduced and re-prioritized to enable critical funding of center-based activities in Center Management & Operations.

Office of Chief Financial Officer

The Office of Chief Financial Officer (OFCO) is responsible for the financial leadership of NASA and its primary duty is to uphold strong financial management and accountability while providing timely, accurate, and reliable financial information and enhancing internal control.

Changes: Activities reduced and re-prioritized to enable critical funding of center-based activities in Center Management & Operations.

Office of Security & Program Protection

This Functional Support Office serves as the focal point for policy formulation, oversight, coordination and management of the Agency security, counter-intelligence (CI), counter-terrorism (CT), emergency preparedness planning, and continuity of operations functions.

Changes: Activities reduced and re-prioritized to enable critical funding of center-based activities in Center Management & Operations.

Office of Program Analysis and Evaluation

The Office of Program Analysis and Evaluation (PA&E) is an independent assessment organization that provides objective, transparent, and multidisciplinary analysis to inform strategic decision-making. PA&E examines a variety of issues of strategic importance to NASA. The office will ensure all aspects of a major decision are considered and obtain pertinent information required to assist the Administrator in making well-informed, timely decisions.

Changes: Activities reduced and re-prioritized to enable critical funding of center-based activities in Center Management & Operations.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Safety and Mission Success

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**174.1**	**161.6**	**163.4**	**165.4**	**167.3**	**169.3**	**171.3**
Safety and Mission Assurance	49.8	42.2	42.9	43.4	43.8	44.2	44.6
Chief Engineer	90.7	87.7	87.0	88.2	89.4	90.6	91.9
Chief Health and Medical Officer	4.7	2.8	4.1	4.1	4.2	4.2	4.2
Independent Verification and Validation	29.0	29.0	29.3	29.7	30.0	30.3	30.6
FY 2008 President's Budget Request	**187.0**	**185.8**	**184.3**	**177.5**	**178.6**	**182.2**	**0**
Safety and Mission Assurance	46.7	45.8	45.4	44.9	45.5	46.9	0
Chief Engineer	109.6	109.7	108.3	102.5	102.6	104.3	0
Chief Health and Medical Officer	4.7	4.7	4.7	4.6	4.7	4.8	0
Independent Verification and Validation	26.0	25.6	25.9	25.5	25.8	26.2	0
Changes from FY 2008 Request	**-12.9**	**-24.2**	**-20.9**	**-12.1**	**-11.3**	**-12.9**	**171.3**

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is shown in direct dollars.

Program Overview

The Safety and Mission Success (SMS) program directly supports NASA's core values and serves to improve the likelihood for safety and mission success for NASA's programs, projects, and operations. SMS includes the corporate work managed by the offices of the Chief, Safety and Mission Assurance (including the NASA Safety Center (NSC)), Chief Engineer (including the NASA Engineering and Safety Center (NESC)), the Chief Health and Medical Officer (OCHMO), and the Director of the Independent Verification and Validation (IV&V) Facility.

SMS is responsible for developing policy and procedural requirements, and for providing advice to the Administrator, Mission Directorates, and Center Directors who are ultimately accountable for the safety and mission success of all NASA programs, projects and operations. In addition, SMS provides the foundation for the system of "checks and balances" enabling the effective application of the strategic management framework defined in NASA's Strategic Management and Governance Handbook (NPD 1000.0). SMS is also responsible for assuring the existence of a competent technical workforce within the disciplines of system engineering (system safety, reliability, and quality) and space medicine.

SMS judges the implications on safety and mission success, as well as the biomedical aspects of new requirements and departures from existing requirements. SMS determines the criticality of the associated risk and evaluates the risk acceptability through an established process of independent review and assessment. SMS informs decision-making through the proper execution of the delegated technical authority applied at program and project decision forums.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Safety and Mission Success

Program Relevance

The multiple organizations comprising the Safety and Mission Success (SMS) Program assure the safety and enhance the success of all NASA activities. These organizations develop and enforce policies governing safety, reliability, maintainability, quality assurance, system engineering, and program/project management. In addition, they provide space medicine and bio-ethics policies and procedures. These policies apply to all operations at NASA and, therefore, influence the outcome of every activity.

The SMS stakeholders include the NASA Administrator, Associate Administrators, and the Mission Directorates (the ultimate "Risk" managers). The customers of the SMS program are the NASA missions, programs, and projects that receive SMS products and services. SMS customers benefit from these efforts by correcting problems identified earlier in the development phase instead of correcting them later.

Plans For FY 2009

The plans for FY 2009 directly support the objectives of the Agency's four Mission Directorates by helping to improve the likelihood of Safety and Mission Success (SMS) for all NASA programs, projects, and operations. SMS will continue to manage and refine the pertinent policy, procedural requirements, and technical standards, as well as participate in the necessary forums that provide advice to the Administrator, Mission Directorates, and Center Directors who are ultimately accountable for the safety and mission success of all NASA programs, projects, and operations.

The plans for FY 2009 support the NASA Engineering and Safety Center (NESC), the NASA Safety Center (NSC), and the Independent Verification and Validation (IV&V) Facility. This support assures that NASA has, and continues to apply, the appropriate knowledge, skills, abilities, and tools for sound and well-informed decision-making on matters critical to safety and mission success. The plans will include prioritized development, maintenance, and conduct of training and education necessary for assuring the existence of a competent technical workforce. The plans will also include support for independent research, audit, and assessment of NASA activities. The independent reviews judge the safety and likelihood of success of NASA activities. In addition, they assess the biomedical aspects of new requirements, departures from conformance with existing requirements, and determine the criticality of the risk and evaluate its acceptability. This established process of independent review supports informed decision-making through the proper execution of delegated technical authority applied to program and project decisions.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Safety and Mission Success

Project Descriptions and Explanation of Changes

Office of Safety and Mission Assurance

The Office of Safety and Mission Assurance (OSMA) is responsible for establishing and maintaining an acceptable level of technical excellence and competence in safety, reliability, maintainability and quality engineering within the Agency. OSMA assures that the risk presented by any requirement or departure from requirement is analyzed, assessed, communicated and used for proper decision-making and risk acceptance.

Fundamental to these two responsibilities is the definition and execution of a robust and well-understood methodology and process for the application of the disciplines of safety, reliability and quality (S, R and Q) in defining the level of risk. In addition, the organization conducts a schedule of review and assessments that focus on the life cycle decision milestones for crucial NASA programs and projects and S, R, and Q processes. Embodied in this program is a structured development of methodology and investigation into system attributes that improve the probability of mission success.

Assisting OSMA is the NASA Safety Center (NSC) in Cleveland, OH. The NSC was established in FY 2007 and will begin its first full year of operations in FY 2008. NSC is establishing a Technical Excellence initiative to improve and formalize training and qualification requirements for five SMA engineering disciplines: system safety; reliability and maintainability; quality; software assurance; and operational and aviation safety. Additionally, NSC is increasing and sustaining domain knowledge within the SMA community by: facilitating the storage and retrieval of important documents and lessons learned; providing data analysis and trending of mishap-related data; rapidly disseminating mishap-related Agency Safety Alerts; and improving the Agency Incident Reporting Information System (a mature, comprehensive, Agency-wide tool used for the reporting of mishaps and close calls). NSC is increasing its role and improving the conduct for supplier audits and mishap investigations, with an end result of promoting the highest level of safety and reliability for NASA's programs and projects.

Changes: Activities reduced and re-prioritized to enable critical funding of Center-based activities in Center Management and Operations.

Office of Chief Engineer

The Office of the Chief Engineer (OCE) promulgates policy and requirements for program and project management, for the engineering excellence of the Agency, system engineering methodology, and for the Agency's system of engineering standards. The Office of Chief Engineer manages the NASA Engineering and Safety Center (NESC), which is responsible for rapid, cross-Agency response to mission-critical engineering issues and for improving the state of practice in critical engineering areas. OCE also sponsors the Academy of Program/Project and Engineering Leadership (APPEL) to develop Program and Project Management and Systems Engineering skills.

APPEL supports NASA's Mission in program/project management and engineering through the application of learning strategies, methods, models and tools. APPEL provides professional development products and services for individual practitioners and program and project teams. This includes: a formal training curriculum designed to address four career levels from recent college graduate to executive; direct support to project teams in the field through workshops, coaching, and technical experts; and conferences, forums and publications.

The NESC, established in 2003 in response to the Columbia accident, is responsible for rapid, cross-Agency response to mission-critical engineering issues and for improving the state of the practice in critical engineering areas. The NESC performs value-added independent testing, analyses and technical assessments of NASA's projects and technical activities to enhance safety and mission success. The NESC also works proactively to help NASA avoid problem recurrence and to prevent future problems. The core NESC organization is comprised of senior engineering experts from across the Agency, including the NASA Technical Fellows and their Technical Discipline Teams composed of experts from NASA, industry, and academia.

Changes: Activities reduced and re-prioritized to enable critical funding of Center-based activities in Center Management and Operations.

Office of Chief Health and Medical Officer

The Office of the Chief Health and Medical Officer (OCHMO) is responsible for promulgating Agency health and medical policy, standards, and requirements, assuring the medical technical excellence of the Agency, assuring the physical and mental well being of the NASA workforce, and assuring the safe and ethical conduct of NASA-sponsored human and animal research. OCHMO exercises oversight of NASA medical and health related activities through audit processes, and monitors the implementation of health and medical related requirements in all developmental human spaceflight programs through designated discipline experts at NASA Centers. OCHMO also provides oversight of medical and health related activities in operational human spaceflight through Center-based discipline experts and clinical boards. On-going medical and health discipline professionalism and licensure is supported through annual certified Continuing Medical Education (CME) activities, and flight surgeon education and clinical currency is provided through OCHMO-sponsored, university-based physician training programs. NASA's biomedical research programs in support of human spaceflight are guided by OCHMO-developed health and medical standards. Center-based review boards under OCHMO sponsorship provide direct supervision of NASA-sponsored human and animal research safety and ethics, completing a comprehensive system of oversight to maintain robust health and medical support of NASA personnel at all levels.

Changes: Activities reduced and re-prioritized to enable critical funding of Center-based activities in Center Management and Operations.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Safety and Mission Success

Independent Verification and Validation

The NASA Independent Verification and Validation (IV&V) Project, as a part of the Agency's overall Software Assurance and Risk Mitigation strategy, is responsible for providing systems engineering activities that improve software safety, reliability, and quality of NASA programs and projects through effective applications of systems and software IV&V methods, practices, techniques, and tools. The NASA IV&V Facility applies software engineering best practices to evaluate the correctness and quality of critical and complex software systems throughout the project's System Development Life Cycle (SDLC).

Changes: Programmatic content increases in all years to maintain the same funding level of activity as in FY 2007.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency IT Services

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	173.2	133.1	163.9	145.9	133.1	133.5	133.9
IT Management	59.9	33.2	24.2	24.9	23.5	22.3	22.3
Applications	75.8	68.0	61.4	65.0	61.7	62.0	62.2
Infrastructure	37.5	31.9	78.4	56.0	48.0	49.1	49.5
FY 2008 President's Budget Request	154.6	160.3	132.0	134.4	132.7	134.8	0
Advanced Business Systems	80.8	84.1	56.8	58.9	55.7	55.7	0
Chief Information Officer	73.8	76.2	75.2	75.5	77.0	79.1	0
Changes from FY 2008 Request	18.6	-27.2	31.9	11.5	0.4	-1.3	133.9

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 Actual Column, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 Column, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is shown in direct dollars.

Program Overview

Agency Information Technology Services (AITS) encompasses cross-cutting IT services and initiatives in IT management, applications, and infrastructure necessary to enable the NASA Mission and improve security, integration and efficiency of Agency operations. In FY 2009 significant emphasis will be placed on consolidation of networks and network management, improved security incident detection, response and management, further consolidation of desktop/laptop computer services, data center assessment for consolidation, and application portfolio management leading to consolidation. NASA is using an enterprise architecture approach to assess current assets, capabilities and costs for services and developing requirements, projects and procurements for transition to the desired consolidated state. Additionally, the underlying infrastructure and systems to instill strong authentication and access to information systems in alignment with HSPD-12 will progress significantly in FY 2009.

Critical work will continue under the Integrated Enterprise Management Program (IEMP) to improve business processes by minimizing data redundancy, standardizing information and electronic data exchanges, and processing. Also, NASA will continue participation in several federal E-Government initiatives and Lines of Business to improve services to citizens and gain efficiencies across the government.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency IT Services

Program Relevance

Identified as a Cross-Cutting Management Strategy in the 2006 NASA Strategic Plan, the strategic management of information and information technologies is imperative for Mission success. Mission success requires significant collaboration across NASA facilities. The AITS Program aligns the NASA budget with consolidation initiatives to support this collaboration and integrate people, processes and technologies, as well as improving security, and achieving efficiencies in NASA's IT infrastructure and applications. The program performs the following activities: 1) Align information technology investments with the NASA Mission; 2) Ensure NASA's information and information systems are appropriately secure, and protect the confidentiality, integrity, and availability of information and information systems, based on the categorization of the information processed by, or stored within, NASA's information systems; 3) Improve information sharing and efficiencies through Agency-wide solutions; and 4) Implement an IT asset management and operations capability that provides Agency-wide visibility and monitoring of its networks and systems.

This program supports Outcomes IEM-1 and IEM-2.

Plans For FY 2009

In FY 2009 significant emphasis will be placed on consolidation of networks and network management, improved security incident detection, response and management, further consolidation of desktop/laptop computer services, data center assessment for consolidation, and application portfolio management leading to consolidation. NASA is using an enterprise architecture approach to assess current assets, capabilities and costs for services, and developing requirements, projects, and procurements for transition to the desired consolidated state. Additionally, the underlying infrastructure and systems to instill strong authentication and access to information systems will progress significantly in FY 2009, in alignment with HSPD-12. The following is a partial list of the planned activities that will be performed in FY 2009:

- Transition to an Agency IT "Demilitarized Zone";
- Consolidate remote access to networks;
- Partial consolidation of networks;
- Conduct acquisition for Enterprise Network Services Acquisition;
- Implement Phase I of the Security Operations Center;
- Begin Phase II of Security Operations Center implementation;
- Achieve improved Network Operations Center monitoring;
- Begin centralized network management;
- Standardize internal firewalls;
- Implement a consolidated active directory architecture;
- Implement web-enabled authentication application migration;
- Implement desktop smartcard integration;
- Conduct Phase I data center consolidation at the Center level;
- Implement Enterprise Data Center Services;
- Consolidate management of end-user devices (desktops, laptops, phones, PDAs, etc.); and
- Consolidate project lifecycle management (PLM) applications.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency IT Services

Project Descriptions and Explanation of Changes

Agency IT Services

Agency IT Services Program inculcates the cross-cutting IT services that enable the NASA Mission and improve security, integration and efficiency of Agency operations. Agency IT Services consolidates Agency IT projects into a single program which includes critical work under the Integrated Enterprise Management Program (IEMP) to improve business processes by minimizing data redundancy, standardizing information and electronic data exchanges, and processing. Also, NASA will continue participation in several federal E-Government initiatives and Lines of Business to improve services to citizens and gain efficiencies across the government.

IT Management

Includes IT management functions, including: Enterprise Architecture, E-Government, and other Agency-level management and operations, such as IT policy (IT management, records management, privacy, etc.), project management, portfolio management, and operations (management of scientific and technical information).

Applications

Includes development and operations of Agency applications, such as those under the IEMP (core financial, aircraft management, contract management, human capital management, etc), as well as applications identified for consolidation under the application portfolio management process.

Infrastructure

Includes IT Security (including certification and accreditation), NASA portal operations, NASA email and calendaring, NASA data center, and other initiatives to consolidate networks, desktops and data centers.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency IT Services

Implementation Schedule

Project	Phase	Beg	End
Integrated Asset Management (IAM) Property, Plant, & Equipment (PP&E)	Tech		
	Form	Jul-06	May-07
	Dev	May-07	Apr-08
	Ops	Apr-08	Jul-08
	Res		
Human Capital Information Environment - IOC	Tech		
	Form	Apr-06	May-07
	Dev	May-07	Oct-07
	Ops	Oct-07	Mar-08
	Res		
Human Capital Information Environment - FOC	Tech		
	Form		
	Dev	Sep-07	Sep-08
	Ops	Sep-08	Dec-08
	Res		
Aircraft Management Module Phase 2	Tech		
	Form	Oct-06	Mar-07
	Dev	Mar-07	Apr-09
	Ops	Apr-09	Jun-09
	Res		

Schedule by Fiscal Year: Prior, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

- Tech & Adv Concepts (Tech)
- Formulation (Form)
- Development (Dev)
- Operations (Ops)
- Research (Res)
- Represents a period of no activity for the Project

Program Management

IEMP components are managed at Marshall Space Flight Center, Johnson Space Center, and the NASA Shared Services Center.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Aircraft Management Module (AMM)	Headquarters Program Office	Johnson Space Flight Center	ARC, DFRC, GRC, GSFC, KSC, LaRC, and MSFC
Integrated Asset Management (IAM) Property, Plant, and Equipment Module	Headquarters Program Office	Marshall Space Flight Center	All Centers
Human Capital Information Enviornment	Headquarters Program Office	NASA Shared Services Center	All Centers

Acquisition Strategy

No major acquisitions are planned for FY 2009.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Center Systems Mgt. Office	06/2006	Independent Standing Review Board formed by the Program Director in mid FY 2006. This team attends and prepares assessments of major project milestone review materials and completion of review entry and exit criteria.	N/A
Quality	Fairmont IV&V Facility	09/2006	Independent Assessment by a third party contractor is in place on the program. Independent Assessment Team has been assigned by the Program to review all project requirements for completeness and testability, and to verify that requirements traceability into the project test effort is clear and complete.	N/A
Performance	IPAO	03/2006	The Program Implementation Review assesses continued consistency with baseline commitments (performance, safety, cost, risk, and schedule) and strategic alignment, as defined in a Program Commitment Agreement (PCA) and program plan. The results of this review are reported to the Agency Program Management Council.	03/2008
Performance	Center Systems Mgt. Office	N/A	A Non-Advocate Review (NAR) is an independent assessment of projects conducted at the end of NPR 7120.5's formulation phase. It provides Agency management with an assessment of the readiness of the project to proceed into the implementation phase. Upon successful completion of this review process, a recommended project baseline is established.	N/A

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Concept of Operations	Lack of Agency Business System ConOps for NASA's business environment may result in the implementation of requirements which are sub-optimally integrated or prioritized.	1) Complete Gap Analysis to identify business requirements set. 2) Perform stakeholder identification and engagement. 3) Charter ConOps Team. 4) Develop a scope definition. 5) Develop draft ConOps. 6) Obtain approval.
Human Capital Information Environment	If stakeholders are unable to agree on the authoritative data sources, common data elements, and data usage, then data may not be accurate or available in a timely manner and users may not use the HCIE system.	Create Data Czar position with authority to manage OHCM data across HRIS systems. Data Czar will build and maintain data dictionary to ensure common understanding and usage of OHCM data. During realization, functional project team members, with assistance from OHCM, will perform this function.
Integrated Asset Management (IAM)	If the Scrum Teams are unable to meet the defined goals of each Sprint then work may have to be shifted to future Sprints causing schedule impacts.	Plan each Sprint in a manner that is realistic and offers a good chance of success. The Project Manager will work closely with the Scrum Masters to quickly resolve any obstacles that are hindering the team's progress.
Agency Requirements	Evolving Agency requirements may require more funding and staff than is available.	1) Leverage M/B SIG to prioritize future requirements. 2) Perform IEMP projects analysis to determine availability of resources against various liens. 3) Develop de-scope plan. 4) Align new requirements to the Planning, Programming, Budgeting, and Execution (PPBE) process.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Innovative Partnerships Program

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**189.2**	**146.8**	**175.7**	**181.9**	**178.0**	**178.1**	**178.1**
Small Business Innovative Research	124.4	103.7	117.9	124.1	124.1	124.1	124.1
Small Business Technology Transfer Research	14.9	12.5	14.1	14.1	14.1	14.1	14.1
Partnership Development	41.0	21.2	24.1	25.4	22.3	22.2	22.0
SBIR-STTR- Program Support	8.6	8.5	9.1	7.8	7.0	7.2	7.4
Future Centennial Challenges	0	0	4.0	4.0	4.0	4.0	4.0
Independent Project Review Capability	0	0.8	0	0	0	0	0
FAST	0	0	2.0	2.0	2.0	2.0	2.0
Investment Seed Fund	0	0	4.0	4.0	4.0	4.0	4.0
Innovation Transfusion	0	0	0.5	0.5	0.5	0.5	0.5
Space Product Development	0.3	0	0	0	0	0	0
FY 2008 President's Budget Request	**178.6**	**162.0**	**161.8**	**164.7**	**165.2**	**165.3**	**0**
Innovative Partnerships Program	178.6	162.0	161.8	164.7	165.2	165.3	0
Changes from FY 2008 Request	**10.6**	**-15.2**	**13.9**	**17.2**	**12.8**	**12.8**	**178.1**

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is shown in direct dollars.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Innovative Partnerships Program

Program Overview

NASA's Innovative Partnerships Program is focused on adding value to NASA through partnerships. The mission of the program is to provide leveraged technology alternatives for NASA's Mission Directorates, programs, and projects through joint partnerships with industry, academia, government agencies, and national laboratories. Products include leveraged technology investments, dual-use technology-related partnerships, and secured intellectual property assets. Partnerships serve to increase the range of technology solutions for NASA, enable cost avoidance, and accelerate technology maturation. Dual-use partnerships and licensing create socio-economic benefits within the broader community through technology transfer or spinoffs.

The Innovative Partnerships Program consists of three elements. Technology Infusion includes the Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) programs and the Innovative Partnerships Program Seed Fund. Innovation Incubator includes Centennial Challenges, Facilitated Access to the Space Environment for Technology Development and Training, Innovation Ambassadors, Innovation Scouts, and new efforts to facilitate purchase of services from the emerging commercial space sector. The final element is Partnership Development, which includes Intellectual Property Management, Technology Transfer, and new innovative partnerships. The Program is administered at NASA Headquarters and executed by offices at each of NASA's Field Centers.

Space exploration provides the scientific and technological progress to meet challenging mission requirements. Many commercial technologies are the direct result of NASA-supported funding for internal research and development projects performed at NASA's Centers, and NASA-supported external research performed by the small business community. These technologies, while targeted for integration into the mainstream NASA flight programs, can also provide opportunities for improving the quality of life for the American public on Earth. Identifying those technologies and transferring them for public good is a key focus for IPP. Each year, IPP documents recent successes in its "Spinoff" publication. "Spinoff 2007" highlights 39 new examples of how NASA innovation can be transferred to the commercial marketplace and applied to areas such as health and medicine, transportation, public safety, consumer goods, homes and recreation, environmental and agricultural resources, computer technology, and industrial productivity.

IPP's Technology Infusion seeks emerging technologies externally that fill key needs in NASA's technology portfolio and support NASA's Strategic Goals.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Innovative Partnerships Program

Program Relevance

IPP provides the technology solutions for NASA programs and projects through dual-use technology development and joint-partnerships with industry, academia, federal agencies, and laboratories. By broadening NASA's connection to emerging technologies, IPP reduces program costs by increasing range of technological solutions.

IPP provides technology transfer out of NASA for commercial and other socio-economic benefit to the Nation. In addition, IPP facilitates protection of the government's rights in NASA's inventions, as mandated by legislation. IPP implements NASA's SBIR and STTR programs with the primary objective of providing the high-technology small business sector with an opportunity to develop technology for NASA. Technology partnerships, SBIR/STTR, and Centennial Challenges tap into sources of innovation outside NASA and leverage NASA's resources with private or other external resources to develop new technologies for NASA mission use. IPP has also established a Seed Fund to contribute to the development of technology through leveraged development with industry and other partners, and to support NASA programs and priorities. IPP serves NASA's mission interests, both in the near and long terms, through developing a broad range of technologies and advancing their technology readiness. IPP provides opportunities to a broad spectrum of U.S. industrial and non-profit entities for direct involvement in addressing NASA's technology needs in exploration and other missions.

This program supports Outcomes 5.1, 5.3, and IPP-1.

Plans For FY 2009

IPP's portfolio of technology investments and partnerships will continue to address the technology needs of NASA's Mission Directorates.

IPP plans to develop at least 12 technology-related significant partnerships that create value for NASA programs and projects; complete at least 30 technology transfer agreements with the commercial and academic community through licensing, software use agreements, facility use agreements, and Space Act Agreements.

IPP strives to keep abreast of the changes in emphasis within the Agency's technology landscape to be better positioned to meet Mission Directorate needs through the IPP technology portfolio.

Centennial Challenges will continue to address key technology needs with new sources of innovation. IPP will continue ongoing prize competitions, awarding one or more prizes to further encourage partnerships with innovative technology providers including the emerging commercial space sector.

IPP will also encourage the pursuit of appropriate partnerships with the emerging commercial space sector through a new project titled "Facilitate Access to the Space Environment for Technology Development and Training" (FAST), and other activities.

Innovation Transfusion will implement a plan with three project elements to accomplish its objectives. Innovation Ambassadors is a training program that places technical employees at external organizations for approximately 12 months where they work on achieving the goals and objectives they have set in their individual development plans. Innovation Scouts is an activity to take IPP staff and technology experts out to visit innovative organizations for focused workshops and information exchanges on specific innovations. The final element is communication to the NASA community to disseminate what has been learned.

Project Descriptions and Explanation of Changes

Small Business Innovative Research (SBIR)

The Small Business Innovation Research (SBIR) Program was established by Congress in 1982 to increase research and development opportunities for small businesses, to increase employment, and to improve U.S. competitiveness. The program's specific objectives are to stimulate U.S. technological innovation, employ small businesses to meet federal research and development needs, increase private-sector commercialization of innovations derived from federal research and development, and foster and encourage participation by socially disadvantaged businesses. Legislation enacted in 2000 extended and strengthened the SBIR program and increased its emphasis on pursuing commercial applications of SBIR project results.

The SBIR and Small Business Technology Transfer (STTR) programs provide opportunities for small, high-technology companies and research institutions (RI) to participate in government-sponsored research and development efforts in key technology areas. The SBIR program is for small businesses with 500 or fewer employees and non-profit RI, such as a university or a research laboratory with ties to a Small Business Concern (SBC). NASA encourages these organizations to learn more about its programs as a significant source of seed funding for the development of innovations.

The SBIR Phase I contracts last for six months with a maximum funding of $100,000, and Phase II contracts last for 24 months with a maximum funding of $600,000 (up to $750,000 with Phase IIB and matching $150,000 from a Mission Directorate). The STTR Phase I contracts last for 12 months with a maximum funding of $100,000, and Phase II contracts last for 24 months with the maximum contract value of $600,000 (up to $750,000 with Phase IIB and matching $150,000 from a Mission Directorate). Historically, the ratio of the number of Phase I proposals to awards for SBIR is 8:1 and for STTR is 5:1. About 40 percent of the completed Phase I projects receive funding for Phase II development.

Small Business Technology Transfer Research (STTR)

The Small Business Technology Transfer Research (STTR) Program awards contracts to small business concerns for cooperative research and development with a non-profit research institution, such as a university. The goal of the STTR Program is to facilitate the transfer of technology developed by a research institute through the entrepreneurship of a small business. The small business and its partnering institution are required to sign an intellectual property agreement.

Modeled after the SBIR Program, with the same basic requirements and phased funding structure, STTR is a separately funded activity. It differs from SBIR in several important aspects. STTR is a smaller program whose funding set-aside is three-tenths of a percent of the extramural research and development budget, approximately one-twentieth of the amount for SBIR. The small company must take the research and intellectual property of the research institution and convert it into a useful product. In comparison to SBIR, twice as much time is allowed for performance of Phase I. The Phase II activity is two years. While the proposal is still submitted by small business concerns, at least 30 percent of the funding and work must originate with the research institution, while only a minimum of 40 percent must come from the small business concerns. Phase I STTR projects receive up to $100,000 in funds for a one-year effort. The maximum contract value for STTR Phase II is $600,000 (up to $750,000 with Phase IIB and matching $150,000 from a Mission Directorate). The STTR Program Solicitation research areas correspond to the central underlying technological competencies of each participating NASA Center. The Jet Propulsion Laboratory (JPL) participates in the management of the STTR Program.

Partnership Development

The Partnership Development Program element, formerly Technology Transfer Partnerships, seeks partnerships for transfer of new or improved technology and innovations to NASA missions, and transfer of NASA technology for commercial or other benefits to the Nation. Partnership Development encourages participation by all firms, from small to Fortune 500 companies, including companies from the non-aerospace ("non-traditional") sectors that otherwise might not recognize the opportunity to partner with NASA. Partnerships often involve state and other federal agencies, academic institutions, and other non-profit entities. Partnership Development facilitates protection of NASA's intellectual property rights in its innovations. IPP has strengthened the involvement of the Mission Directorates and Mission Support Offices in all of its program elements to better serve Agency-wide and public needs.

SBIR/STTR Program Support

SBIR/STTR Program Support provides direct assistance to the administration of NASA's SBIR and STTR programs. This includes managing the "electronic handbook," NASA's paperless system for processing thousands of proposals, and managing the SBIR and STTR award budgets. A great deal of staff effort is required at the Center level to ensure the successful management of SBIR and STTR award processes.

Future Centennial Challenges

The Centennial Challenges program conducts prize competitions for revolutionary, breakthrough accomplishments that advance the Vision for Space Exploration and other NASA priorities. Some of NASA's most difficult technical challenges require novel solutions from non-traditional sources of innovations. By making awards based on actual achievements, instead of proposals, NASA is tapping innovators in academia, industry, and the public. This effort is modeled on successful past prize competitions, including an 18th century navigation prize, early 20th century aviation prizes, and more recent prizes offered by the U.S. government and private sector.

In 2007, a prize of $200,000 was awarded to an individual inventor in the Astronaut Glove Challenge for a new glove design that exceeded the performance of spacesuit gloves currently used by NASA. In the Personal Air Vehicle Challenge, seven prizes totaling $250,000 were awarded to three different competitors for demonstrating significant improvements in efficiency, noise reduction and other factors important to future aviation technology. In other challenges, such as the Lunar Lander, teams have demonstrated impressive technical capabilities and have come very close to meeting the demanding criteria for success. Overall, the amount of team diversity (representing small and large businesses, high school and university students, and enthusiastic hobbyists and garage mechanics) and the variety of technologies implemented exceeded Agency expectations.

As the prize purses increase, the amount of participation and level of technical maturity and ingenuity will also increase. In the past competitions where the prize purses were on the order of $300,000 each, it is estimated that the 10-15 participating teams represented an investment of $50,000 - $100,000 each. In the competition with a $2 million prize purse, teams invested on the order of $250,000 - $500,000 each.

Centennial Challenges is continually working with each of the NASA Mission Directorates to ensure that competitions selected are addressing the current set of NASA's technology priorities.

Facilitated Access to Space Environment for Technology Development and Training (FAST)

The Facilitated Access to Space Environment for Technology Development and Training (FAST) program objective is to mature technologies for future space flight use, especially those technologies that need to be proven in the microgravity environment. FAST will provide access to commercial microgravity flight services to advance NASA technologies, reducing risk levels and enabling more verification and validation of these technologies for space flight missions. FAST also facilitates the procurement of commercial space services by NASA to support the development of future space flight-certified technologies.

Investment Seed Fund

The Investment Seed Fund supports the future technology needs of the NASA Mission Directorates. The Seed Fund serves many purposes within NASA. It acts as "bridge" funding to Centers in support of Mission Directorate programs; promotes partnerships and cost sharing with NASA programs and industry; and leverages resources with a greater return on investment. Proposals selected must possess the following: scientific/technical merit and feasibility, relevance and value to NASA Mission Directorates, capability and strength of partnership team (composed of representatives from industry, programs, and IPP), quality cost share of resources as demonstrated by a realistic budget and schedule needed to complete the seed fund activity. The IPP Seed Fund is an annual process to enhance NASA's ability to meet mission technology goals by providing seed funding to counter barriers and initiate cost-shared joint-development partnerships. The IPP Seed Fund is used to provide funding that will enable larger partnerships and development efforts to occur, and will encourage the leveraging of funding, resources, and expertise from non-NASA partners, NASA programs and projects, and NASA Centers. In 2006 and 2007 an investment of $15.9 million by IPP facilitated the generation of 67 partnerships. This amount was leveraged by a factor of four from partner contributions, providing a total of $62.2 million for the advancement of critical technologies and capabilities for the Agency.

Innovation Transfusion

The Innovation Transfusion goal is to create strategic connections between innovative external organizations and NASA. The objectives are to: identify strategic areas of innovation with potential benefit to NASA; recognize and learn from current innovations occurring outside the Agency; disseminate innovations from external sources to appropriate individuals internal to NASA; foster future partnerships; and provide an innovation focus to career development. There are three methods used by the Innovation Transfusion project: Innovation Ambassadors (a developmental assignment where individuals from NASA's technical workforce are placed at an external organization for approximately 12 months); Innovation Scouts (a focused one- to two-day workshop to exchange information on specific innovations); and Agency Dissemination (broad communication of learned innovations to the NASA community).

Program Commitments

Commitment/Output FY 2009	Program/Project	Changes from FY 2008 PB Request
Integrate SBIR/STTR technology into Agency science and technology plans.	Small Business Innovative Research (SBIR)	Introduction of Phase IIB to encourage cost sharing with Mission Directorates
Integrate SBIR/STTR technology into Agency science and technology plans.	Small Business Technology Transfer (STTR)	Introduction of Phase IIB to encourage cost sharing with Mission Directorates
12 partnerships, 30 tech transfer agreements, portfolio licensing, intellectual property management	Partnership Development	Reduced 40% to reflect impact of FY 2008 omnibus reductions
Hold 3 Centennial Challenges competitions	Future Centennial Challenges	None

Program Management

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Small Business Innovative Research (SBIR)	NASA HQ IPP	All	NASA Programs/Projects for Phase IIB
Small Business Technology Transfer Research (STTR)	NASA HQ IPP	All	NASA Programs/Projects for Phase IIB
Partnership Development	NASA HQ IPP	All	All NASA Centers
SBIR-STTR Program Support	NASA HQ IPP	All	N/A
Future Centennial Challenges	NASA HQ IPP	NASA HQ	5 allied organizations and their sponsors
Faciliatated Access to the Space Environment for Technology Development and Training (FAST)	NASA HQ IPP	All	All NASA Centers and non-NASA organizations
Investment Seed Fund	NASA HQ IPP	All	NASA Mission Directorates and non-NASA organizations
Innovation Transfusion	NASA HQ IPP	All	N/A

Acquisition Strategy

No major acquistions are planned for FY 2009.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Rand Corporation	01/2007	Review requested by NASA Office of Program Analysis and Evaluation (PAE); independent review of management efficiency and program effectiveness.	N/A
Performance	OMB	12/2006	SBIR Program Assessment Rating Tool review.	N/A
Quality	NASA PAE	10/2006	Review of Technology Transfer program; review completed.	N/A
Performance	National Research Council	09/2006	Review of SBIR/STTR Program: Review is currently in Phase II of a 2-phase study; each study phase to be completed within a 3-year period, currently in the 2nd year of study phase. Phase I results are available. Phase II planned to be completed in FY 2008.	09/2008
Performance	GAO	09/2006	Report GAO-07-38, "Small Business Innovation Research: Agencies Need to Strengthen Efforts to Improve the Completeness, Consistency, and Accuracy of Awards Data."	N/A
Quality	GAO	06/2006	GAO Review 360715, "Direct Services to Small Manufacturers."	N/A
Quality	NASA PAE	01/2006	Review of Space Product Development Program; review completed March 2006.	N/A
Quality	NASA PAE	01/2006	Review of SBIR/STTR program.	12/2008
Quality	National Academy of Public Adm	10/2004	Review of Technology Transfer program; review completed fourth quarter FY 2004.	N/A
Quality	Booz Allen Hamilton	05/2004	Review of Space Product Development: completed second quarter FY 2004.	N/A

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
SBIR/STTR	Uncertain infusion of SBIR/STTR technologies into NASA programs and projects.	Continue close coordination with all Mission Directorates to align topics and subtopics with needs; proactively work infusion throughout SBIR/STTR lifecycle, not just at end.
Partnership Development	Insufficient resources to support and protect the Government's rights in its inventions and transfer technology out of the Agency for national economic and quality of life benefits.	Ensure adequate resources to meet statutory requirements.
SBIR-STTR Program Support	Resource constraints limiting infusion activities.	Seek flexibility in use of SBIR/STTR funds in reauthorization.
Future Centennial Challenges	With a lack of new challenges, Future Centennial Challenges competitions are at risk of losing the number and quality of competitors that makes the program so successful. Without the number and high quality of competitors, expanding the scope of competitions will become difficult.	Continue to develop excellent Future Centennial Challenges competitions, as well as develop and maintain interest in Centennial Challenges by providing information to the taxpayers, Congress, academic institutions, and industry about the technological benefits of these competitions. Ensure NASA remains a reliable partner and follows through on plans.
Faciliatated Access to Space Environment for Technology Development and training (FAST)	Timing of flights with technology availablity.	Conduct advanced planning to ensure adequate time for planning, preparation, and integration.
Investment Seed Fund	Lack of project continuity due to FY 2008 omnibus reductions.	Continue to work with existing partners and communicate NASA's commitment for future plans to prospective partners.
Innovation Transfusion	Lack of partners	Conduct outreach to indentify external sources of innovation.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Strategic Capabilities Assets Program

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**71.5**	**27.2**	**28.0**	**29.8**	**30.7**	**30.7**	**30.7**
Simulators	11.5	10.9	11.5	11.9	12.3	12.3	12.3
Thermal Vacuum Chambers	7.5	7.7	7.2	8.2	8.4	8.4	8.4
Arc Jets	9.9	8.6	9.3	9.7	10.0	10.0	10.0
Microgravity Flight Services	0.1	0	0	0	0	0	0
SCAP Maintenance Projects	0.6	0	0	0	0	0	0
Space Power Facility Upgrades	42.0	0	0	0	0	0	0
FY 2008 President's Budget Request	**18.3**	**28.0**	**28.0**	**29.8**	**30.7**	**30.7**	**0**
Shared Capabilities Assets Program	18.3	28.0	28.0	29.8	30.7	30.7	0
Changes from FY 2008 Request	**53.2**	**-0.8**	**0.0**	**0.0**	**0.0**	**0.0**	**30.7**

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is shown in direct dollars.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Strategic Capabilities Assets Program

Program Overview

The Strategic Capability Assets Program (SCAP) manages the capabilities under its purview by: establishing an alliance between all centers with like assets; making decisions on disposition of capabilities no longer required; identifying re-investments/re-capitalization requirements, within and among classes of assets; and executing changes. SCAP reviews these capabilities each year to ensure the requirements continue to be valid.

These facility capabilities are sustained to ensure their availability when needed to support NASA missions.

New capabilities will be assessed during the budget formulation process and added as necessary and affordable to support Agency programs.

In its initial year (FY 2007), the SCAP concentrated on understanding mission requirements for SCAP assets. SCAP also began working with Centers to coordinate aspects of the various asset classes within and among Centers. The program began expanding alliances such as the DOD/NASA National Partnership for Aeronautical Testing (NPAT). This agreement created increased cooperation, such as charging uniform rates among similar users, e.g., government to government use of each others' facilities, and collaborating on quarterly performance reviews for testing at NASA and Department of Defense (DOD) facilities. SCAP has met goals established in FY 2007 to create consistent pricing policies, quarterly program reviews and uniform management of the portfolios for uniform use of the funds provided to the portfolio assets.

Assets slated for disposition, such as "mothballing" and abandonment, with initiation in FY 2007, the disposition process will be completed in FY 2008. The Hypersonic Tunnel Facility (HTF) at Glenn Research Center was scheduled to complete the mothballing process by December 31, 2007. Verification of the HTF mothballing status by Aeronautics Test Program (ATP) management will occur in February 2008. The Marshall Space Center Coating Chamber will complete their disposition process during FY 2008.

In FY 2008, the ATP program within SCAP will be performing an in-depth study of facilities within the ATP portfolio to determine the condition of the assets and the maintenance requirements for immediate and future funding. Other SCAP assets within the Flight Simulation, Thermal Vacuum Chamber and Arc Jet projects will be subjects of the same study.

Program Relevance

NASA has many unique World-class test facilities and engineering capabilities which must be retained to meet the current and future needs of the agency.

SCAP facilities and workforce allow NASA programs to model, design, and test concepts, prototypes, and flight systems in order to reduce mission risks, minimize operational costs, and optimize exploration and science capabilities.

This program supports Outcome SC-1.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Strategic Capabilities Assets Program

Plans For FY 2009

SCAP will concentrate on sustaining needed infrastructure within asset classes and between Centers. SCAP will institute consistency in reimbursable pricing policies, initiate quarterly program reviews for better management insight into the capabilities, and provide a forum for cooperation between all the centers within asset classes.

SCAP will continue the management of assigned capabilities added in FY 2007 and will begin to broaden it's alliances outside of the Agency for such capabilities as thermal vacuum chambers. Organizations such as the Space Environments Simulation Facilities Alliance (SESFA) will help to build NASA's alliances. SCAP will examine and scrutinize new proposals for additional capabilities submitted as part of the FY 2009 budget process.

SCAP is committed to developing and implementing disposition plans for assets within its purview which are no longer required by the Agency.

Project Descriptions and Explanation of Changes

Simulators

This capability includes an array of flight simulator assets at the Ames Research Center (Ames) and the Langley Research Center (Langley). Principal assets include the Vertical Motion Simulator (the world's largest motion system) and its supporting cabs, labs, and equipment at Ames and the Cockpit Motion Facility and its supporting suite of simulators (the Differential Maneuvering Simulator, the Visual Motion Simulator) and other central support facilities at Langley.

Thermal Vacuum Chambers

This capability includes thermal-vacuum, vacuum, and acoustic chambers at NASA facilities (Glenn Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center and Plum Brook Station) that are large enough to accommodate a four foot cube (spacecraft/flight hardware) with adequate space surrounding the structure for safe, easy access while inside the chamber. Chambers with minimum dimensions of 10 ft. by 10 ft. will generally meet this provision. These chambers have the capability of producing pressures of 1 X 10-2 torr or lower, and thermal shrouds capable of LN2 temperatures or lower. Acoustic chambers are capable of generating approximately 150 dB at frequencies in the range of 25 to 1000 Hertz.

Arc-Jets

An arc-jet facility provides ground-based high-enthalpy environments that support the Nation's Design, Development, Test and Evaluation (DDT&E) activities in thermal protection materials, vehicle structures, aerothermodynamics, and hypersonics. A gas (typically air) is heated and accelerated to supersonic/hypersonic speeds by a continuous electrical arc. This high-enthalpy gas passes over a test sample, producing an approximation of the surface temperature and pressure environments experienced by a vehicle on atmospheric entry. The NASA arc-jet complexes are located at Ames Research Center and the Johnson Space Center.

Microgravity Flight Services

Microgravity Flight Services will be managed under SCAP while the Agency reviews the performance of the commercial vendor (contract awarded January 2, 2008. Funding of commercial service will be in SCAP's direct budget.

Aeronautics Test Program (ATP)

The ATP budget is in the Aeronautics Appropriation Account. ATP's purpose is to ensure the strategic availability of a minimum, critical suite of aeronautical test facilities necessary to meet the long-term needs and requirements of the Nation. ATP is responsible for the strategic and business management of the major wind tunnels/ground test facilities at Ames, Glenn, and Langley Research Centers and the Western Aeronautical Test Range (WATR), support aircraft, and test bed aircraft at Dryden Flight Research Center. ATP ensures continuous operations at ATP facilities and appropriate levels of maintenance and investments. A major benefit of this program is that it establishes stable user pricing at its facilities. ATP is responsible for related alliances with the Department of Defense such as the NPAT. This program supports the objective to ensure the continuous availability of a portfolio of NASA-owned wind tunnels/ground test facilities and flight operations/test infrastructure that are strategically important to meeting national aerospace program goals and requirements.

Flight Operations and Test Infrastructure Capability

This project includes the following Dryden Flight Research Center (Dryden) Infrastructure and Capabilities:

1. Test Range Support: This collection of facilities provides radar, telemetry, video, communications, data acquisition and management, mission control, and range safety support for all Dryden flight missions. It is a fundamental capability utilized by all four Mission Directorates.

2. Support Aircraft Maintenance and Operations: This capability supports the maintenance and operations of support aircraft (F-18s, T-38s, T-34, B-200s) required for mission preparation, safety chase, and pilot proficiency. This is an essential capability required to ensure Dryden's flight crew (11 test pilots, 6 other flight crew) retain proficiency and meet aviation safety standards. Access to the Edwards Air Force Base airfields and emergency response services are also covered here.

3. Testbed Aircraft: This capability supports uniquely-configured highly-instrumented research aircraft testbeds at Dryden, used to support all four Mission Directorates in their key flight experiments. Current testbed aircraft include the F-15B, ER-2s, C-20, C-3, 747 SOFIA, DC 8, and Global Hawk UAV aircraft.

SCAP Maintenance

The SCAP Maintenance project provides accounting for funds provided to NASA Centers, specifically for maintenance projects, and to provide the ability to send funding to centers under the SCAP umbrella but funded through Mission Directorates.

High End Computing Capability (HECC)

The HECC project at Ames Research Center is focused around the Columbia supercomputer and the associated network connectivity, data storage, data analysis/visualization, and application software support. The Science Mission Directorate currently funds and manages the HECC resources, which serves the supercomputing needs of all NASA Mission Directorates as well as external users. Science Mission Directorate funding supports the operation, maintenance, and upgrade of NASA's supercomputing capability, while SCAP exercises the oversight and insight functions.

Program Management

The Strategic Capabilities Asset Program Director builds extensive liaisons to coordinate and monitor Mission Directorate and Center management of the SCAP supported facilities.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Strategic Capabilities Assets Program (SCAP)	SCAP Theme Director (Acting) is Richard Wickman at NASA HQ.		

Mission Directorate:	Cross-Agency Support
Theme:	Institutional Investments

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**223.8**	**319.7**	**308.7**	**331.7**	**335.9**	**330.4**	**338.3**
Institutional Construction of Facilities	160.4	243.2	233.9	260.5	269.6	279.1	286.9
Environmental Compliance and Restoration	63.4	76.5	74.8	71.2	66.3	51.3	51.4
FY 2008 President's Budget Request	**211.0**	**319.7**	**323.2**	**331.7**	**335.9**	**330.4**	**--**
Institutional Construction of Facilities	160.4	243.2	251.7	260.4	269.5	279.1	--
Environmental Compliance and Restoration	50.6	76.5	71.5	71.3	66.4	51.3	--
Total Change from FY 2008 Request	**12.8**	**0.0**	**-14.5**	**0.0**	**0.0**	**0.0**	**338.3**

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. The FY 2008 President's Budget Request is shown in direct dollars.

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**12.8**	**--**	**-14.5**	**--**	**--**	**--**	**338.3**
Institutional Construction of Facilities	**--**	**--**	**-17.8**	**--**	**--**	**--**	**286.9**
Programmatic Content	--	--	--	--	--	--	286.9
Programmatic Transfers	--	--	-17.8	--	--	--	--
Environmental Compliance and Restoration	**12.8**	**--**	**3.3**	**--**	**--**	**--**	**51.4**
Programmatic Content	12.8	--	3.3	--	--	--	51.4

Explanation of Program Changes

Institutional Construction of Facilities

FY 2009 reduced to reflect transfer of Strategic IT Infrastructure Investment content to Agency IT Services.

Environmental Compliance and Restoration

FY 2009 increased $3.3M for Strategic Institutional Investments in Energy and Water Effieciency activities.

Mission Directorate:	Cross-Agency Support
Theme:	Institutional Investments

Theme Overview

Institutional Investments funds the critical infrastructure investments required at all NASA installations to safely and efficiently perform the agency's missions. It includes design and execution of non-programmatic Discrete and Minor Revitalization Construction of Facility projects, Facility Demolition projects and Environmental Compliance and Restoration activities.

The Supporting Data Section in the back of this document provides all the CoF information for Programmatic and Non programmtic projects to address the 2008 Omnibus Appropriations Act (Public Law 110-161).

Relevance

Relevance to national priorities, relevant fields, and customer needs:

Institutional Investments funding ensures that NASA's facilities and field installations meet the Agency's infrastructure needs in a safe, secure, and environmentally sound manner. Activities implement sustainable design practices, and support compliance with state and national environmental laws and initiatives outlined under the Energy Policy Act of 2005.

Relevance to the NASA Mission and Strategic Goals:

NASA facilities are essential to the Agency and facility revitalization is needed to maintain infrastructure that is safe and capable of supporting NASA's missions. The facilities being revitalized or constructed in this program are expected to remain active in the long term and are consistent with current and anticipated Agency roles and missions.

Mission Directorate:	Cross-Agency Support
Theme:	Institutional Investments
Program:	Institutional Construction of Facilities

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	160.4	243.2	233.9	260.5	269.6	279.1	286.9
Institutional Construction of Facilities	160.4	243.2	233.9	260.5	269.6	279.1	286.9
FY 2008 President's Budget Request	160.4	243.2	251.7	260.4	269.5	279.1	0
Institutional Construction of Facilities	160.4	243.2	251.7	260.4	269.5	279.1	0
Changes from FY 2008 Request	0.0	0.0	-17.8	0.1	0.1	0.0	286.9

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is shown in direct dollars.

Program Overview

The Institutional Construction of Facilities (CoF) funding provides for the construction, repair, rehabilitation, and modification of the Agency's basic infrastructure and institutional facilities. The program ensures that the basic infrastructure and institutional facilities critical to achieving NASA's space and aeronautics programs are the right size and type, and that they are safe, secure, environmentally sound, and operated efficiently and effectively. It also ensures that NASA installations conform to requirements and initiatives for the protection of the environment and human health.

Program Relevance

NASA facilities are essential to the Agency and facility revitalization is needed to maintain infrastructure that is safe and capable of supporting NASA's missions. The facilities being revitalized or constructed in this program are expected to remain active in the long term and are consistent with current and anticipated Agency roles and missions.

Plans For FY 2009

Detailed plans are included in the Supporting Data Section.

Project Descriptions and Explanation of Changes

Strategic Investments

Changes: FY 2009 includes transfer to Agency IT Services and to Environmental Compliance and Restoration for Strategic Investments in IT Infrastructure and Energy Efficiency activities.

Mission Directorate:	Cross-Agency Support
Theme:	Institutional Investments
Program:	Environmental Compliance and Restoration

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	63.4	76.5	74.8	71.2	66.3	51.3	51.4
Environmental Compliance and Restoration	63.4	76.5	74.8	71.2	66.3	51.3	51.4
FY 2008 President's Budget Request	50.6	76.5	71.5	71.3	66.4	51.3	0
Environmental Compliance and Restoration	50.6	76.5	71.5	71.3	66.4	51.3	0
Changes from FY 2008 Request	12.8	0.0	3.3	-0.1	-0.1	0.0	51.4

Note: FY 2009 President's Budget Request is in direct dollars and represents the July 2007 Operating Plan for the 2007 actual, the 2008 Omnibus Appropriations Act (P.L. 110-161) for the 2008 enacted, and the 5-year Proposed Budget Estimates for 2009 through 2013. FY 2008 President's Budget Request is shown in direct dollars.

Program Overview

The Environmental Compliance and Restoration (ECR) Program provides for personnel, services, and activities necessary to complete the cleanup of hazardous materials and wastes that have been released to the surface or groundwater at NASA installations, NASA-owned industrial plants supporting NASA activities, and other current or former NASA sites where NASA operations have contributed to environmental problems and where the Agency is obligated to contribute to cleanup costs. Program activities include projects, studies, assessments, investigations, plans, designs, related engineering, program support, sampling, monitoring, regulatory Agency oversight costs, and any land necessary to acquire to ensure operation of remedial treatment processes and sites as part of the remediation and cleanup measures.

Program Relevance

The majority of the Environmental Compliance and Restoration Program cleanups are mandated under a variety of federal and state environmental laws and regulations, as well as legally enforceable orders and agreements. Program resources are used to address compliance with environmental management system initiatives as outlined under the Energy Policy Act of 2005 and Executive Order 13423. The program also promotes focused investment in environmental areas that would be of direct benefit to NASA missions and the Agency as a whole. Deferral of these necessary environmental remediation measures would preclude NASA from complying with environmental requirements and regulatory agreements, and could jeopardize NASA operations.

Mission Directorate:	Cross-Agency Support
Theme:	Institutional Investments
Program:	Environmental Compliance and Restoration

Plans For FY 2009

The FY 2009 funding request represents a phased approach in relation to a total Agency environmental cleanup liability approaching one billion dollars that must be addressed within the next several years, for the strategic environmental management initiatives previously noted. Based on relative urgency and potential health hazards and safety, these activities are the highest priority requirements currently planned for accomplishment in FY 2009.

As studies, assessments, investigations, plans, regulatory approvals, and designs progress and as new discoveries or regulatory requirements change, it is expected that priorities may change requiring revisions to planned activities.

Activities with the highest priority requirements planned for accomplishment in FY 2009 include the following:

1) Continue decontamination and demolition of NASA's Plum Brook Reactor Facility;

2) Address groundwater and drinking water issues associated with contamination emanating from NASA's Jet Propulsion Laboratory;

3) Continue cleanup of groundwater contamination at White Sands Test Facility; and

4) Accelerate cleanup of contamination at Santa Susana Field Laboratory.

Project Descriptions and Explanation of Changes

Environmental Management Investments

Changes: FY 2009 includes $3.3M for Strategic Institutional Investments in Energy and Water Efficiency activities.

Mission Directorate:	Cross-Agency Support
Theme:	Congressionally Directed Items

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	--	80.0	--	--	--	--	--
Congressionally Directed Items	--	80.0	--	--	--	--	--
Total Change from FY 2008 Request	**0.0**	**80.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Theme Budget Changes

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**--**	**80.0**	**--**	**--**	**--**	**--**	**--**
Congressionally Directed Items	**--**	**80.0**	**--**	**--**	**--**	**--**	**--**
Programmatic Content	--	80.0	--	--	--	--	--

Theme Overview

Per P.L. 110-161, Consolidated Appropriations for FY 2008, dated December 26, 2007, funding is being provided for congressional directives.

Overview

The NASA Office of Inspector General (OIG) budget request for FY 2009 is $35.5 million. The NASA OIG consists of 203 auditors, analysts, specialists, investigators, and support staff at NASA Headquarters in Washington, DC, and NASA Centers throughout the United States. The FY 2009 request supports the OIG mission to prevent and detect crime, fraud, waste, abuse, and mismanagement while promoting economy, effectiveness, and efficiency within the Agency.

The OIG Office of Audits (OA) conducts independent, objective audits and reviews of NASA and NASA contractor programs and projects to improve NASA operations, as well as a broad range of professional audit and advisory services. It also comments on NASA policies and is responsible for the oversight of audits performed under contract. OA helps NASA accomplish its objectives by bringing a systematic, disciplined approach to evaluate and improve the economy, efficiency, and effectiveness of NASA operations.

The OIG Office of Investigations (OI) identifies, investigates, and refers for prosecution cases of crime, waste, fraud, and abuse in NASA programs and operations. The OIG's federal law enforcement officers investigate false claims, false statements, conspiracy, theft, computer crimes, mail fraud, and violations of federal laws, such as the Procurement Integrity Act and the Anti-Kickback Act. Through its investigations, OI also seeks to prevent and deter crime at NASA.

NASA's FY 2009 OIG request is broken out as follows:

- 82 percent of the proposed budget is dedicated to personnel and related costs, including salaries, benefits, monetary awards, worker's compensation, permanent change of station costs, as well as the Government's contributions for Social Security, Medicare, health and life insurance, retirement accounts, and matching contributions to Thrift Savings Plan accounts. Salaries include the required additional 25 percent law enforcement availability pay for criminal investigators.

- 4 percent of the proposed budget is dedicated to travel, per diem at current rates, and related expenses. The OIG staff is located at 12 offices on or near NASA installations and contractor facilities.

- 14 percent of the proposed budget is dedicated to operations and equipment primarily funding for the Agency's annual financial audit, and also includes funding for training, government vehicles, special equipment for criminal investigators, metro subsidies, and information technology equipment unique to the OIG.

Inspector General

FY 2009 Budget Request

Budget Authority ($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
FY 2009 President's Budget Request	**32.2**	**32.6**	**35.5**	**36.4**	**37.3**	**38.3**	**39.2**
Inspector General	32.2	32.6	35.5	36.4	37.3	38.3	39.2
FY 2008 President's Budget Request	**33.5**	**34.6**	**35.5**	**36.4**	**37.3**	**38.3**	**--**
Inspector General	33.5	34.6	35.5	36.4	37.3	38.3	--
Total Change from FY 2008 President's Budget Request	**-1.3**	**-2.0**	**0.0**	**0.0**	**0.0**	**0.0**	**39.2**

Budget Changes

Budget Authority ($ millions)	Actual FY 2007	Enacted FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Changes	**-1.3**	**-2.0**	**--**	**--**	**--**	**--**	**39.2**
Inspector General	**-1.3**	**-2.0**	**--**	**--**	**--**	**--**	**39.2**
Programmatic Content	-1.3	-2.0	--	--	--	--	39.2

Explanation of Mission Directorate Changes

Inspector General

Inspector General

Programmatic Content:

The Omnibus 2008 Appropriations Act (P.L. 110-161) reduced the FY 2008 budget by $2.0 million.

There have been no changes to FY 2009 and out.

The FY 2009 budget estimates for the IG is a total of $35.5 million:
Personnel and related costs - $29.2 million.
Travel - $1.2 million.
Operations and Equipment - $5.1 million.

OVERVIEW

The Supporting Data section provides information that has been requested in the:

- *Consolidated Appropriations Act, 2008* (P.L. 110-161) and accompanying Explanatory Statement;
- *The NASA Authorization Act of 2005* (P.L. 109-155);
- Reimbursable Estimates by Appropriation;
- Summary of Consulting Services;
- OMB Circular A-11, Sections 22.6 and 53.5 E-Gov Benefits and Initiatives

Consolidated Appropriations Act, 2008 as reported in the Senate P.L.110-161

Bill Language:

For fiscal year 2009 and hereafter, the National Aeronautics and Space Administration shall provide, at a minimum, the following information in its annual budget justification:

(1) The actual, current, proposed funding level, and estimated budgets for the next five fiscal years by directorate, theme, program, project and activity within each appropriations account.

(2) The proposed programmatic and non-programmatic construction of facilities.

(3) The budget for headquarters including--

(A) the budget by office, and any division thereof, for the actual, current, proposed funding level, and estimated budgets for the next five fiscal years;

(B) the travel budget for each office, and any division thereof, for the actual, current, and proposed funding level; and

(C) the civil service full time equivalent assignments per headquarters office, and any division thereof, including the number of Senior Executive Service, noncareer, detailee, and contract personnel per office.

(4) Within 14 days of the submission of the budget to the Congress an accompanying volume shall be provided to the Committees on Appropriations containing the following information for each center, facility managed by any center, and federally funded research and development center operated on behalf of the National Aeronautics and Space Administration:

(A) the actual, current, proposed funding level, and estimated budgets for the next five fiscal years by directorate, theme, program, project, and activity;

(B) The proposed programmatic and non-programmatic construction of facilities;

(C) The number of civil service full time equivalent positions per center for each identified fiscal year; and

(D) The number of civil service full time equivalent positions considered to be uncovered capacity at each location for each identified fiscal year.

(5) The proposed budget as designated by object class for each directorate, theme, and program.

(6) Sufficient narrative shall be provided to explain the request for each program, project, and activity, and an explanation for any deviation to previously adopted baselines for all justification materials provided to the Committees.

P.L.110-161 (1) The actual current, proposed funding level, and estimated budgets for the next five fiscal years by directorate, theme, program, project and activity within each appropriations account.

Please refer to Mission Directorate, Theme, Program and Project sections in this volume.

P.L.110-161 (2) Programmatic and Non-Programmatic Construction of Facilities

SUMMARY OF RESOURCES INCLUDED IN BUDGET REQUEST

In Millions of Dollars	FY 2007	FY 2008	FY 2009
Total Construction of Facilities	**374.9**	**363.6**	**345.7**
Science	58.7	39.9	
Exploration	89.8	76.9	95.5
Space Operations	24.0	3.6	16.3
Cross-Agency Support	42.0		
Institutional Investments	160.4	243.2	233.9

The Construction of Facilities (CoF) program ensures that the facilities critical to achieving NASA's space and aeronautics programs are the right size and type, and that they are safe, secure, environmentally sound, and operated efficiently and effectively. It also ensures that NASA installations conform to requirements and initiatives for the protection of the environment and human health. NASA facilities are essential to the Agency and facility revitalization is needed to maintain infrastructure that is safe and capable of supporting NASA's missions. The facilities being revitalized or constructed in this program are expected to remain active in the long term and are consistent with current and anticipated Agency roles and missions.

Funding for construction projects required for specific programs is included in the appropriate budget line item within each Mission Directorate and summarized herein as program direct projects. Institutional CoF projects, also summarized herein, are required for components of NASA's basic infrastructure and institutional facilities. Funding for Institutional CoF projects is included within the Agency's Institutional Investment account. Descriptions and cost estimates of FY 2009 institutional and programmatic projects are provided to show a complete picture of NASA's budget requirement for facilities revitalization and construction.

The institutional facility projects requested for FY 2009 continue the vital rehabilitation, modification, and repair of facilities to renew and help preserve and enhance the capabilities and usefulness of existing facilities and ensure the safe, economical, and efficient use of NASA's physical plants. The projects repair and modernize deteriorating and obsolete building and utility systems that have reached or exceeded their normal design life, are no longer operating effectively or efficiently, and cannot be economically maintained. These projects include mechanical, structural, cooling, steam, electrical distribution, sewer, and storm drainage systems. Some projects replace substandard facilities in cases where it is more economical to demolish and rebuild than it is to restore. Projects with initial cost estimates between $0.5 million and $5.0 million are included as Minor Revitalization and Construction projects, and projects with initial cost estimates of at least $5.0 million are budgeted as discrete projects. Projects with initial cost estimates of less than $0.5 million are accomplished by routine day-to-day facility maintenance and repair activities provided for in program and Center operating budgets. Funds requested for Facility Planning and Design (FP&D) cover: advance planning and design requirements for future projects; preparation of facility project design drawings and bid specifications; master planning; facilities studies; engineering reports and studies; and critical functional leadership activities directed at increasing the rate of return of constrained Agency resources while keeping the facility infrastructure safe, reliable, and available.

The projects that comprise this request are of the highest priority based on relative urgency and expected return on investment. The titles of the projects are designed to identify the primary intent of each project and may not always capture the entire scope or description of each project. During the year, some rearrangement of priorities may be necessary which may force a change in some of the items to be accomplished. Also, should residual CoF resources become available they will be used for urgently needed facility revitalization requirements. Any such changes, however, will be accomplished within the total resources available and Congress will be notified before work is initiated for any new construction project that is estimated to cost $5 million or greater.

SUMMARY OF FY 2009 PROGRAMMATIC COF PROJECTS

In Millions of Dollars	FY 2007	FY 2008	FY 2009
SCIENCE	**58.7**	**39.9**	**----**
Construct Exploration Sciences Building (GSFC)	30.0	20.0	----
Construct Flight Projects Center (JPL)	26.8	14.2	----
Minor Revitalization of Facilities at Various Locations (less than $5M per project)	1.9	5.7	
EXPLORATION	**89.8**	**76.9**	**95.5**
Modify Launch Complex 39B for ARES 1 Vehicles (KSC)	33.3	----	21.7
Modify Multi-Payload Processing Facility for Crew Exploration Vehicle (KSC)	----	----	7.7
Modify Vehicle Assembly Building (KSC)	----	31.2	2.5
Construct Vertical Assembly & Welding Highbay in Building 103, MAF (MSFC)	----	----	25.7
Modify Building 103 to Support Upper Stage Manufacturing, MAF (MSFC)	----	----	17.4
Enlarge Acoustic Chamber at Space Power Facility (GRC)	9.0	4.0	----
Construct Crew Exploration Vehicle Avionics and Integration Lab (JSC)	----	22.0	----
Modify A-1 Propulsion Test Facility (KSC)	----	6.6	----
Construct A-3 Propulsion Test Facility (SSC)	19.3	----	----
Minor Revitalization of Facilities at Various Locations (less than $5M per project)	9.4	7.2	18.3
Facility Planning and Design	18.8	5.9	2.2
SPACE OPERATIONS	**24.0**	**3.6**	**16.3**
Repairs to Vehicle Assembly Building (KSC)	14.1	----	----
Minor Revitalization of Shuttle Facilities at Various Locations (less than $5M per project)	6.0	----	----
Minor Revitalization of SFS Facilities at Various Locations (less than $5M per project)	2.8	3.3	3.9
Minor Revitalization of DSN Facilities at Various Locations (less than $5M per project)			12.1
SFS Facility Planning and Design	1.1	0.3	0.3
CROSS-AGENCY SUPPORT	**42.0**	----	----
Modifications to Space Power Facility	42.0	----	----

Supporting Data: Construction of Facilities

SUMMARY OF FY 2009 NON-PROGRAMMATIC COF PROJECTS

In Millions of Dollars	FY 2007	FY 2008	FY 2009
CROSS-AGENCY SUPPORT (INSTITUTIONAL)	**160.4**	**243.2**	**233.9**
Construct Collaborative Support Facility, Building N232 (ARC)	----	----	29.0
Repair and Construct Consolidated Information Technology Center (DFRC)	----	----	5.8
Upgrade Auxiliary Chiller Plant (JSC)	----	----	7.5
Revitalize Electrical Maintenance Complex (KSC)	----	----	5.9
Renovation of Operations & Checkout Building (KSC)	9.0	11.0	11.0
Construct Replacement Propellants North Maintenance Facility (KSC)	----	----	5.0
Replace Asbestos Siding and Provide Energy/Safety Upgrades, Building 4707 (MSFC)	----	----	10.9
Construct New Office Facility (JSC)	15.0	11.9	----
Construct Replacement Administrative Office Building (LaRC)	----	28.8	----
Construct Replacement Engineering Building (MSFC)	----	30.0	----
Replace Asbestos Siding and Provide Energy/Safety Upgrades, Building 4705 (MSFC)	----	8.9	----
Repair Emergency Chiller System, Building 23 (GSFC)	3.3	----	----
Upgrade Roads for Master Plan (GSFC)	6.4	----	----
Construct Flight Projects Center (JPL)	1.0	----	----
Rehabilitate Building Systems, Building 4207 (MSFC)	9.9	----	----
Minor Revitalization of Facilities at Various Locations (less than $5M per project)	75.1	104.5	97.4
Facility Planning and Design	14.8	12.8	23.7
Demolition of Facilities	10.1	14.4	15.0
Labor & Travel	15.8	20.9	22.7

PROGRAMMATIC DISCRETE PROJECTS

Project Title: Modify Launch Complex 39B for ARES 1 Vehicles

Location: Kennedy Space Center, Merritt Island, Florida

Mission Directorate: Exploration Systems

FY 2009 Estimate: $21.7M

This project modifies and upgrades Launch Complex 39B to support launch of Constellation ARES I crew launch vehicles. Launch Complex 39B is currently configured to support launch of the Space Shuttle. The differences in vehicle architecture between ARES I and Shuttle are significant enough to necessitate considerable changes to the existing launch complex. Implementation of these changes is critical to enable safe and affordable operation of the ARES I crew launch vehicle. The $38.4 million first phase of this project is already underway and is funded using fiscal year 2006 and 2007 resources. This phase increases total funding to $60.1 million. If additional facility changes are required as a result of changes to the overall system architecture or if costly unforeseen field conditions are encountered, NASA will pursue additional funding in subsequent fiscal years.

Project Title: Modify Multi-Payload Processing Facility for Crew Exploration Vehicle

Location: Kennedy Space Center, Merritt Island, Florida

Mission Directorate: Exploration Systems

FY 2009 Estimate: $7.7M

This project modifies and upgrades the Multi-Payload Processing Facility to enable off-line Orion spacecraft processing for hazardous fueling operations as well as non-hazardous cargo loading and system testing. The capability to conduct hazardous operations of the Orion spacecraft offline will provide a safer environment for personnel conducting the hazardous operations, a four-day critical path reduction for launch processing, and a rollback and de-servicing capability for contingency operations. These capabilities are critical requirements to enable safe and affordable deployment of the Orion Crew Exploration Vehicle and cannot be economically accommodated in any other facility. If additional facility changes are required as a result of changes to the overall system architecture or if costly unforeseen field conditions are encountered, NASA will pursue additional funding in subsequent fiscal years.

Project Title: Modify Vehicle Assembly Building

Location: Kennedy Space Center, Merritt Island, Florida

Mission Directorate: Exploration Systems

FY 2009 Estimate: $2.5 M

This project modifies the Vehicle Assembly Building to accommodate assembly of the ARES I crew launch vehicles. This is the second increment of a multi-year funded project. The $31.2 million first increment of this project is funded with FY 2008 resources. The original description provided to Congress for the first increment reflected plans at the time to modify the existing work platforms, lifting devices, lighting, and other building infrastructure systems. Trade studies performed as part of preliminary engineering work determined it would be more cost effective to replace the existing platforms rather than modify them. Additional facility modifications have also been identified that are critical to enable the safe and affordable operation of the ARES I crew launch vehicle. This second increment increases total funding to $33.7 million. Total project cost is estimated to be about $55-60 million.

Project Title: Construct Vertical Assembly & Welding Highbay in Building 103

Location: Michoud Assembly Facility (MAF), New Orleans, Louisiana

Mission Directorate: Exploration Systems

FY 2009 Estimate: $25.7M

This project provides for the construction of a new high-bay addition to the main manufacturing and assembly facility (Building 103) at MAF. The 100 feet by 140 feet by 150 feet high addition will be used to support vertical production and welding of an integrated upper stage including the liquid oxygen and hydrogen tanks, common bulkhead and end domes. This addition will provide adequate height for welding and assembly and will be able to accommodate vertical circumferential and longitudinal welders. Vertical stacking and horizontal break-over will also be performed in the addition. The project provides the envelope, mechanical, electrical and safety systems and two overhead bridge cranes.

Project Title: Modify Building 103 to Support Upper State Manufacturing

Location: Michoud Assembly Facility, New Orleans, Louisiana

Mission Directorate: Exploration Systems

FY 2009 Estimate: $17.4M

This project provides for modifications to Building 103 at MAF for horizontal welding, reaction control system assembly, avionics integration, test and assembly, machining, and common bulkhead assembly and cleaning. The project will modify various locations in Building 103 to accommodate robotic weld tools, humidity and temperature controlled environments, heavy machinery, ovens, and cleaning tanks. Modifications will include the installation of mass foundations, various mechanical systems such as shop air, pneumatics, hydraulics, and electrical systems such as power, lighting and grounding.

NON-PROGRAMMATIC DISCRETE PROJECTS

Project Title: Construct Collaborative Support Facility, Building N232

Location: Ames Research Center, Moffett Field, CA

FY 2009 Estimate: $29.0M

This project provides for the construction of a new 75,000 square foot mission support staff facility to replace the existing facilities. The existing aging facilities are in a poor and unsafe condition, as well as extremely costly to maintain. Building N232 will provide one single state-of-the-art conferencing, audio/visual laboratory and office space for approximately 288 support staff who are currently scattered throughout the Center. This will improve operational efficiencies. The facility will be energy efficient and sustainable, meeting the United States Green Building Council Leadership in Energy and Environmental Design (LEED) Silver Rating. The completed building will provide a collaborative environment for the Center mission support staff. Ames will demolish an equal 75,000 square feet of aging, substandard and antiquated existing facilities and trailers as part of this project.

Project Title: Repair and Construct Consolidated Information Technology Center

Location: Dryden Flight Research Center, Kern County, California

FY 2009 Estimate: $5.8M

This project constructs 11,300 square feet of new computer operations space and refurbishes electrical and mechanical systems and architectural finishes in an existing data processing facility. The project also provides for emergency power to the Information Technology Center. The project will consolidate data processing functions currently done at five separate sites to a single location. The Consolidated Information Technology Center will improve operational efficiency and increase reliability to 99.99 percent, thereby reducing data loss and data corruption. The new facility will also enhance security for critical data and IT assets. This project is a follow on to the FY 2008 project "Construct Consolidated Information Technology Center."

Project Title: Upgrade Auxiliary Chiller Plant

Location: Johnson Space Center, Houston, Texas

FY 2009 Estimate: $7.5M

The project provides a new open drive 2,000 ton centrifugal water chiller with gear box, 4,160 volt drive motor, compressor, evaporator and condenser sections, and a new control panel. The existing cooling tower will be expanded to provide a new 6,000 gallon per minute masonry cooling tower cell, including basin, poly vinyl chloride fill, drift eliminators, wind brake partitions, fan, gear box, electric drive motor, condenser water pump and access stairs. Project requires a new 2500 kva transformer, and medium voltage motor starter cabinet for the chiller drive motor. The plant will be extended one bay to the north and includes new pre-cast exposed aggregate facing panels to match the existing building. It will provide for: relocation of the existing roll up door; a new bridge crane for the new bay or modification of the existing crane to serve the new chiller; new lighting, fire detection monitors; new exhaust fan and supply fan; extension of the chilled and condenser water piping; and extension of the refrigerant liquid and gas piping to the new chiller. The new bay will require some site work which includes grading, relocation of landscaping, and construction of an access to Building 27 mechanical room. It will also include relocation of underground utilities. The project also provides a new electrical feeder from the site substation to the Building 28 auxiliary chiller plant.

The Auxiliary Chiller plant, Building 28 was originally built for the addition of another chiller. Current site load has increased. With the addition of the new Office Building 20 and the construction of the Crew Exploration Vehicle Avionic Integration Lab in Building 29, additional chiller capacity is needed to provide reliable site capacity cooling. This has been verified through a recent hydraulic load analysis of the chill water distribution system.

Project Title: Revitalize Electrical Maintenance Complex

Location: Kennedy Space Center, Merritt Island, Florida

FY 2009 Estimate: $5.9M

This project will renew and “right size” the Electrical Maintenance Complex that provides maintenance shop space, office space, and equipment and material storage space in support of the electrical maintenance function. The existing facilities have indoor air quality problems due to high humidity, inadequate ventilation, mold growing behind finished walls, and water-damaged carpet and ceiling tiles. This situation poses a threat to employee health and safety and is costly to mitigate on a recurring basis. The existing facilities are also costly to sustain in their present configuration because they are disjointed, in poor physical condition, and functionally inadequate for their designated use. Through a combination of renovation, new construction, and demolition, this project will eliminate the stated deficiencies.

Project Title: Renovation of Operations and Checkout Building

Location: Kennedy Space Center, Merritt Island, Florida

FY 2009 Estimate: $11.0M

This project revitalizes the Operations and Checkout Building for indoor air quality, energy efficiency and life safety compliance in various locations. The revitalization will consist of installing a sprinkler system, energy-efficient office lighting, complete updating of the Heating, Ventilation, and Air Conditioning (HVAC) systems and demolishing the existing HVAC ductwork that contributes to poor indoor air quality and asbestos abatement. Other facility systems include HVAC controls, lighting and fire protection. This phase will include the demolition and renovation of a portion of the north wing, and replacement of the north wing roof and lower roofs between the north and south wings. In addition, this project will upgrade employees' office areas, including power, communications and data systems. A critical need exists at the Kennedy Space Center to revitalize substandard facilities affecting the health, safety and welfare of personnel. The deteriorated substandard facilities are contributing to costly maintenance requirements, highly inefficient energy consumption and unhealthy working environments. The facility has not been updated to current Florida Building Codes, Florida Fire Prevention Codes, or National Fire Protection Association Life Safety Standards.

This project will relieve personnel of the health dangers associated with poor Indoor Air Quality and Building Related Illnesses. An increase in space utilization will be realized. This is the fourth of five phases with a total estimated construction cost of $55 million and the last phase planned for FY 2010.

Project Title: Construct Replacement Propellants North Maintenance Facility

Location: Kennedy Space Center, Merritt Island, Florida

FY 2009 Estimate: $5.0M

This project will construct a new administration and maintenance facility of approximately 10,000 square feet to provide essential administration office space, maintenance shop and receiving area in support of the north propellant operations. The three existing buildings (K7-416, K7-416A and K7-416B) will be demolished. The current conditions of these facilities pose a threat to employee health and safety. This project also includes the addition of a Paging and Area Warning system (pole mounted strobes and speakers) to existing outdoor propellant transfer pads for life safety issues.

Project Title: Replace Asbestos Siding and Provide Energy/Safety Upgrades to Building 4707

Location: Marshall Space Flight Center, Huntsville, Alabama

FY 2009 Estimate: $10.9M

This project includes upgrades to mechanical and electrical distribution systems that no longer meet the current and future operational needs of this facility. Electrical systems will be modified as required to meet current fire and life safety codes. Air handling units will be replaced, centralized and/or supplemented. The mechanical and electrical systems will be added to the Utility Control System network for automated control for improved energy conservation. Three existing chilled water piping systems from the central chiller plant will be re-routed/replaced to a single location. Steam will be converted to hot water for heating the facility. This project will contribute toward meeting MSFC's requirement to operate at or below the established 2010 energy efficiency goals and will also reduce deferred maintenance, enhance indoor air quality, and optimize operational and maintenance practices.

Building 4707 offers unique capabilities not otherwise available on or off-site. It is defined as a "Significant" mission support facility and will continue to be a showcase of unique technological capabilities. This building houses the highest state-of-the-art equipment that supports both national collaborative strategies and joint programs for manufacturing research and development including the National Center for Advanced Manufacturing. The facility does not provide an adequate environment for its current functions and will not support future functions. Mechanical systems are fragmented and subject to breakdown, while operating, maintenance, and repair costs are increasing.

INSTITUTIONAL MINOR REVITALIZATION AND CONSTRUCTION OF FACILITIES (PROJECTS LESS THAN $5.0M EACH)

	Institutional Investments	Program
FY 2009 Estimate (Millions of Dollars)	97.4	34.3
Ames Research Center	11.1	
Dryden Flight Research Center	4.0	
Glenn Research Center	13.3	
Goddard Space Flight Center	16.1	
Jet Propulsion Laboratory	11.1	12.1
Johnson Space Center	15.1	
Kennedy Space Center	3.7	3.9
Langley Research Center	11.2	
Marshall Space Flight Center	4.9	13.6
Stennis Space Center	6.9	4.7

This request includes facility revitalization and construction needs with initial cost estimates greater than $0.5 million but less than $5.0 million per project. Projects with initial cost estimates of $0.5 million and less are normally accomplished by routine day-to-day facility maintenance and repair activities provided for in direct program and Center operating budgets. Proposed FY 2009 institutional minor revitalization and construction projects total $97.4 million for components of the basic infrastructure and institutional facilities, funded in Institutional Investments, and $34.3 million for program-funded projects. These resources provide for revitalization and construction of facilities at NASA field installations and government-owned industrial plants supporting NASA activities. Revitalization and modernization projects provide for the repair, modernization, and/or upgrade of facilities and collateral equipment. Repair projects restore facilities and components to a condition substantially equivalent to the originally intended and designed capability. Repair and modernization work includes the substantially equivalent replacement of utility systems and collateral equipment necessitated by incipient or actual breakdown. It also includes major preventive measures that are normally accomplished on a cyclic schedule and those quickly needed out-of-cycle based on adverse condition information revealed during predictive testing and inspection efforts. Modernization and upgrade projects include both restoration of current functional capability and enhancement of the condition of a facility so that it can more effectively accomplish its designated purpose or increase its functional capability or so that it can meet new building, fire, and accessibility codes.

The minor revitalization and construction projects that comprise this request are of the highest priority, based on relative urgency and expected return on investment. The titles of the projects are designed to identify the primary intent of each project and may not always capture the entire scope or description of each project. Also, during the year, some rearrangement of priorities may be necessary which may cause a change in some of the items to be accomplished.

INSTITUTIONAL MINOR REVITALIZATION PROJECTS: $97.4 MILLION

A. Ames Research Center (ARC), $11.1 million for the following:

1. Upgrades for Seismic N213 & N243
2. Restoration Electrical Distribution System Phase 7B
3. Improvements to Electrical Supply Reliability (NASA Advanced Supercomputing Facility) Phase II Bldg N258
4. Improvements to Electrical Supply Reliability (NASA Advanced Supercomputing Facility) Phase IB Bldg N258
5. Improvements to Life Safety N220, N237
6. Replace Fire Alarm, N246

B. Dryden Flight Research Center (DFRC), $4.0 million for the following:

1. Repair Aircraft Ramps, Various Locations
2. Repair Fire Mains

C. Glenn Research Center (GRC), $13.3 million for the following:

1. Upgrade Security Requirements for GRC/Lewis Field Main Gate Area, Phase 2
2. Repair Steam Regulator Stations, Phase 2
3. Repair of Space Power Facility Test Building No. 1411 Institutional Systems, Plum Brook Station
4. Repair of GRC Main Steam Plant, Building No. 12
5. Repair Roof, Engineering Bldg. #7141, Plum Brook Station
6. Repair Steam Regulator Station, Phase 2

D. Goddard Space Flight Center (GSFC), $16.1 million for the following:

1. Replacement of Fire Detection System, Wallops Island
2. Replace Load Center, Building 13, Greenbelt
3. Replace Building 16 Complex, Greenbelt
4. Launch Facility Protection, Wallops Island
5. Repair Site Steam Distribution System, Greenbelt and Wallops
6. Restoration of Site Steam Distribution, Phase VII, Greenbelt

E. Jet Propulsion Laboratory (JPL), $11.1 million for the following:

1. Upgrade Thermal Vacuum Test Lab, B144
2. Upgrade 2.4 kV Electrical Distribution System, Phase 8
3. Replace LN2 Tank 10
4. Replace GN2 Storage System and Piping
5. Replace Hi-Voltage Cables

F. Johnson Space Center (JSC), $15.1 million for the following:

1. Upgrade B32 Cranes for Critical Lift
2. Replace Uninterruptible Power Supply, Building 46
3. Replace Roofs, Various Buildings
4. Repair & Upgrade 100 and 400 Areas, WSTF, Phase 1B
5. Rehab Fire Alarm and Detection Systems, WSTF
6. Upgrades and Repair Fire Suppression Sprinkler & Fire Alarm Systems, Var. Buildings, Phase 7B
7. Repair Sprinkler & Fire Alarms System
8. Rehab & Modernize HVAC System, Building 32
9. Rehab Mechanical Systems, WSTF

G. Kennedy Space Center (KSC), $3.7 million for the following:

1. Construct Replacement Operations Building, Fuel Storage Area No. 1, CCAFS
2. Replace Fire Alarms, Various Locations, CCAFS

H. Langley Research Center (LaRC), $11.2 million for the following:

1. Upgrade Fire Suppression Systems, Various Facilities
2. Upgrade Sewer System and Utilities
3. Replace Electrical Systems, Various Facilities
4. Replace Electrical Power Cables, Various Facilities
5. Rehabilitate Roofs, Various Facilities
6. Rehabilitate Heating and Air Conditioning Systems, B1244
7. Repair Roads and Parking Lots

I. Marshall Space Flight Center (MSFC), $4.9 million for the following:

1. Repair Electrical Distribution, South Campus, Phase 1
2. Repair/Replace Steam Generation & Distribution South of Fowler Road
3. Repair/Replace Roofs (4201, 4250, 4727, 4207)

J. Stennis Space Center, $6.9 million for the following:

1. Refurbish High Pressure Gas Distribution
2. Modifications to Security Gates
3. Repairs to High and Low Voltage Electrical Systems, B1100 & Other Locations

PROGRAMMATIC MINOR REVITALIZATION PROJECTS: $34.3 MILLION

EXPLORATION

A. Marshall Space Flight Center (MSFC), $13.6 million for the following:

1. Modifications to Aft Dome Thrust Cone Structural Test for US Bldg 4572 (CLV)
2. Modification for Internal Tank Cleaning with SOLGEL Bldg 4707 (CLV)
3. Modification to MPTA Facility Vertical Weld Bldg 4707 (CLV)
4. Modification for MPTA Final Assembly Bldg 4708 (CLV)
5. Modification for Upper Stage Internal; Cleaning Bldg 110, MAF (CLV)
6. Modification for Thermal Protection System, Cell N Bldg 131, MAF (CLV)
7. Modification MPTA Reactive Stage Test Facility Bldg 4670 (CLV)

B. Stennis Space Center (SSC), $4.7 million for the following:

1. Modify Propulsion Test facility A-1 (CLV)
2. Modify Propulsion Test facility A-2 (CLV)
3. Modify Propulsion Test facility B-2 (CLV)

SPACE OPERATIONS

A. Jet Propulsion Laboratory (JPL), $12.1 million for the following:

1. Replace 70M Hoists, 70M Subnet (DSN)
2. Extend DSS-65 Antenna Life 34M HEF, Madrid, Spain (DSN)
3. Refurbishment of 70M Radial Bearing Wear Strips, 70M Subnet, Phase 1 (DSN)
4. Upgrade 70M Azimuth Gearbox Support System, 70M Subnet (DSN)
5. Replacement of HVAC Controls, Goldstone, CA (DSN)
6. Upgrade Apollo & Venus Fire Protection Goldstone, CA (DSN)
7. Refurbish HVAC System Bldg. 300-900, Madrid, Spain (DSN)

8. Upgrade Fire Protection System, Madrid, Spain (DSN)
9. Modify Power Distribution System, Madrid Spain (DSN)
10. Construct Upgrades to Sitewide UPS Implementation Goldstone, CA (DSN)

B. Kennedy Space Center (KSC), $3.9 million for the following:

1. Upgrade Electrical Distribution, Vandenberg AFB (LSP)
2. Renovate AE Lobby (LSP)
3. Renovate AE Electrical (LSP)
4. Revitalize PHSF Roof & Gutters (LSP)

Facility Planning and Design (FP&D)

Cognizant Office: Office of Infrastructure and Administration

FY 2009 Estimate: $23.7M

These funds are required to provide for: advance planning and design activities; special engineering studies; facility engineering research; preliminary engineering efforts required to initiate design-build projects; preparation of final designs, construction plans, specifications, and associated cost estimates; and participation in facilities-related professional engineering associations and organizations. These resources provide for project planning and design activities associated with non-programmatic construction projects. Project planning and design activities for construction projects required to conduct specific programs or projects are included in the appropriate budget line item. Other activities funded include: master planning; value engineering studies; design and construction management studies; facility operation and maintenance studies; facilities utilization analyses; engineering support for facilities management systems; and capital leveraging research activities.

Demolition of Facilities

Cognizant Office: Office of Infrastructure and Administration

FY 2009 Estimate: $15.0M

The amount requested is required to fund major demolition projects Agency-wide. NASA owns over 2,500 buildings, and over 2,300 other structures, totaling more than 40 million square feet with a current replacement value of over $24 billion. About 420 of these facilities are "mothballed" or "abandoned." Closed facilities are a drain on NASA resources and should be demolished because they can deteriorate into potential safety hazards. Demolition projects have accounted for a significant deferred maintenance reduction and have an estimated payback period of seven years.

P.L.110-161 (3) (A) Headquarters Agency Management and Operations Budget

The budget for Headquarters is a portion of the Agency Management Program within the Agency Management and Operations Theme. It includes all of the salaries and travel budgets for Headquarters employees, as well as procurement funding for any Headquarters support contractors. It also includes funding for key support functions that are performed at the Centers, such as the Regional Finance Office at Goddard Space Flight Center, that executes core Headquarters finance and procurement functions.

Summary of Headquarters Budget by Office

Headquarters Management & Operations Budget by Office ($ in millions)	**FY 2007 Actual**	**FY 2008 Enacted**	**FY 2009 Est.**	**FY 2010 Est.**	**FY 2011 Est.**	**FY 2012 Est.**	**FY 2013 Est.**
Total Headquarters Corporate Management & Operations	**285.6**	**305.4**	**347.5**	**354.9**	**362.4**	**370.1**	**378.0**
Office of the Administrator	3.5	3.1	3.4	3.6	3.7	3.9	4.1
Science Mission Directorate	20.9	23.9	26.6	27.7	29.0	30.6	32.2
Aeronautics Research Mission Directorate	5.8	5.8	6.5	6.8	7.1	7.5	7.9
Exploration Systems Mission Directorate	12.7	14.9	16.6	17.3	18.1	19.0	19.9
Space Operations Mission Directorate	13.3	15.3	16.9	17.7	18.5	19.4	20.4
Office of Safety and Mission Assurance	6.1	6.0	6.7	7.0	7.3	7.7	8.1
Office of Chief Engineer	3.1	3.5	4.0	4.2	4.4	4.6	4.9
Office of Chief Health & Medical Officer	1.3	1.2	1.4	1.5	1.5	1.6	1.7
Office of Chief Information Office	3.8	5.2	5.9	6.2	6.5	6.9	7.2
Office of Innovative Partnership Program	1.4	1.6	1.8	1.9	2.0	2.1	2.2
Office of Chief Financial Officer	11.2	14.0	16.0	16.8	17.6	18.6	19.6
Office of Program Analysis and Evaluation	8.9	10.4	11.8	12.4	13.1	13.8	14.5
Office of the General Counsel	7.7	7.9	9.2	9.7	10.1	10.6	10.8
Office of Security and Program Protection	5.0	4.6	7.5	7.8	8.2	8.7	9.2
Office of Program and Institutional Integration	10.2	8.2	11.0	10.9	10.9	11.1	11.4
Office of Institutions and Management (includes HQ Operations costs)							
Institutions and Management	90.3	104.8	120.2	121.1	119.5	115.5	112.9
Infrastructure and Administration	26.1	27.5	29.7	30.6	31.9	33.3	34.8
Human Capital Management	6.9	7.2	8.1	7.8	8.1	8.5	8.8
Diversity and Equal Opportunity	3.4	3.9	5.5	4.1	4.1	4.3	4.4
Procurement	6.7	6.0	6.6	6.9	7.0	7.4	7.6
Small Business Programs	1.7	1.5	1.5	1.5	1.5	1.5	1.5
Internal Controls	1.4	2.3	2.5	2.5	2.6	2.7	2.8
Office of Strategic Communications							
Strategic Communications	0.5	0.6	0.6	0.6	0.6	0.6	0.6
Public Affairs	14.5	7.9	7.9	7.9	7.9	7.9	7.9
Legislative & Intergovernmental Affairs	3.6	3.5	3.7	3.9	4.1	4.3	4.4
Education	3.4	2.6	2.7	2.9	3.0	3.2	3.3
Communications Planning	3.0	1.8	2.1	2.2	2.2	2.3	2.4
Office of External Relations	9.3	9.9	11.1	11.5	11.8	12.3	12.5

P.L.110-161 (3)(B) Headquarters Travel Budget

Summary of Headquarters Travel Budget

Headquarters Travel Budget ($ in millions)	FY 2007 Actual	FY 2008 Current	FY 2009 Estimated
Total Travel	**10.9**	**10.2**	**9.2**
Office of the Administrator	0.3	0.5	0.4
Science Mission Directorate	1.2	1.5	1.2
Aeronautics Research Mission Directorate	0.5	0.5	0.4
Exploration Systems Mission Directorate	1.8	1.5	1.5
Space Operations Mission Directorate	1.6	1.6	1.4
Office of Safety and Mission Assurance	0.4	0.4	0.3
Office of Chief Engineer	0.2	0.2	0.2
Office of Chief Health & Medical Officer	0.1	0.1	0.1
Office of Chief Information Office	0.3	0.3	0.3
Office of Innovative Partnership Program	0.1	0.1	0.1
Office of Chief Financial Officer	0.6	0.4	0.5
Office of Program Analysis and Evaluation	0.3	0.3	0.2
Office of the General Counsel	0.1	0.1	0.1
Office of Security and Program Protection	0.4	0.1	0.1
Office of Program and Institutional Integration	0.3	0.2	0.1
Office of Institutions and Management			
Institutions and Management	0.2	0.1	0.1
Infrastructure and Administration	0.5	0.5	0.5
Human Capital Management	0.2	0.1	0.1
Diversity and Equal Opportunity	0.1	0.1	0.1
Procurement	0.2	0.2	0.2
Small Business Programs	0.1	0.1	0.1
Internal Controls	0.0	0.0	0.0
Office of Strategic Communications			
Strategic Communications	0.0	0.1	0.0
Public Affairs	0.2	0.2	0.2
Legislative & Intergovernmental Affairs	0.1	0.1	0.1
Education	0.2	0.2	0.2
Communications Planning	0.0	0.0	0.0
Office of External Relations	0.8	0.8	0.7

P.L.110-161 (3)(C) Headquarters FTE Assignments

Headquarters FTE assignments by office shown below include all civil servants assigned to Headquarters, including Senior Executive Service (SES) and Non-Career employees. As the number and assignments for detailees varies significantly throughout the year, FTE for detailees are included in the total FTE numbers shown for their home center. Contractor workforce data is not shown because the data has not been collected by office. NASA will provide Contractor workforce data in the FY 2010 Budget Estimates.

Summary of Headquarters FTE Assignments by Office

	FY 2007			FY 2008			FY 2009		
	Total FTE	SES	Non-Career	Total FTE	SES	Non-Career	Total FTE	SES	Non-Career
Total Headquarters Civil Servants (FTEs)	**1240**	**129**	**59**	**1260**	**154**	**48**	**1240**	**154**	**59**
Office of the Administrator	25	7	5	20	7	6	20	7	7
Science Mission Directorate	151	18	2	157	19	1	156	19	2
Aeronautics Research Mission Directorate	42	7	2	38	8	2	38	8	3
Exploration Systems Mission Directorate	88	9	2	96	11	1	95	11	2
Space Operations Mission Directorate	95	10	2	98	9	2	98	9	2
Office of Safety and Mission Assurance	42	5	0	37	5	0	37	5	0
Office of Chief Engineer	23	7	0	23	9	0	23	9	0
Office of Chief Health & Medical Officer	10	2	0	9	1	0	9	1	0
Office of Chief Information Office	26	2	2	34	5	0	34	5	0
Office of Innovative Partnership Program	10	1	0	11	1	0	11	1	0
Office of Chief Financial Officer	96	9	7	108	12	7	108	12	7
Office of Program Analysis and Evaluation	66	9	7	70	10	3	70	10	4
Office of the General Counsel	47	6	3	47	6	4	47	6	5
Office of Security and Program Protection	39	1	1	51	2	1	51	2	2
Office of Program and Institutional Integration	38	3	1	37	3	1	37	3	2
Office of Institutions and Management									
Institutions and Management	3	1	0	3	1	0	3	1	0
Infrastructure and Administration	161	8	2	171	10	0	171	10	1
Human Capital Management	39	4	1	40	5	0	40	5	0
Diversity and Equal Opportunity	18	2	1	20	4	0	20	4	1
Procurement	43	3	5	37	4	2	37	4	0
Small Business Programs	6	1	2	3	1	1	3	1	2
Internal Controls	11	0	0	12	0	1	12	0	1
Office of Strategic Communications									
Strategic Communications	4	0	3	1	1	2	1	1	3
Public Affairs	45	3	5	40	4	6	40	4	7
Legislative & Intergovernmental Affairs	31	3	4	28	3	2	28	3	3
Education	23	2	0	16	3	0	16	3	0
Communications Planning	8	1	0	10	2	1	10	2	1
Office of External Relations	52	7	1	50	8	3	50	8	4
Undistributed Reductions				-7			-25		

Supporting Data: Funds Distribution by Installation

P.L.110-161 (4) *Within 14 days of the submission of the budget to the Congress an accompanying volume shall be provided to the Committees on Appropriations containing the following information for each center. . .* This data will be provided under separate cover. Summary data by installation is included here.

FUNDS DISTRIBUTION BY INSTALLATION

($ in millions)	FY 2009 Estimate	FY 2010	FY 2011	FY 2012	FY 2013
Ames Research Center	**548.3**	**511.6**	**526.0**	**545.2**	**548.2**
Science	132.3	127.7	122.3	127.9	125.3
Aeronautics	103.9	103.3	102.1	103.8	108.7
Exploration	62.8	60.8	76.0	81.8	77.3
Space Operations	1.6	1.5	0.6	0.6	0.5
Education	0.5	5.2	5.2	5.2	5.3
Cross-Agency Support	247.3	213.1	219.9	225.9	231.1
Dryden Flight Research Center	**243.1**	**242.5**	**192.1**	**192.4**	**192.9**
Science	51.0	50.7	38.9	36.2	39.5
Aeronautics	50.3	51.0	53.3	53.6	51.9
Exploration	38.4	36.3	4.1	4.1	1.0
Space Operations	4.0	4.0	0.0	0.0	0.0
Education	14.7	14.8	14.8	14.8	14.8
Cross-Agency Support	84.7	85.7	81.1	83.7	85.7
Glenn Research Center	**538.5**	**541.1**	**579.5**	**593.6**	**632.2**
Science	15.3	16.0	14.1	14.2	14.9
Aeronautics	105.5	114.5	114.2	116.9	121.9
Exploration	123.6	113.1	145.6	168.4	196.8
Space Operations	16.5	22.7	25.4	21.9	21.0
Education	8.9	17.0	17.0	17.0	17.0
Cross-Agency Support	268.7	257.9	263.1	255.1	260.6
Goddard Space Flight Center	**2,421.5**	**2,243.5**	**2,069.6**	**1,843.6**	**1,800.3**
Science	1,702.4	1,636.9	1,453.7	1,203.3	1,156.7
Aeronautics	0.0	0.0	0.0	0.0	0.0
Exploration	35.3	22.5	28.8	32.2	37.2
Space Operations	211.6	100.2	102.9	110.2	96.6
Education	3.8	3.9	3.9	3.9	3.9
Cross-Agency Support	468.5	479.9	480.2	493.9	505.8
Jet Propulsion Laboratory	**1,222.3**	**1,197.9**	**1,115.0**	**862.3**	**1,115.3**
Science	974.0	922.3	832.8	577.7	816.2
Aeronautics	0.0	0.0	0.0	0.0	0.0
Exploration	30.0	36.0	46.4	46.1	58.9
Space Operations	173.2	174.1	188.4	196.3	197.1
Education	6.7	10.7	10.7	10.7	10.7
Cross-Agency Support	38.4	54.8	36.7	31.4	32.3
Johnson Space Center	**5,758.6**	**5,991.1**	**6,428.3**	**6,248.1**	**6,040.3**
Science	16.4	15.6	15.8	15.9	16.1
Aeronautics	0.0	0.0	0.0	0.0	0.0
Exploration	1,699.6	1,800.9	3,921.6	3,457.3	3,544.0
Space Operations	3,596.7	3,711.9	2,038.8	2,310.7	2,005.6
Education	7.9	8.8	8.8	8.8	8.8
Cross-Agency Support	437.9	453.9	443.3	455.4	465.9

FUNDS DISTRIBUTION BY INSTALLATION (CONT.)

($ in millions)	FY 2009 Estimate	FY 2010	FY 2011	FY 2012	FY 2013
Kennedy Space Center	**1,486.6**	**1,245.7**	**1,448.5**	**1,473.9**	**1,769.7**
Science	358.5	239.8	226.5	98.5	84.0
Aeronautics	0.0	0.0	0.0	0.0	0.0
Exploration	321.3	237.4	663.5	803.4	1,104.5
Space Operations	396.2	355.0	143.8	144.3	142.8
Education	3.8	5.4	5.4	5.4	5.4
Cross-Agency Support	407.0	408.1	409.3	422.2	433.1
Langley Research Center	**608.1**	**598.4**	**620.2**	**626.1**	**642.8**
Science	55.0	56.1	47.4	39.3	38.4
Aeronautics	151.4	148.4	152.8	154.2	159.0
Exploration	78.4	72.1	87.9	91.5	96.4
Space Operations	0.1	0.1	0.1	0.1	0.1
Education	7.8	7.9	7.9	7.9	7.9
Cross-Agency Support	315.4	313.7	324.0	333.1	341.0
Marshall Space Flight Center	**2,496.8**	**2,436.5**	**2,611.8**	**2,888.6**	**3,054.0**
Science	126.5	122.1	116.8	93.9	89.3
Aeronautics	0.0	0.0	0.0	0.0	0.0
Exploration	948.3	1,189.8	1,904.0	2,192.5	2,352.2
Space Operations	977.6	686.4	142.2	141.6	143.3
Education	2.4	4.7	4.7	4.7	4.7
Cross-Agency Support	442.1	433.4	444.1	455.7	464.4
NASA HQ, IG, & Undistributed Program Budgets	**2,075.3**	**2,823.7**	**2,677.8**	**3,370.0**	**3,348.4**
Science	994.5	1,283.2	1,656.0	2,425.8	2,370.5
Aeronautics	35.5	30.3	29.9	28.2	26.2
Exploration	98.9	111.8	95.7	97.3	104.8
Space Operations	334.3	757.7	223.4	129.5	146.9
Education	58.6	47.0	44.7	44.7	44.6
Cross-Agency Support	518.0	557.3	590.8	606.2	616.3
Inspector General	35.5	36.4	37.3	38.3	39.2
Stennis Space Center	**215.0**	**194.3**	**191.7**	**261.2**	**214.7**
Science	15.6	11.6	10.6	10.6	10.8
Aeronautics	0.0	0.0	0.0	0.0	0.0
Exploration	64.0	56.9	74.8	142.3	93.7
Space Operations	63.0	59.1	34.5	34.5	34.5
Education	0.5	0.6	0.6	0.6	0.6
Cross-Agency Support	72.0	66.2	71.2	73.3	75.1
Total	**17,614.2**	**18,026.3**	**18,460.4**	**18,905.0**	**19,358.8**

CIVIL SERVICE FTE BY CENTER

The retirement of the Space Shuttle and development of the Orion Crew Exploration Vehicle as well as sustaining ISS operations translates into a dramatic shift in NASA's workforce needs over the next four years. This transition needs to be carefully planned within the projected budget for the Agency. NASA Transition Managers recently completed a Shuttle-to-Constellation workforce mapping exercise to identify skill gaps and surpluses. Further work is underway to complete detailed planning for retraining and reassignment of the critical workforce.

The workforce levels as proposed reflect the results of a grassroots planning activity to match workforce at the centers with demand across all Agency programs. Maintaining a workforce level of 17,900 is vitally important to meeting the challenges of NASA’s current commitments and the Vision for Space Exploration, but this level will decrease after the Space Shuttle is retired in 2010.

NASA is implementing near-term actions to facilitate the transition of the workforce including employee buyouts in surplus skill areas. The Agency has also developed strategies for recruiting and retaining critical personnel. These strategies are intended to make good use of the flexibilities granted to the Agency in the NASA Flexibility Act of 2004.

NASA has met the commitment to evolve to a more flexible workforce by reducing the full time permanent workforce and increasing the percentage of non-permanent workforce from 5 percent to 11 percent since 2004.

			FTE Estimates				
Center	**FY 2007 Actual**	**FY 2008 Enacted**	**FY 2009 Estimated**	**FY 2010 Estimated**	**FY2011 Estimated**	**FY 2012 Estimated**	**FY 2013 Estimated**
Ames Research Center	1219	1200	1200	1200	1200	1200	1200
Dryden Flight Research Center	517	530	525	507	500	485	485
Glenn Research Center	1626	1590	1590	1590	1590	1590	1590
Goddard Space Flight Center	3186	3150	3150	3150	3150	3150	3150
Johnson Space Center	3304	3265	3265	3265	3265	3265	3265
Kennedy Space Center	2102	2105	2105	2105	2105	2105	2105
Langley Research Center	1919	1890	1890	1890	1890	1890	1890
Marshall Space Flight Center	2527	2540	2540	2540	2540	2540	2540
Stennis Space Center	269	265	265	265	265	265	265
Headquarters	1239	1240	1240	1240	1235	1235	1235
NSSC	105	125	130	148	160	175	175
TOTAL	**18013**	**17900**	**17900**	**17900**	**17900**	**17900**	**17900**

P.L.110-161 (5) Obligations by Object Class Code

The following tables reflect funds obligated in FY 2007 by object class, and projections of obligations for FY 2008 and FY 2009 based on past trends.

The tables and data are organized in all years to reflect the Mission Directorate, Theme and Program structure proposed for the FY 2009 budget, in accordance with P.L. 110-161. For each mission directorate level a summary table shows the FY 2007, FY 2008, and FY 2009 budget by object classification. A detailed table follows showing the breakdown by Theme and Program for FY 2007.

Object class data at all levels is displayed for FY 2007 obligations. Projections for FY 2008 and FY 2009 are displayed at the appropriation/mission directorate levels which is the lowest level at which they can be adequately estimated.

AERONAUTICS RESEARCH MISSION DIRECTORATE SUMMARY

AERONAUTICS RESEARCH MISSION DIRECTORATE OBLIGATIONS BY OBJECT CLASSIFICATION $M	ACTUAL FY 2007	CURRENT FY 2008	ESTIMATE FY 2009
Total Personnel compensation	133.4	137.3	141.3
Full-time permanent	126.8	130.4	134.2
Other than full-time permanent	6.0	6.2	6.4
Other personnel compensation	0.7	0.7	0.7
Special personal service payments	0.0	0.0	0.0
Civilian personnel benefits	34.0	35.0	36.0
Benefits to former personnel	0.4	0.4	0.4
Travel & transportation of persons	4.2	4.6	3.6
Transportation of things	0.1	0.1	0.1
Rental payments to GSA	0.0	0.0	0.0
Rental payments to others	0.0	0.0	0.0
Communications, utilities & misc charges	4.3	4.7	3.6
Printing and reproduction	0.1	0.1	0.0
Advisory and assistance services	18.0	19.9	15.4
Other services	29.1	32.3	24.9
Other purchases of goods & services from Gov accounts	18.1	20.0	15.4
Operation and maintenance of facilities	20.6	22.8	17.6
Research & development contracts	157.0	173.8	134.0
Medical care	-	-	-
Operation and maintenance of equipment	6.6	7.3	5.6
Supplies and materials	11.3	12.5	9.6
Equipment	26.9	29.7	22.9
Land and structures	8.6	9.5	7.3
Grants, subsidies, and contributions	46.9	51.9	40.0
TOTAL	**519.5**	**561.8**	**477.7**

AERONAUTICS RESEARCH MISSION DIRECTORATE DETAIL

AERONAUTICS RESEARCH MISSION DIRECTORATE OBLIGATIONS BY OBJECT CLASSIFICATION FY 2007 ACTUAL $M	Aeronautics Test Program	Airspace Systems Program	Aviation Safety Program	Fundamental Aeronautics Program	**Total FY 2007**
Total Personnel compensation	11.9	13.3	22.8	85.4	**133.4**
Full-time permanent	11.2	12.5	21.8	81.3	**126.8**
Other than full-time permanent	0.5	0.8	0.9	3.7	**6.0**
Other personnel compensation	0.2	0.0	0.1	0.4	**0.7**
Special personal service payments	-	-	-	-	**-**
Civilian personnel benefits	3.0	3.4	5.9	21.7	**34.0**
Benefits to former personnel	0.2	-	0.0	0.2	**0.4**
Travel & transportation of persons	0.4	0.7	0.8	2.2	**4.2**
Transportation of things	0.0	0.0	0.0	0.1	**0.1**
Rental payments to GSA	-	-	0.0	-	**0.0**
Rental payments to others	-	-	0.0	-	**0.0**
Communications, utilities & misc charges	1.7	0.0	0.0	2.6	**4.3**
Printing and reproduction	0.0	0.0	0.0	0.0	**0.1**
Advisory and assistance services	0.3	9.5	4.4	3.8	**18.0**
Other services	14.7	1.9	2.7	9.9	**29.1**
Other purchases of goods & services from Gov accounts	1.6	0.2	1.1	15.1	**18.1**
Operation and maintenance of facilities	11.2	0.4	0.5	8.5	**20.6**
Research & development contracts	3.5	49.9	16.2	87.5	**157.0**
Medical care	-	-	-	-	**-**
Operation and maintenance of equipment	2.8	0.4	0.5	2.9	**6.6**
Supplies and Materials	3.5	0.2	0.9	6.7	**11.3**
Equipment	3.5	3.2	2.2	17.9	**26.9**
Land and Structures	3.3	0.1	0.0	5.1	**8.6**
Grants, Subsidies, and Contributions	2.0	9.1	5.4	30.5	**46.9**
TOTAL	**63.6**	**92.5**	**63.4**	**300.0**	**519.5**

CROSS AGENCY SUPPORT (MISSION DIRECTORATE LEVEL) SUMMARY

CROSS AGENCY SUPPORT (MISSION DIRECTORATE LEVEL) OBLIGATIONS BY OBJECT CLASSIFICATION $M	ACTUAL FY 2007	CURRENT FY 2008	ESTIMATE FY 2009
Total Personnel compensation	904.9	930.5	958.2
Full-time permanent	809.6	833.0	857.2
Other than full-time permanent	57.3	59.0	60.7
Other personnel compensation	37.4	38.5	39.6
Special personal service payments	0.6	-	0.6
Civilian personnel benefits	234.8	241.6	248.6
Benefits to former personnel	4.2	4.3	4.4
Travel & transportation of persons	32.2	34.2	34.3
Transportation of things	4.3	4.5	4.5
Rental payments to GSA	23.8	25.2	25.4
Rental payments to others	1.9	2.1	2.1
Communications, utilities & misc charges	72.3	76.7	77.1
Printing and reproduction	4.2	4.5	4.5
Advisory and assistance services	193.6	205.6	206.7
Other services	248.3	263.7	265.0
Other purchases of goods & services from Gov accounts	42.2	44.8	45.0
Operation and maintenance of facilities	409.6	435.0	437.2
Research & development contracts	341.0	362.2	364.0
Medical care	4.9	5.2	5.3
Operation and maintenance of equipment	295.0	313.3	314.9
Supplies and materials	35.6	37.8	37.9
Equipment	57.4	60.9	61.3
Land and structures	184.7	196.1	197.1
Grants, subsidies, and contributions	26.3	27.9	28.0
TOTAL	**3,121.1**	**3,276.9**	**3,321.5**

Supporting Data: Obligations by Object Code

CROSS AGENCY SUPPORT (MISSION DIRECTORATE LEVEL) DETAIL

CROSS AGENCY SUPPORT OBLIGATIONS BY OBJECT CLASSIFICATION FY 2007 ACTUAL $M	Agency Management	Safety & Mission Success	Agency IT Services	IPP	SCAP	Agency Management and Operation	CoF	ECR	Institutional Investments	CMO	TOTAL FY 2007
Total Personnel compensation	184.6	35.5	25.3	13.7	9.3	**268.4**	17.6	4.9	**22.4**	**614.1**	**904.9**
Full-time permanent	167.7	33.1	21.9	12.8	8.8	**244.2**	16.1	4.3	**20.4**	**544.9**	**809.6**
Other than full-time permanent	10.1	1.8	2.4	0.8	0.4	**15.5**	1.3	0.5	**1.8**	**40.0**	**57.3**
Other personnel compensation	6.6	0.6	1.0	0.1	0.1	**8.4**	0.1	0.1	**0.2**	**28.8**	**37.4**
Special personal service payments	0.2	0.0	0.0	0.0	0.0	**0.2**	0.0	0.0	**0.0**	**0.4**	**0.6**
Civilian personnel benefits	43.7	8.9	6.1	3.4	2.3	**64.3**	4.3	1.2	**5.6**	**165.0**	**234.8**
Benefits to former personnel	0.6	0.0	0.0	0.1	0.0	**0.7**	0.0	0.0	**0.0**	**3.4**	**4.2**
Travel & transportation of persons	13.8	2.7	1.0	0.7	0.1	**18.3**	0.2	0.1	**0.3**	**13.5**	**32.2**
Transportation of things	0.5	0.0	0.0	0.0	0.0	**0.5**	0.0	0.0	**0.0**	**3.7**	**4.3**
Rental payments to GSA	22.2	-	0.0	0.0	-	**22.2**	-	-	**-**	**1.5**	**23.8**
Rental payments to others	0.1	0.0	1.1	0.0	-	**1.2**	-	0.2	**0.2**	**0.6**	**1.9**
Communications, utilities & misc charges	1.9	0.1	2.7	0.2	0.0	**4.9**	0.1	0.2	**0.3**	**67.0**	**72.3**
Printing and reproduction	1.0	0.1	0.0	0.0	0.0	**1.2**	-	-	**-**	**3.0**	**4.2**
Advisory and assistance services	23.0	27.0	18.7	5.0	39.8	**113.5**	0.7	13.1	**13.8**	**66.4**	**193.6**
Other services	70.6	9.2	38.1	2.6	0.4	**120.9**	2.5	2.8	**5.3**	**122.0**	**248.3**
Other purchases of goods & services from Gov accounts	5.0	1.9	0.6	1.8	0.1	**9.3**	0.1	9.3	**9.4**	**23.5**	**42.2**
Operation and maintenance of facilities	8.1	1.1	2.9	3.0	6.2	**21.4**	10.1	16.5	**26.6**	**361.7**	**409.6**
Research & development contracts	12.0	73.7	2.1	131.3	13.4	**232.6**	1.2	10.4	**11.7**	**96.8**	**341.0**
Medical care	0.0	0.0	-	-	-	**0.0**	-	-	**-**	**4.9**	**4.9**
Operation and maintenance of equipment	35.5	3.6	91.0	2.2	0.5	**132.8**	4.4	0.3	**4.6**	**157.6**	**295.0**
Supplies and materials	1.1	0.5	0.2	0.6	0.5	**2.8**	11.2	0.5	**11.7**	**21.0**	**35.6**
Equipment	3.7	2.7	5.5	0.8	0.3	**13.0**	0.5	0.2	**0.7**	**43.7**	**57.4**
Land and structures	3.7	0.0	4.7	0.0	1.7	**10.1**	100.1	9.8	**110.0**	**64.6**	**184.7**
Grants, subsidies, and contributions	0.1	6.5	0.2	5.9	0.1	**12.8**	-	-	**-**	**13.5**	**26.3**
TOTAL	**431.4**	**173.5**	**200.2**	**171.1**	**74.7**	**1,051.1**	**153.1**	**69.5**	**222.5**	**1,847.4**	**3,121.1**

EDUCATION MISSION DIRECTORATE LEVEL SUMMARY

EDUCATION MISSION DIRECTORATE OBLIGATIONS BY OBJECT CLASSIFICATION $M	ACTUAL FY 2007	CURRENT FY 2008	ESTIMATE FY 2009
Total Personnel compensation	3.722	3.830	3.941
Full-time permanent	3.323	3.420	3.519
Other than full-time permanent	0.391	0.402	0.414
Other personnel compensation	0.008	0.008	0.008
Special personal service payments	-	-	-
Civilian personnel benefits	0.960	1.426	1.105
Benefits to former personnel	-	-	-
Travel & transportation of persons	0.494	0.733	0.568
Transportation of things	0.002	0.003	0.003
Rental payments to GSA	-	-	-
Rental payments to others	0.001	0.002	0.002
Communications, utilities & misc charges	0.001	0.001	0.001
Printing and reproduction	0.021	0.031	0.024
Advisory and assistance services	3.822	5.678	4.401
Other services	8.545	12.696	9.841
Other purchases of goods & services from Gov accounts	0.096	0.142	0.110
Operation and maintenance of facilities	0.571	0.849	0.658
Research & development contracts	1.579	2.346	1.818
Medical care	-	-	-
Operation and maintenance of equipment	1.624	2.413	1.870
Supplies and materials	0.241	0.359	0.278
Equipment	0.183	0.272	0.211
Land and structures	0.002	0.003	0.002
Grants, subsidies, and contributions	91.408	135.816	105.268
TOTAL	**113.271**	**166.600**	**130.100**

EXPLORATION SYSTEMS MISSION DIRECTORATE SUMMARY

EXPLORATION SYSTEMS MISSION DIRECTORATE OBLIGATIONS BY OBJECT CODE $M	ACTUAL FY 2007	CURRENT FY 2008	ESTIMATE FY 2009
Total Personnel compensation	261.4	269.0	276.8
Full-time permanent	243.8	250.9	258.2
Other than full-time permanent	16.1	16.6	17.1
Other personnel compensation	1.4	1.4	1.5
Special personal service payments	0.1	0.1	0.1
Civilian personnel benefits	66.6	68.6	70.6
Benefits to former personnel	0.2	0.2	0.2
Travel & transportation of persons	17.0	21.6	22.5
Transportation of things	106.0	135.1	140.2
Rental payments to GSA	(0.0)	-	-
Rental payments to others	0.2	0.3	0.3
Communications, utilities & misc charges	5.4	6.9	7.1
Printing and reproduction	1.1	1.4	1.5
Advisory and assistance services	137.1	174.7	181.3
Other services	52.2	66.6	69.1
Other purchases of goods & services from Gov accounts	53.2	67.8	70.4
Operation and maintenance of facilities	78.8	100.4	104.2
Research & development contracts	1,620.0	2,063.9	2,142.0
Medical care	-	-	-
Operation and maintenance of equipment	42.6	54.3	56.4
Supplies and materials	22.8	29.0	30.1
Equipment	38.4	48.9	50.7
Land and structures	97.2	123.9	128.6
Grants, subsidies, and contributions	119.1	151.8	157.5
TOTAL	**2,719.6**	**3,384.3**	**3,509.5**

Supporting Data: Obligations by Object Code

EXPLORATION SYSTEMS MISSION DIRECTORATE DETAIL

EXPLORATION SYSTEMS MISSION DIRECTORATE OBLIGATIONS BY OBJECT CLASSIFICATION FY 2007 ACTUAL $M	Constellation Systems	Human Research	Exploration Technology Development	Lunar Precursor Robotic Program	Prometheus Power and Propulsion	Advanced Capabilities	Total FY2007
Total Personnel compensation	**191.1**	15.3	35.1	19.9	-	**70.3**	**261.4**
Full-time permanent	**177.6**	14.3	33.0	18.9	-	**66.2**	**243.8**
Other than full-time permanent	**12.3**	0.9	2.0	1.0	-	**3.9**	**16.1**
Other personnel compensation	**1.2**	0.0	0.1	0.1	-	**0.2**	**1.4**
Special personal service payments	**0.1**	-	-	-	-	**-**	**0.1**
Civilian personnel benefits	**48.7**	3.8	8.9	5.2	-	**17.9**	**66.6**
Benefits to former personnel	**0.1**	0.0	0.0	0.1	-	**0.1**	**0.2**
Travel & transportation of persons	**11.7**	1.1	3.1	1.0	0.1	**5.3**	**17.0**
Transportation of things	**105.7**	0.1	0.2	0.0	0.0	**0.3**	**106.0**
Rental payments to GSA	**0.0**	(0.0)	-	-	-	**(0.0)**	**(0.0)**
Rental payments to others	**0.0**	0.2	0.0	0.0	0.0	**0.2**	**0.2**
Communications, utilities & misc charges	**4.5**	0.0	0.9	0.0	-	**0.9**	**5.4**
Printing and reproduction	**0.5**	0.1	0.5	0.0	0.0	**0.6**	**1.1**
Advisory and assistance services	**102.7**	4.5	26.5	3.2	0.3	**34.4**	**137.1**
Other services	**32.9**	5.9	10.9	1.4	1.2	**19.4**	**52.2**
Other purchases of goods & services from Gov accounts	**34.1**	11.4	2.3	5.6	(0.2)	**19.1**	**53.2**
Operation and maintenance of facilities	**71.1**	0.3	5.8	0.8	0.8	**7.7**	**78.8**
Research & development contracts	**1,155.0**	111.7	214.9	128.3	10.2	**465.1**	**1,620.0**
Medical care	**-**	-	-	-	-	**-**	**-**
Operation and maintenance of equipment	**33.8**	2.8	4.7	1.2	0.2	**8.9**	**42.6**
Supplies and materials	**20.1**	1.0	(0.1)	1.4	0.4	**2.7**	**22.8**
Equipment	**28.0**	2.0	5.6	2.1	0.7	**10.4**	**38.4**
Land and structures	**95.9**	0.7	0.4	0.1	0.0	**1.3**	**97.2**
Grants, subsidies, and contributions	**9.3**	64.6	41.6	1.7	1.9	**109.9**	**119.1**
TOTAL	**1,945.1**	**225.5**	**361.2**	**172.2**	**15.6**	**774.5**	**2,719.6**

SCIENCE MISSION DIRECTORATE SUMMARY

SCIENCE MISSION DIRECTORATE OBLIGATIONS BY OBJECT CLASSIFICATION $M	ACTUAL FY 2007	CURRENT FY 2008	ESTIMATE FY 2009
Total Personnel compensation	174.5	179.6	185.0
Full-time permanent	165.9	170.7	175.9
Other than full-time permanent	8.1	8.3	8.6
Other personnel compensation	0.5	0.6	0.6
Special personal service payments	-	-	-
Civilian personnel benefits	42.5	43.8	45.1
Benefits to former personnel	0.4	0.4	0.4
Travel & transportation of persons	14.1	14.5	13.7
Transportation of things	1.5	1.6	1.5
Rental payments to GSA	0.0	0.0	0.0
Rental payments to others	3.4	3.5	3.3
Communications, utilities & misc charges	1.4	1.4	1.3
Printing and reproduction	1.4	1.5	1.4
Advisory and assistance services	132.9	136.3	129.3
Other services	137.9	141.4	134.2
Other purchases of goods & services from Gov accounts	129.6	132.8	126.1
Operation and maintenance of facilities	12.3	12.6	12.0
Research & development contracts	3,351.4	3,435.9	3,260.5
Medical care	0.0	0.0	0.0
Operation and maintenance of equipment	20.9	21.5	20.4
Supplies and materials	12.0	12.3	11.7
Equipment	75.3	77.2	73.3
Land and structures	81.4	83.4	79.2
Grants, subsidies, and contributions	460.0	471.6	446.2
TOTAL	**4,653.1**	**4,771.2**	**4,544.5**

SCIENCE MISSION DIRECTORATE THEMES OBLIGATIONS BY OBJECT CLASSIFICATION FY 2007 ACTUAL $M	Astrophysics	Earth Science	Heliophysics	Planetary Science	TOTAL FY 2007
Total Personnel compensation	53.2	65.1	34.2	22.0	174.5
Full-time permanent	49.9	62.2	32.8	21.1	165.9
Other than full-time permanent	3.1	2.9	1.3	0.8	8.1
Other personnel compensation	0.2	0.1	0.2	0.0	0.5
Special personal service payments	-	-	-	-	-
Civilian personnel benefits	13.2	15.6	8.4	5.4	42.5
Benefits to former personnel	0.1	0.1	0.1	0.1	0.4
Travel & transportation of persons	4.6	5.0	1.8	2.7	14.1
Transportation of things	0.2	0.5	0.7	0.1	1.5
Rental payments to GSA	0.0	0.0	-	-	0.0
Rental payments to others	0.0	1.6	1.8	0.0	3.4
Communications, utilities & misc charges	0.2	0.4	0.5	0.2	1.4
Printing and reproduction	0.4	0.6	0.3	0.1	1.4
Advisory and assistance services	2.7	120.8	1.3	8.0	132.9
Other services	15.4	48.7	66.7	7.1	137.9
Other purchases of goods & services from Gov accounts	7.8	40.2	10.3	71.3	129.6
Operation and maintenance of facilities	1.8	7.9	0.4	2.2	12.3
Research & development contracts	1,127.1	612.8	614.6	996.8	3,351.4
Medical care	0.0	-	-	-	0.0
Operation and maintenance of equipment	2.4	12.8	3.6	2.2	20.9
Supplies and materials	3.6	5.4	1.1	1.9	12.0
Equipment	6.4	60.7	4.6	3.6	75.3
Land and structures	0.7	8.2	42.7	29.8	81.4
Grants, subsidies, and contributions	85.0	171.8	78.9	124.3	460.0
TOTAL	**1,324.9**	**1,178.3**	**872.1**	**1,277.8**	**4,653.1**

Supporting Data: Obligations by Object Code

SCIENCE MISSION DIRECTORATE ASTROPHYSICS THEME DETAIL

SCIENCE MISSION DIRECTORATE ASTROPHYSICS THEME OBLIGATIONS BY OBJECT CLASIFICICATION FY 2007 ACTUAL $M	Astrophysics Research	Astrophysics Explorer	Beyond Einstein	Discovery	GLAST	HST	International Space Science Collaboration	JWST	Navigator	SOFIA	Astrophysics Total
Total Personnel compensation	7.3	1.2	2.4	1.0	4.9	13.6	-	17.7	-	5.0	**53.2**
Full-time permanent	7.0	1.1	2.0	1.0	4.8	13.0	-	16.6	-	4.4	**49.9**
Other than full-time permanent	0.3	0.1	0.4	0.0	0.1	0.6	-	1.0	-	0.5	**3.1**
Other personnel compensation	0.0	-	0.0	0.0	0.0	0.0	-	0.0	-	0.2	**0.2**
Special personal service payments	-	-	-	-	-	-	-	-	-	-	**-**
Civilian personnel benefits	1.8	0.3	0.6	0.2	1.1	3.3	-	4.6	-	1.2	**13.2**
Benefits to former personnel	0.0	-	-	0.0	0.0	0.1	-	-	-	-	**0.1**
Travel & transportation of persons	0.7	0.1	0.2	0.2	0.5	0.7	0.0	1.3	0.0	1.0	**4.6**
Transportation of things	0.0	0.0	0.0	0.0	0.0	0.0	(0.0)	0.0	0.0	0.1	**0.2**
Rental payments to GSA	-	-	-	-	-	-	-	0.0	-	-	**0.0**
Rental payments to others	0.0	0.0	0.0	0.0	-	-	-	0.0	-	-	**0.0**
Communications, utilities & misc charges	0.0	0.0	0.0	0.0	0.0	0.1	-	0.1	-	0.1	**0.2**
Printing and reproduction	0.0	0.0	0.0	0.0	0.0	0.3	-	0.0	(0.0)	0.0	**0.4**
Advisory and assistance services	0.7	0.0	0.4	0.1	0.0	0.0	-	0.4	-	1.0	**2.7**
Other services	2.2	0.2	0.6	0.1	2.8	1.6	-	2.1	0.0	5.8	**15.4**
Other purchases of goods & services from Gov accounts	3.2	0.3	0.3	0.1	0.4	2.8	-	0.3	0.1	0.3	**7.8**
Operation and maintenance of facilities	0.0	-	0.0	0.0	0.0	1.0	-	0.0	-	0.7	**1.8**
Research & development contracts	176.4	71.1	7.3	140.2	58.7	205.5	20.5	334.2	70.2	42.9	**1,127.1**
Medical care	-	-	-	-	-	0.0	-	-	-	-	**0.0**
Operation and maintenance of equipment	0.0	0.0	0.1	0.0	0.3	0.1	-	1.1	-	0.6	**2.4**
Supplies and materials	0.4	0.0	0.1	0.0	0.1	0.8	(0.0)	1.5	0.0	0.6	**3.6**
Equipment	0.9	0.2	0.4	0.1	0.1	2.3	-	1.7	0.1	0.6	**6.4**
Land and structures	0.0	0.0	0.0	0.0	0.1	0.1	-	0.1	0.0	0.4	**0.7**
Grants, subsidies, and contributions	65.0	3.3	3.2	2.1	1.1	4.5	-	2.2	3.6	0.0	**85.0**
TOTAL	**258.8**	**76.7**	**15.6**	**144.2**	**70.3**	**236.9**	**20.5**	**367.4**	**74.1**	**60.3**	**1,324.9**

Supporting Data: Obligations by Object Code

SCIENCE MISSION DIRECTORATE EARTH SCIENCE THEME DETAIL

SCIENCE MISSION DIRECTORATE EARTH SCIENCE THEME OBLIGATIONS BY OBJECT CLASIFICICATION FY 2007 ACTUAL $M	Applied Sciences	Earth Science Research	Earth Science Technology	Earth Systematic Missions	Earth System Science Pathfinder	Education and Outreach	Earth Science Multi-Mission Operations	**Earth Science Total**
Total Personnel compensation	3.3	25.1	5.5	21.1	3.3	0.2	6.6	**65.1**
Full-time permanent	3.3	23.7	5.3	20.4	3.1	0.2	6.2	**62.2**
Other than full-time permanent	0.1	1.4	0.3	0.7	0.2	0.0	0.3	**2.9**
Other personnel compensation	0.0	0.1	0.0	0.0	0.0	-	0.0	**0.1**
Special personal service payments	-	-	-	-	-	-	-	**-**
Civilian personnel benefits	0.9	5.9	1.4	5.1	0.8	0.1	1.5	**15.6**
Benefits to former personnel	-	0.0	-	0.1	0.0	-	0.0	**0.1**
Travel & transportation of persons	0.5	2.4	0.4	1.3	0.2	0.0	0.2	**5.0**
Transportation of things	0.0	0.4	0.0	0.1	(0.0)	0.0	0.0	**0.5**
Rental payments to GSA	-	-	-	0.0	-	-	-	**0.0**
Rental payments to others	0.0	0.2	0.0	1.4	-	-	-	**1.6**
Communications, utilities & misc charges	0.0	0.0	0.0	0.1	0.0	0.0	0.1	**0.4**
Printing and reproduction	0.0	0.4	0.0	0.1	(0.0)	(0.0)	0.0	**0.6**
Advisory and assistance services	0.7	19.8	1.4	14.1	2.8	(0.0)	82.1	**120.8**
Other services	1.2	41.8	1.4	2.8	0.3	0.2	0.9	**48.7**
Other purchases of goods & services from Gov accounts	1.9	30.9	0.1	3.8	0.9	0.6	1.9	**40.2**
Operation and maintenance of facilities	7.7	0.2	0.1	0.0	-	(0.0)	(0.0)	**7.9**
Research & development contracts	16.8	81.8	36.2	278.0	144.4	2.5	53.1	**612.8**
Medical care	-	-	-	-	-	-	-	**-**
Operation and maintenance of equipment	0.0	8.2	0.1	2.3	0.2	0.2	1.7	**12.8**
Supplies and materials	0.3	2.6	1.4	0.6	0.3	0.0	0.3	**5.4**
Equipment	0.1	15.7	1.7	38.2	0.3	0.1	4.8	**60.7**
Land and structures	6.1	1.4	0.1	0.4	0.0	-	0.2	**8.2**
Grants, subsidies, and contributions	18.0	98.9	10.4	22.7	2.7	10.1	9.1	**171.8**
TOTAL	**57.5**	**335.7**	**60.0**	**392.0**	**156.2**	**14.1**	**162.7**	**1,178.3**

SCIENCE MISSION DIRECTORATE HELIOPHYSICS THEME DETAIL

SCIENCE MISSION DIRECTORATE HELIOPHYSICS THEME OBLIGATIONS BY OBJECT CLASIFICICATION FY 2007 ACTUAL $M	Deep Space Mission Systems	Heliophysics Explorer	Heliophysics Research	Living with a Star	Near Earth Networks	New Millennium	Solar Terrestrial Probes	Heliophysics Total
Total Personnel compensation	-	2.3	9.8	12.2	2.5	0.7	6.7	**34.2**
Full-time permanent	-	2.3	9.3	11.7	2.4	0.7	6.4	**32.8**
Other than full-time permanent	-	0.0	0.4	0.4	0.1	0.0	0.3	**1.3**
Other personnel compensation	-	0.0	0.1	0.1	0.0	-	0.0	**0.2**
Special personal service payments	-	-	-	-	-	-	-	**-**
Civilian personnel benefits	-	0.5	2.3	3.2	0.6	0.2	1.6	**8.4**
Benefits to former personnel	-	-	0.1	-	-	-	-	**0.1**
Travel & transportation of persons	-	0.2	0.7	0.5	0.1	0.0	0.3	**1.8**
Transportation of things	-	0.0	0.3	0.1	0.4	0.0	0.0	**0.7**
Rental payments to GSA	-	-	-	-	-	-	-	**-**
Rental payments to others	-	1.0	0.0	0.8	-	-	0.0	**1.8**
Communications, utilities & misc charges	-	0.1	0.3	0.1	0.0	-	0.0	**0.5**
Printing and reproduction	-	0.0	0.0	0.2	(0.0)	0.0	0.1	**0.3**
Advisory and assistance services	0.1	0.0	0.3	0.3	0.3	0.0	0.2	**1.3**
Other services	0.4	0.4	2.0	7.0	56.4	0.2	0.3	**66.7**
Other purchases of goods & services from Gov accounts	0.5	1.2	3.4	0.6	1.1	0.0	3.6	**10.3**
Operation and maintenance of facilities	-	0.1	0.1	0.0	0.2	-	0.0	**0.4**
Research & development contracts	245.8	71.2	78.4	128.5	2.5	41.4	46.9	**614.6**
Medical care	-	-	-	-	-	-	-	**-**
Operation and maintenance of equipment	0.0	0.0	1.5	1.7	0.1	0.0	0.3	**3.6**
Supplies and materials	-	(0.0)	0.2	0.7	0.0	0.0	0.1	**1.1**
Equipment	-	0.1	0.6	3.3	0.1	0.0	0.4	**4.6**
Land and structures	-	0.0	42.5	0.0	0.0	-	0.1	**42.7**
Grants, subsidies, and contributions	0.3	0.1	62.9	13.0	-	-	2.6	**78.9**
TOTAL	**247.0**	**77.3**	**205.3**	**172.1**	**64.3**	**42.6**	**63.4**	**872.1**

SCIENCE MISSION DIRECTORATE PLANETARY SCIENCE THEME DETAIL

SCIENCE MISSION DIRECTORATE PLANETARY SCIENCE THEME OBLIGATIONS BY OBJECT CLASIFICICATION FY 2007 ACTUAL $M	Discovery	Mars Exploration	New Frontiers	Planetary Research	Technology	**Planetary Science Total**
Total Personnel compensation	1.9	6.6	2.2	6.7	4.6	**22.0**
Full-time permanent	1.8	6.3	2.1	6.5	4.5	**21.1**
Other than full-time permanent	0.1	0.3	0.1	0.2	0.1	**0.8**
Other personnel compensation	0.0	0.0	0.0	0.0	0.0	**0.0**
Special personal service payments	-	-	-	-	-	**-**
Civilian personnel benefits	0.5	1.7	0.5	1.5	1.1	**5.4**
Benefits to former personnel	-	-	-	-	0.1	**0.1**
Travel & transportation of persons	0.4	0.5	0.2	1.3	0.4	**2.7**
Transportation of things	0.0	(0.0)	0.0	0.1	0.0	**0.1**
Rental payments to GSA	-	-	-	-	-	**-**
Rental payments to others	-	0.0	-	0.0	0.0	**0.0**
Communications, utilities & misc charges	0.0	0.0	-	0.2	0.0	**0.2**
Printing and reproduction	0.0	0.0	0.0	0.0	0.0	**0.1**
Advisory and assistance services	0.1	1.5	0.1	4.9	1.4	**8.0**
Other services	1.2	2.3	0.0	3.4	0.2	**7.1**
Other purchases of goods & services from Gov accounts	7.6	28.4	(0.1)	23.2	12.2	**71.3**
Operation and maintenance of facilities	0.1	2.0	0.0	0.0	0.0	**2.2**
Research & development contracts	102.4	611.3	111.1	136.3	35.7	**996.8**
Medical care	-	-	-	-	-	**-**
Operation and maintenance of equipment	0.3	0.3	0.3	0.9	0.4	**2.2**
Supplies and materials	0.1	0.6	0.0	0.5	0.6	**1.9**
Equipment	0.2	0.8	0.1	1.5	0.9	**3.6**
Land and structures	(0.5)	30.3	-	0.0	0.0	**29.8**
Grants, subsidies, and contributions	10.7	14.9	0.3	95.9	2.6	**124.3**
TOTAL	**125.0**	**701.3**	**114.7**	**276.5**	**60.3**	**1,277.8**

SPACE OPERATIONS MISSION DIRECTORATE SUMMARY

SPACE OPERATIONS MISSION DIRECTORATE OBLIGATIONS BY OBJECT CLASSIFICATION $M	ACTUAL FY 2007	CURRENT FY 2008	ESTIMATE FY 2009
Total Personnel compensation	317.2	326.3	335.8
Full-time permanent	281.2	289.4	297.8
Other than full-time permanent	32.7	33.6	34.6
Other personnel compensation	3.2	3.3	3.4
Special personal service payments	0.0	0.0	0.0
Civilian personnel benefits	81.4	83.8	86.2
Benefits to former personnel	0.3	0.3	0.4
Travel & transportation of persons	15.2	14.9	16.1
Transportation of things	19.0	18.6	20.0
Rental payments to GSA	-	-	-
Rental payments to others	2.1	2.1	2.2
Communications, utilities & misc charges	41.3	40.5	43.6
Printing and reproduction	2.1	2.1	2.3
Advisory and assistance services	15.1	14.8	15.9
Other services	92.6	90.8	97.8
Other purchases of goods & services from Gov accounts	95.5	93.6	100.8
Operation and maintenance of facilities	2,084.7	2,043.8	2,201.9
Research & development contracts	2,356.7	2,310.5	2,489.2
Medical care	0.2	0.2	0.2
Operation and maintenance of equipment	151.8	148.9	160.4
Supplies and materials	31.0	30.4	32.8
Equipment	167.1	163.8	176.4
Land and structures	29.9	29.3	31.6
Grants, subsidies, and contributions	5.8	5.7	6.1
TOTAL	**5,508.9**	**5,420.3**	**5,819.8**

Supporting Data: Obligations by Object Code

SPACE OPERATIONS MISSION DIRECTORATE DETAIL

SPACE OPERATIONS MISSION DIRECTORATE OBLIGATIONS BY OBJECT CLASSIFICATION FY 2007 ACTUAL $M	ISS	Space Shuttle	Crew Health	Launch Services	Rocket Propulsion Test	Space Communications	Space and Flight Support	Total FY 2007
Total Personnel compensation	122.8	156.3	0.3	21.0	5.9	10.8	38.0	317.2
Full-time permanent	109.5	137.3	0.3	18.0	5.8	10.3	34.4	281.2
Other than full-time permanent	12.4	17.0	0.0	2.7	0.1	0.5	3.3	32.7
Other personnel compensation	0.9	2.0	-	0.2	0.0	0.0	0.3	3.2
Special personal service payments	0.0	0.0	-	-	-	-	-	0.0
Civilian personnel benefits	31.4	40.2	0.1	5.6	1.6	2.6	9.9	81.4
Benefits to former personnel	0.1	0.1	-	0.1	0.0	-	0.1	0.3
Travel & transportation of persons	5.4	7.1	0.0	1.7	0.2	0.8	2.7	15.2
Transportation of things	17.7	0.9	-	0.1	0.2	0.0	0.3	19.0
Rental payments to GSA	-	-	-	-	-	-	-	-
Rental payments to others	0.3	1.8	-	0.0	-	-	0.0	2.1
Communications, utilities & misc charges	5.7	29.9	-	1.7	2.3	1.7	5.6	41.3
Printing and reproduction	0.4	1.7	-	0.1	-	0.0	0.1	2.1
Advisory and assistance services	3.9	8.3	-	1.8	0.0	1.0	2.9	15.1
Other services	35.5	42.8	0.2	0.4	0.9	12.8	14.4	92.6
Other purchases of goods & services from Gov accounts	7.6	59.7	-	3.4	0.3	24.5	28.2	95.5
Operation and maintenance of facilities	153.5	1,907.7	-	1.6	21.7	0.1	23.4	2,084.7
Research & development contracts	1,039.8	1,228.3	7.6	39.4	9.2	32.4	88.6	2,356.7
Medical care	-	0.2	-	0.0	-	-	0.0	0.2
Operation and maintenance of equipment	16.2	113.1	-	3.9	0.1	18.6	22.5	151.8
Supplies and materials	(15.7)	43.6	0.0	1.4	1.3	0.5	3.2	31.0
Equipment	119.5	43.6	-	2.0	0.2	1.8	4.0	167.1
Land and structures	0.2	26.8	-	0.2	2.5	0.2	2.9	29.9
Grants, subsidies, and contributions	2.5	1.6	0.4	0.2	0.0	1.1	1.7	5.8
TOTAL	1,546.7	3,713.7	8.6	84.3	46.6	109.0	248.6	5,508.9

NASA Authorization Act of 2005 P.L. 109-155

Requirement	Reference
TITLE I - GENERAL PRINCIPLES AND REPORTS SEC. 101. RESPONSIBILITIES, POLICIES, AND PLANS h) BUDGETS.— (1) CATEGORIES.—The proposed budget for NASA submitted by the President for each fiscal year shall be accompanied by documents showing -	
(A) by program— (i) the budget for space operations, including the ISS and the Space Shuttle; (ii) the budget for exploration systems; (iii) the budget for aeronautics; (iv) the budget for space science; (v) the budget for Earth science; (vi) the budget for microgravity science; (vii) the budget for education; (viii) the budget for safety oversight; and (ix) the budget for public relations;	(i) Space Operations Mission Directorate (ii) Explorations Systems Mission Directorate (iii) Aeronautics Research Mission Directorate (iv) Science Mission Directorate (v) Science Mission Directorate: Earth Science Theme (vi) See Following Sections (vii) Education Section (viii) See Following Sections (ix) See Following Sections
(B) the budget for technology transfer programs;	See Following Sections
(C) the budget for the Integrated Enterprise Management Program, by individual element;	Cross-Agency Support: IT Development & Ops
(D) the budget for the Independent Technical Authority, both total and by Center;	See Following Sections
(E) the total budget for the prize program under section 104, and the administrative budget for that program;	Innovative Partnerships Program – Project Narrative for Centennial Challenges
(F) the comparable figures for at least the 2 previous fiscal years for each item in the proposed budget.	Mission Directorate sections
(G) The amount of unobligated funds and unexpended funds, by appropriations account--	
(i) that remained at the end of the fiscal year prior to the fiscal year in which the budget is being presented that were carried over into the fiscal year in which the budget is being presented; (ii) that are estimated will remain at the end of the fiscal year in which the budget is being presented that are proposed to be carried over into the fiscal year for which the budget is being presented; and (iii) that are estimated will remain at the end of the fiscal year for which the budget is being presented	See Following Sections

P.L. 109-155 (A) (i through v, and vii) Program Budgets

Please refer to Mission Directorate, Theme, Program and Project sections in this volume.

P.L. 109-155 (A) (vi) Budget for Microgravity Science

The Exploration Systems Mission Directorate (ESMD) and Space Operations Mission Directorate (SOMD) support research to take advantage of the unique environment of reduced gravity in two broad categories – Exploration and Non-Exploration ISS Research.

SUMMARY OF MICROGRAVITY RESEARCH

$ in millions	FY2007 (actual)	FY2008 (enacted)	FY2009	FY2010	FY2011	FY2012	FY2013
Exploration ISS Research	$128	$142	$138	$138	$142	$138	$142
Non- Exploration ISS Research	$35	$45	$30	$29	$28	$28	$28
Total	**$163**	**$186**	**$168**	**$167**	**$171**	**$166**	**$170**
% of Non-Exploration to Total	21%	24%	18%	17%	17%	17%	17%

Note: Shown in direct dollars.

Exploration ISS Research

Exploration ISS Research supports the Agency's need for improved knowledge about working and living in space to enable long-duration human exploration missions in the future.

The Human Research Program will provide research results that reduce risks to crew health and performance that stem from prolonged exposure to reduced gravity, space radiation and isolation during exploration missions. Risk mitigation and countermeasure development will be achieved by conducting ISS research in human health countermeasures, space human factors and habitability, behavioral health and performance, and exploration medicine tools and technologies.

The Exploration Technology Development Program will investigate the underlying gravity-dependent phenomena in the following areas: fire prevention, detection, and suppression; multiphase flow of fluids; exploration life support, propellant storage, power generation thermal control, and advanced environmental monitoring and control. The above table also includes the portion of the Multi-User System Support (MUSS) which supports Exploration ISS Research.

Non-Exploration ISS Research

NASA allocates at least 15 percent of its funds budgeted for ISS research to ground-based, free-flyer, and ISS life and microgravity science research that is not directly related to supporting the human exploration program. NASA ensures said capacity to support ground-based research leading to space-based basic and applied scientific research in a variety of disciplines with potential national benefits and applications that can be advanced significantly from exposure to microgravity and the space environment. The knowledge gained from these investigations has the potential to uncover information that may lead to novel applications both on Earth and in space. The above table also includes the Alpha Magnetic Spectrometer, and that portion of the MUSS which supports Non-Exploration ISS research. In FY 2008, the Non-Exploration ISS Research budget under the Exploration Technology Development program was increased by $11M per Congressional direction.

P.L. 109-155 (A) (viii) Budget for Safety Oversight

This information is the estimate for Safety and Mission Assurance staffing support to the Mission Directorates. The budget runout will be updated as the Agency completes its refinement of transition costs associated with the retirement of the Space Shuttle and the development of Constellation Systems components.

BUDGET SUMMARY FOR SAFETY OVERSIGHT

($ in millions)	FY 2007 Actual	FY 2008 Current	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total Safety Oversight	**662.1**	**681.8**	**702.3**	**723.4**	**745.2**	**767.4**	**785.8**
Aeronautics	**3.4**	**3.5**	**3.6**	**3.7**	**3.8**	**3.9**	**4.0**
Exploration	**47.5**	**48.9**	**50.4**	**51.9**	**53.5**	**55.1**	**56.4**
Science	**60**	**61.8**	**63.7**	**65.6**	**67.6**	**69.6**	**71.3**
Space Operations	**395.3**	**407.1**	**419.3**	**431.9**	**444.9**	**458.2**	**469.2**
Space Shuttle	334.2	344.2	354.6	365.2	376.2	387.5	396.8
International Space Station	50.5	52.1	53.6	55.2	56.9	58.6	60.0
Launch Services	7.5	7.7	7.9	8.2	8.4	8.7	8.9
Radiation Projects	3.1	3.1	3.2	3.3	3.4	3.5	3.6
Agency-wide Safety Oversight	**127.8**	**131.6**	**135.5**	**139.6**	**143.8**	**148.1**	**151.7**
Office of Safety and Mission Assurance	24.7	25.5	26.2	27	27.8	28.7	29.4
Institutional (Safety, Health, Environmental)	36.9	38	39.2	40.4	41.6	42.8	43.8
Contractor Oversight (DCMA, SAC, NCAS)	66.1	68.1	70.1	72.2	74.4	76.6	78.4
Other Programs	**28.1**	**28.9**	**29.8**	**30.7**	**31.6**	**32.5**	**33.3**

P.L. 109-155 (A) (ix) Budget for Public Relations

The NASA budget for Public Affairs (referred to as “public relations” in the Authorization Act) is not funded by programs. Instead, it is budgeted in two separate accounts under 1) Center Management and Operations (CM&O) and 2) Agency Management and Operations. All the Installations listed below except for Headquarters are in the CM&O account and the Headquarters budget is in the Agency Management and Operations account.

These budgets include dissemination of information to the news media and the general public concerning NASA programs. Content includes support for public affairs/public relations, Center newsletters, internal communications, guest operations (including bus transportation), public inquiries, NASA TV, nasa.gov portal and other multimedia support.

Funding by installation is shown below.

BUDGET FOR PUBLIC RELATIONS BY CENTER

Center ($ in millions)	FY 2008 Current	FY 2009 Estimate	FY 2010	FY 2011	FY 2012	FY 2013
Ames Research Center	1.0	1.0	1.0	1.0	1.0	1.0
Dryden Flight Research Center	0.7	0.7	0.7	0.7	0.7	0.7
Glenn Research Center	1.9	1.9	1.9	1.9	1.9	1.9
Goddard Space Flight Center	3.6	3.6	3.6	3.6	3.6	3.6
Headquarters	7.9	7.9	7.9	7.9	7.9	7.9
Johnson Space Center	6.6	6.6	6.6	6.6	6.6	6.6
Kennedy Space Center	4.7	4.7	4.7	4.7	4.7	4.7
Langley Research Center	2.1	2.1	2.1	2.1	2.1	2.1
Marshall Space Flight Center	2.7	2.7	2.7	2.7	2.7	2.7
Stennis Space Center	1.4	1.4	1.4	1.4	1.4	1.4
Total	**32.6**	**32.6**	**32.6**	**32.6**	**32.6**	**32.6**

P.L. 109-155 (B) Budget for Technology Transfer Programs

SUMMARY OF TECHNOLOGY TRANSFER PARTNERSHIPS

($ in millions)	FY 2007 Actual	FY 2008 Current	FY 2009 Estimate	FY 2010	FY 2011	FY 2012	FY 2013
Technology Transfer Partnerships	40.5	35.6	33.6	32.7	29.7	29.5	29.3

P.L. 109-155 (C) Budget for the Integrated Enterprise Management Program, by Individual Element;

Please refer to the Agency Information Technology Services Program in this volume.

P.L. 109-155 D) Budget for the Independent Technical Authority, Total and by Center

Independent Technical Authority is no longer a separate account. Last year it was changed to Technical Excellence. The scope of Technical Excellence is the costs associated with Lead Flight Program/Project Chief Engineers and engineering management providing independent authoritative decisions on technical requirements for programs and projects.

SUMMARY OF BUDGET FOR TECHNICAL EXCELLENCE BY CENTER

($ millions)	FY 2007 Actual	FY 2008 Enacted	FY 2009	FY 2010	FY2011	FY 2012	FY 2013
Ames Research Center	2.5	2.5	2.6	2.7	2.8	2.9	3.0
Dryden Flight Research Center	6.1	6.5	6.5	6.7	6.9	7.2	7.4
Glenn Research Center	12.9	13.1	13.5	14.1	14.4	15.0	15.3
Goddard Space Flight Center	10.3	10.2	10.8	11.4	12.1	12.8	13.5
Jet Propulsion Laboratory	--	--	--	--	--	--	--
Johnson Space Center	19.2	18.2	18.7	19.4	22.0	22.7	22.7
Kennedy Space Center	10.7	10.3	10.6	11.0	11.3	11.7	12.1
Langley Research Center	15.0	15.5	16.1	16.8	17.4	18.1	18.9
Marshall Space Flight Center	32.2	35.3	35.2	37.1	38.4	39.7	41.2
Stennis Space Center	2.8	2.8	2.9	3.0	3.1	3.2	3.3
NASA Headquarters	--	--	--	--	--	--	--
TOTAL	**111.6**	**114.4**	**117.0**	**122.1**	**128.5**	**133.2**	**137.5**

P.L. 109-155 (E) Total budget for the prize program under section 104, and the administrative budget for that program;

Please refer to the Innovative Partnerships Program – Project description for Centennial Challenges in this volume.

P.L. 109-155 (F) Comparable figures for at least the 2 previous fiscal years for each item in the proposed budget.

Please refer to the Mission Directorate, Theme, Program and Project sections in this volume.

P.L. 109-155 (G) The amount of unobligated funds and unexpended funds, by appropriations account--

The figures below represent actual unobligated balances within NASA's individual appropriation accounts as of September 30, 2007, and estimates for the disposition of those accounts at the future dates specified.

UNOBLIGATED AND UNEXPENDED FUNDS BY APPROPRIATION ACCOUNT

FY 2007 – FY 2009 Appropriations ($ in millions)	Unobligated Balances Sept. 30, 2007	Estimated Unobligated Balances Sept. 30, 2008	Estimated Unobligated Balances Sept. 30, 2009
Science, Exploration, & Aeronautics	1467	1160	
Science			415
Exploration			317
Aeronautics			36
Education			9
Cross-Agency Support			300
Exploration Capabilities	316	539	
Space Operations			462
Inspector General	1	0	0
Total NASA	**1784**	**1699**	**1539**

Prior Year Appropriations ($ in millions)	Unobligated Balances Sept. 30, 2007	Estimated Unobligated Balances Sept. 30, 2008	Estimated Unobligated Balances Sept. 30, 2009
Science, Exploration, & Aeronautics	100		
Science			
Exploration			
Aeronautics			
Education			
Cross-Agency Support			
Exploration Capabilities	185	65	
Space Operations			
Other (SAT/HFS/MS)	13		
Total NASA	**298**	**65**	**0**

Other Supporting Data Requested

- Reimbursable Estimates by Appropriation;
- Summary of Consulting Services;
- E-Gov Initiatives and Benefits

Reimbursable Estimates by Appropriation

Reimbursable agreements are agreements where the NASA costs associated with the undertaking are borne by the non-NASA partner. NASA undertakes reimbursable agreements when it has equipment, facilities, and services that it can make available to others in a manner that does not interfere with NASA mission requirements. As most reimbursable requests to NASA do not occur until the year of execution, the FY 2009 estimate is projected based on historical data.

Budget Authority ($ in millions)	FY 2007 Actual	FY 2008 Current	FY 2009 Estimate
Science, Aeronautics & Exploration,	**834.4**	**778.5**	
Science			610.0
Exploration			11.0
Aeronautics			131.0
Cross-Agency Supt			28.0
Exploration Capabilities	**478.1**	**383.7**	
Space Operations			390.0
Office of Inspector General	**0.2**	**0.6**	0.5
TOTAL	**1312.7**	**1162.8**	**1,170.5**

Summary of Consulting Services

NASA uses paid experts and consultants to provide advice and expertise to or beyond that which is available from its in-house civil service workforce. Management controls are established which assure that before entering into a consultanting services arrangement with an individual that there is ample justification presented and the action is approved at top management levels.

NASA also uses experts and consultants to provide expertise on the selection of experiments for future space missions. The use of these experts and consultants, in addition to NASA civil service personnel, provides the Agency with an independent view that assures the selection of experiments likely to have the greatest scientific merit. Other individuals are used to provide independent analysis of technical and functional problems in order to give top management the widest possible range of views before making major decisions.

Expert/Consultants (Total NASA) ($ in millions)	FY 2007 Actual	FY 2008 Current	FY 2009 Estimate
Number of Paid Experts and Consultants	31	31	31
Annual FTE Usage	4	4	4
Salaries	0.4	0.4	0.4
Total Salary and Benefits Costs	0.4	0.4	0.4
Travel Costs	0.4	0.4	0.4
Total Costs	**0.8**	**0.7**	**0.8**

Supporting Data: Other Government Reporting Requirements

E-Gov initiatives and Benefits

OMB Circular A-11, Sections 22.6 and 53.5

Each agency's Congressional Justification should include funding for E-Gov initiatives as provided below as well as the benefits associated with each initiative for the Agency.

FY 2008 and FY 2009 Expected Benefits to NASA from the President's E-Gov Initiatives

NASA is providing funding contributions in FY 2008 and FY 2009 for each of the following E-Government Initiatives:

Initiative	2008 Contributions (Includes In-Kind)	2008 Service Fees	2009 Contributions (Includes In-Kind)	2009 Agency Service Fees
E-Rulemaking 026-00-01-99-04-0060-24	$241,000			$28,625
Business Gateway 026-00-01-99-04-0100-24	$44,000		$46,894	
Grants.gov 026-00-01-99-04-0160-24	$536,187		$517,763	
E-Training 026-00-01-99-04-1217-24		$700,000		$700,000
Recruitment One-Stop		$116,014		$120,655
EHRI 026-00-01-99-04-1219-24		$417,533		$434,234
E-Payroll 026-00-01-99-04-1221-24		$3,704,840		$3,704,840
E-Travel 026-00-01-99-04-0220-24		$49,640		$1,862,465
Integrated Acquisition Environment 026-00-01-99-04-0230-24	$1,266,334			$1,273,884
IAE-Loans and Grants	$89,973		$89,973	
E-Authentication 026-00-01-99-04-0250-24		$61,300		$101,200
Financial Management LoB 026-00-01-99-04-1100-24	$75,000		$75,000	
Human Resources Management LoB 026-00-01-99-04-1200-24	$65,217		$65,217	
Grants Management LoB 026-00-01-99-04-1300-24	$59,316		$59,316	
Geospatial LoB 026-00-01-99-04-3100-24	$15,450		$15,000	
Budget Formulation and Execution LoB 026-00-01-99-04-3200-24	$85,000		$85,000	
IT Infrastructure LoB 026-00-01-99-04-3300-24	$80,000			
NASA Total	**$2,557,477**	**$5,049,327**	**$954,163**	**$8,225,903**

* Service Fees are estimates as provided by the E-Government initiative Managing Partners.

NASA's FY 2008 Exhibit 300 IT business cases will be posted at: www.nasa.gov/offices/ocio/busmanagement/index.html within two weeks of the release of the President's Budget. NASA's Congressional Justification, which will be posted online, will include a link to the Exhibit 300s.

Supporting Data: Other Government Reporting Requirements

The PMA E-Government initiatives serve citizens, businesses, and federal employees by delivering high quality services more efficiently at a lower price. Instead of expensive “stove-piped” operations, agencies work together to develop common solutions that achieve mission requirements at reduced cost, thereby making resources available for higher priority needs. Benefits realized through the use of these initiatives for NASA in FY 2008 and in FY 2009 are as follows:

E-Rulemaking (Managing Partner EPA) FY 2008 and FY 2009 Benefits

Since the deployment of the Federal Docket Management System (FDMS) in December 2005, NASA has used FDMS to receive public comment on Agency rules. Previously, NASA used a paper-based system for all public comments on rulemaking. For calendar year 2007 (through October) NASA posted 22 Federal Register rules and proposed rules in Regulations.gov and posted 6 comments. These actions require broad circulation to be effective, and through the use of FDMS, NASA is able to provide public access and receive public comment.

NASA benefits in several ways through its participation and reliance on FDMS and Regulations.gov. NASA reaps substantial benefits by improving the transparency of its rulemaking actions as well as increasing public participation in the regulatory process. Direct budget cost savings and cost avoidance result from NASA’s transition to FDMS and Regulations.gov, enabling the agency to discontinue efforts to develop, deploy and operate specific individual online docket and public comment systems. Over five years, NASA is estimated to save over $700,000 over alternative options that would provide similar services.

Business Gateway (Managing Partner SBA) FY 2008 and FY 2009 Benefits

For FY 2007 and FY 2008, Business Gateway will continue to offer NASA a valuable channel to identify businesses with the interest and expertise to engage in technological development and partnerships. NASA provides a host of programs focused on business from research contracts to Mentor/Protégé programs. Business Gateway provides a powerful outreach channel to match businesses with the various initiatives that are part of NASA’s outreach to the business community. Finally, the BG Forms Catalog contains links to 18 NASA forms/instructions, which can improve the ability of businesses to locate and submit government forms.

By creating a single portal for business information, such as regulatory compliance information, Business Gateway directly benefits NASA’s “customers” (e.g., aerospace industry, research labs, etc.). NASA’s constituents could potentially receive significant benefits from Business Gateway including time and cost savings, assistance in compliance with the *Small Business Paper Relief Act*, and reduction in burden hours. Through increased outreach, more constituents will be able to realize these benefits. Furthermore, Business Gateway should provide increased citizen and business engagement as a result of quick access to NASA’s regulatory information. The following additional benefit information for NASA was provided by the Business Gateway initiative, based on calculations from publicly available data and data from the existing Business.gov site. [NASA has not independently verified this data]:

- Maintenance savings: Business.gov’s search technology will provide NASA with valuable user statistics and feedback, enabling it to simplify content management on its business compliance site.
- Increased forms management: By making 6 forms (to date) available on Forms.gov, NASA saves Agency time in forms management, and is expected to produce significant savings in paper and postage.

- Reduced burden on field offices: By directing compliance-related inquiries to Business.gov, agencies with field offices will save training and staff-time dollars.
- Data harmonization: Every Federal agency should have or participate in at least one "vertical" opportunity; in the case of NASA, opportunities exist to refine the processes with DoS and DoD regarding the protection of cutting-edge technologies. DoI and DoL together saved $341,000 in the first three years of their vertical, and are expected to save $570,000 over 5 years.
- Increased transparency: Business Gateway enables NASA to meet its public service commitment to transparency in government by providing its customers with ready, equal access to information about its compliance requirements.

Grants.gov (Managing Partner HHS) FY 2008 and FY 2009 Benefits

The Grants.gov Initiative benefits NASA and its grant programs by providing a single location to publish grant (funding) opportunities and application packages, awarding more than $450 billion by the 26 grant-making agencies and other federal grant-making organizations. In FY 2007 Grants.gov received 180,861 grant application submissions from the public, an increase of nearly 100 percent over FY 2006. By providing a single site for the grants community to apply for grants using common forms, processes and systems, it makes the process easier for applicants to apply to multiple agencies. The Grants.gov Website also receives over 1.5 million hits and sends over 1 million email notifications per week at the public's request.

The Grants.gov Initiative benefits NASA and its grant programs by providing broader exposure to a wider community who could potentially apply for NASA funding. In addition, Grants.gov provides a single site for the grantee community to apply for grants using a standard set of forms, processes and systems giving greater access and ability to apply for Federal funding. Through the use of Grants.gov NASA is able to reduce operating costs associated with online posting and application of grants. Additionally, the Agency is able to improve operational effectiveness through use of Grants.Gov by increasing data accuracy and reducing processing cycle times. In FY 2007, NASA posted 86 funding opportunities and 81 application packages, and received 274 proposals.

E-Training (Managing Partner OPM) FY 2008 and FY 2009 Benefits

In 2006, NASA streamlined its three separate online training systems into one centralized, learning management system, SATERN, a "one-stop" approach offering Web-based access to training and career development resources. This centralized approach will allow NASA to reduce costs through the consolidation of multiple learning systems. Through SATERN, employees can view required training, launch online content, view training history, and self-register for courses. In addition, the system allows NASA to identify offices that have not met training requirements, and bring them in line with federal mandates. Once fully implemented, SATERN will also offer employees access to career planning tools, individual development plans, and competency management.

Recruitment One-Stop (Managing Partner OPM) FY 2008 and FY 2009 Benefits

Recruitment One-Stop provides state-of-the-art online recruitment services to federal job seekers that include online job posting, intuitive job searching, resume warehousing, online application submission, and automated eligibility and status feedback. USAJOBS provides federal agencies with a unified system to attract and hire highly qualified and talented individuals. Integration with Recruitment One-Stop (ROS) allows NASA to better attract individuals who can accomplish the Agency's mission. The new USAJOBS interface allows job seekers to view and apply for all NASA employment opportunities, as well as those from other federal agencies. Job seekers now need only one user ID and password to access all NASA employment opportunities.

NASA adopted the USAJOBS resume as the basic application document for all NASA positions, except for Astronaut positions, with Phase II implementation completed 2005. To date NASA has not identified any specific savings, either in terms of budgeted savings or cost avoidance. Although the Agency believes that implementation of ROS has resulted in significant intangible benefits in terms of providing better vacancy information to applicants, it has not resulted in any cost savings.

Enterprise HR Integration (Managing Partner OPM) FY 2008 and FY 2009 Benefits

The Enterprise Human Resources Integration (EHRI) initiative transforms Human Resource (HR) processes from paper-based processes to electronic-based processes. EHRI also provides workforce planning, forecasting, and analytical tools. The initiative streamlines employee transfers and enhances retirement processing throughout the Executive Branch. The initiative has also developed a consolidated EHRI data warehouse containing HR data on all Executive Branch civilian employees and a robust set of tools. EHRI also includes the Electronic Employee Record, or eOPF, to provide a consolidated image and data view that digitally documents the employment actions and history of individuals employed by the Federal government. The initiative is achieving cost savings that are recognized on a per folder basis. The total cost avoidance per folder is estimated at $44.23. In FY 2006, EHRI created a total of 355,132 folders.

Specific EHRI/eOPF benefits to NASA include improved convenience in searching, better security and safety to electronic files, more economical, streamlined business processes, and the ability to have a central repository of OPF records for the Agency. Specific NASA employee benefits include secure online access to OPFs, automatic notification when documents are added, exchange of retirement and HR data across agencies and systems, and the elimination of duplicate and repetitive personnel data in personnel folders. NASA is currently in the process of implementing eOPF; this effort will transition personnel actions processing to the NASA Shared Service Center (NSSC) in January 2008. The Agency will have quantitative cost savings data next year.

E-Payroll (Managing Partner OPM) FY 2008 and FY 2009 Benefits

The E-Payroll Initiative standardizes and consolidates government-wide federal civilian payroll services and processes by simplifying and standardizing Human Resources (HR)/payroll policies and procedures and better integrating payroll, HR, and finance functions. Prior to beginning the initiative, 26 federal agencies provided payroll services. Four providers were selected to furnish payroll services for the Executive branch. In 2004, the Department of Interior began serving as NASA's payroll provider, using their system, the federal Personnel and Payroll System (FPPS), to process NASA's HR and Payroll transactions. The E-Payroll initiative benefits NASA by permitting the Agency to focus on its mission related activities, rather than on administrative payroll functions. Payroll processing costs are reduced through economies of scale and avoiding the cost of duplicative capital system modernization activities. The initiative also promotes standardization of business processes and practices and unified service delivery.

E-Travel (Managing Partner GSA) FY 2008 and FY 2009 Benefits

NASA is currently scheduled to complete migration of its travel services to Electronic Data Systems Corporation (EDS), one of the three designated E-Travel service providers, by October 2008. Upon completion of this migration, NASA will be able to provide more efficient and effective travel management services. The benefits include cost savings associated with cross-government purchasing agreements and improved functionality through streamlined travel policies and processes, strict security and privacy controls, and enhanced Agency oversight and audit capabilities. NASA employees also will also benefit through more efficient travel planning, authorization, and reimbursement processes.

Integrated Acquisition Environment (Managing Partner GSA) FY 2008 and FY 2009 Benefits

The Integrated Acquisition Environment (IAE) initiative launched the new electronic Subcontractor Reporting System (eSRS) (http://www.acq.osd.mil/scst/esrs.htm) in October 2005, with the promise of creating higher visibility and introducing greater transparency into the process of gathering information on federal subcontracting accomplishments. This Internet-based tool is designed to streamline the process of reporting on subcontracting plans and to provide agencies with access to analytical data on subcontracting performance. IAE has seen increased usage of its major acquisition systems over the past year.

Through adoption of the tools and services provided by IAE, NASA improves its ability to make informed and efficient purchasing decisions and allows it to replace manual processes. If NASA were not allowed to use the IAE systems, they would need to build and maintain separate systems to record vendor and contract information, and to post procurement opportunities. Agency purchasing officials would not have access to databases of important information from other agencies on vendor performance and could not use systems to replace paper-based and labor-intensive work efforts.

Integrated Acquisition Environment – Loans & Grants FY 2008 and FY 2009 Benefits

The *Federal Funding Accountability and Transparency Act of 2006* (FFATA) requires OMB to “ensure the existence and operation of a single searchable website, accessible by the public at no cost to access” that includes information on each Federal award. The law specifically requires a unique identifier for the entity receiving the award and of the parent entity of the recipient, should the entity be owned by another entity. Since contracts (and some grants) already require Data Universal Numbering System (DUNS) numbers, a decision was made to leverage this to cover loans and the remainder of the grants. This will allow those areas to feed information into the FFATA portal. The Integrated Acquisition Environment (IAE) currently has a contract with Dun and Bradstreet (D&B) that has been expanded for this purpose. OMB initiated funding requests for each agency to reimburse IAE for this additional cost.

The FY 2008 funding requirements as it relates to the IAE – Loans and Grants funding line supports the FFATA for the relationship with D&B and DUNS support services. In addition to provision of DUNS numbers, D&B is now providing business and linkage data seamlessly, and the business arrangement supports the quality of data by real-time updates. NASA and other agencies will leverage the linkages to corporate organizational rollups based on parental and subsidiary relationships.

E-Authentication (Managing Partner GSA) FY 2008 and FY 2009 Benefits

The Presidential E-Government Initiative, E-Authentication, provides a trusted and secure standards-based authentication architecture to support Federal E-Government applications and initiatives. This approach provides a uniform process for establishing electronic identity and eliminates the need for each initiative to develop their own solution for the verification of identity and electronic signatures, saving time and money across the Federal Government. E-Authentication's distributed architecture allows citizens and businesses to use non-government issued credentials to conduct transactions with the Federal Government.

E-Authentication also created the U.S. E-Authentication Identity Federation, which allows Federation members to recognize and trust login IDs issued by other trusted Federation members. The trusted members issuing these login IDs may be other government agencies, academic institutions, or commercial entities, such as banks or other financial services institutions. As of September 30, 2006, 31 agency systems were members of the Federation, with 70 more scheduled to "go live" within the next 12 months. Six credential service providers are also members of the Federation, providing 3rd party credential provisioning and management to E-Government users.

The initiative will ultimately benefit NASA by providing E-Authentication expertise, guidance, and documentation, including project planning and reporting templates, to enable NASA to achieve production implementation of E-Authentication for its NASA Account Management System (NAMS) application to include a tie to all of its back-end applications that require authentication. In addition, the E-Authentication Federation allows NASA to use identity credentials issued and managed by organizations within and outside the federal government, thereby relieving NASA of much of the cost of providing its own identity management solutions.

Lines of Business

Financial Management LoB (Managing Partners DoE and DoL) FY 2008 and FY 2009 Benefits

Federal agencies began implementing the Financial Management Line of Business (FM LoB) initiative in FY 2006 by actively migrating to centers of excellence service providers and initiating solutions to integrate financial data among and between agency business systems. The FM LoB initiative will ultimately benefit NASA by providing the reference tools and templates needed to assist the Agency in planning and managing migration to a selected center. The FM LoB has established an Advisory Board to govern the activities and decision-making process for the initiative. NASA's involvement with this board affords them the opportunity to review critical issues impacting their FM systems, voice their unique needs and concerns, and collaboratively offer recommendations and influence decisions on how best to implement the common solution.

In the long term, NASA will have the opportunity to play an active role in standardizing core FM business process and data elements. NASA's involvement in this crucial task ensures their needs and requirements are addressed in the target FM LoB enterprise architecture supporting the FM LoB common solution. This work allows NASA to influence the future direction of financial management across the government from both an information technology and business process perspective.

Human Resources Management LoB (Managing Partner OPM) FY 2008 and FY 2009 Benefits

Through the HR LoB, OPM will use enterprise architecture (EA)-based principles and best practices, proven through the E-Gov initiatives and Federal Enterprise Architecture (FEA), to identify common solutions for HR business processes and/or technology-based shared HR services to be made available to government agencies. Driven from a business perspective rather than a technology focus, the solutions will address distinct business improvements that enhance government's performance of HR services in support of agency missions delivering services to citizens. The end result of the HR LoB efforts will be to save taxpayer dollars, reduce administrative burdens, and significantly improve HR service delivery.

NASA will ultimately benefit from the HR LoB through its use of best-in-class HR services and systems provided by one of the approved service providers. Through its adoption of an approved service provider, the Agency can achieve the benefits of "best-in-class" HR solutions without the costs of developing and maintaining their own HR systems. In addition, employees across the Agency will benefit from improved HR services.

Grants Management LoB (Managing Partners HHS and NSF) FY 2008 and FY 2009 Benefits

The Grants Management Line of Business will ultimately offer the development of a government-wide solution to support end-to-end grants management activities promoting citizen access, customer service, and financial and technical stewardship for the Agency. The end result is intended to be a government-wide streamlined grant making process providing transparency and efficiency in the grant decision-making process. The benefits of GM LoB include increased service to citizens through standardized processes; cost savings for grant-making agencies through use of shared IT infrastructure; a reduction in the number of redundant grants management systems; and improved reporting on government-wide grant activities and results. The GM LoB adopted a "consortia-based" approach to implementation and developed a process for forming consortia and having agencies participate in consortia as members. For FY 2007, NASA signed a Memorandum of Understanding (MOU) with its selected consortia partner, the National Science Foundation.

Geospatial LoB (Managing Partner DoI) FY 2008 and FY 2009 Benefits

The Geospatial LoB will better serve the agencies' missions and the Nation's interests developing a more strategic, coordinated, and leveraged approach to producing, maintaining, and using geospatial data and services across the Federal government. Specific goals of the Geospatial LoB include establishing a collaborative governance mechanism, coordinating a government-wide planning and investment strategy, and optimizing and standardizing geospatial data and services. FY 2007 Geospatial LoB activities included baseline data collection activities, a completed LoB performance management strategy and draft performance management plan, establishment of a program management office, completion of an initial FY 2009 Joint Business Case, and signed MOUs/IAAs from all the Federal agencies.

As a science agency, the work of NASA's science and mission professionals is inherently different from duties and functions performed by operational agencies. These differences lead NASA to organize and manage data to best facilitate science activities rather than a central focus of data dissemination. Scientific inquiry often leads scientists to use different schemas for analyzing data and information produced from remote sensing data (e.g., a common grid or projection). NASA will continue to apply the elements of FGDC standards where these are appropriate. In FY 2007, NASA signed an MOU with DoI to actively participate in the Geospatial LoB.

Budget Formulation and Execution LoB (Managing Partner Education) FY 2008 and FY 2009 Benefits

The Budget Formulation and Execution LoB will ultimately benefit NASA by focusing on building a "budget of the future", employing standards and technologies for electronic information exchange to link budget, execution, performance, and financial information throughout all phases of the annual budget formulation and execution cycle. In addition, BFE LoB will identify opportunities for common solutions and automated tools to enhance Agency and central budget processes; provide government with enhanced capabilities for analyzing budget, performance, and financial information; and promote integration and standardize information exchange between budget formulation, execution, financial management, and performance measurement systems and activities across Government.

ITI LoB - IT Infrastructure LoB (Managing Partner GSA) FY 2008 and FY 2009 Benefits

The IT Infrastructure LoB offers the potential to identify opportunities for IT infrastructure consolidation and optimization, and the development of government-wide common solutions. This LoB will define specific common performance measures for service levels and costs, identify best practices, and develop guidance for transition plans within agencies and/or across agencies. Consolidation and optimization of IT infrastructure represents a significant opportunity to realize future cost savings by taking a more coordinated approach to spending on commodity IT infrastructure. IT infrastructure consolidation and optimization case studies also demonstrate agencies could improve IT service levels and, when relieved of the burden of managing these non-core functions, can concentrate more on mission priorities and results.

Throughout FY 2008, NASA and other agencies will gather information on baseline performance for Mainframes and Servers Services and Support, and Telecommunications Systems and Support. In addition, information on costs and service levels in End User Systems and Support shall be reported using performance metrics developed by ITI LoB. In FY 2009, NASA and other agencies will report information on costs and service levels in all three infrastructure areas. Once targets are established, NASA and other agencies will develop and submit 5-year optimization plans and annual progress reports to meet or exceed agency performance targets.

Based on the objectives and goals of this LoB, NASA believes that there is great potential for numerous benefits from the ITI LoB, both for NASA and for other federal agencies. Some of these benefits are relatively easy to quantify, while others are more indirect and require an extended period of time and some econometric analysis prior to producing an estimate. A few of the anticipated FY 2008 - 2009 benefits from NASA's viewpoint are: improved performance, enhanced productivity, greater consistency and standardization of infrastructure platforms, aggregate purchasing of infrastructure components, cross-agency integration possibilities, and planned approach to new technology infusion. At this stage of the ITI formulation process, NASA is unable to provide any quantifiable cost savings that may results from these anticipated benefits.

Management and Performance Overview

The Management and Performance section provides a comprehensive record of the past and planned performance for NASA's programs and projects. This section includes: the key NASA FY 2009 Performance Plan; an update to the FY 2008 Performance Plan based on Congressional budget action; a summary of the cost and schedule performance of NASA's projects with estimated life cycle cost above $250 million; progress on the implementation of the initiatives for the President's Management Agenda (PMA); and the FY 2007 Annual Performance Report.

NASA's planning and performance management processes are an essential part of the Agency's governance and strategic management system. The Agency has an integrated system to: plan strategy and implementation; monitor, assess, and evaluate performance toward commitments; identify issues; gauge programmatic and organizational health; and provide appropriate data and information to NASA decision-makers.

Through its strategic management system, NASA: identifies the Agency's long-term Strategic Goals, multi-year Outcomes, and other key performance measures; develops and implements plans to achieve these Goals; and continuously measures the Agency's progress toward these Goals. NASA managers use performance results as a basis for key investment decisions, and NASA performance data provides a foundation for both programmatic and institutional decision-making processes.

NASA's planning and performance management processes provide data to Agency management via: ongoing monthly and quarterly analysis and reviews; annual assessments in support of budget formulation (for budget guidance and issue identification, analysis, and disposition); annual reporting of performance, management issues, and financial position; periodic, in-depth program or special purpose assessments; and recurring or special assessment reports to internal and external organizations.

NASA's performance system is designed to align with the Agency's internally and externally imposed performance measurement and reporting requirements, tools, and practices, including the Government Performance and Results Act, the President's Management Agenda, and the Office of Management and Budget's Program Assessment Rating Tool (PART) evaluations.

This section contains the updated FY 2008 and the FY 2009 Performance Plans, that reflect the target results for the requested resources, linked to past performance from FY 2007. NASA participated in an OMB pilot for the FY 2007 Performance and Accountability Report, which includes providing an Annual Performance Report, contained in this section, with the budget request. The pilot program also called for a separate Annual Financial Report, published November 15, 2007, and a Performance Highlights document intended for the general public, published electronically on February 1, 2008. Both are available on the NASA Web site at www.nasa.gov/news/budget/index.html. Note that the FY 2009 Performance Plan reflects the new account structure, but does not provide measures for additional content within the Cross-Agency Support Programs. Metrics are under development for next year.

NASA's progress on PMA initiatives and future plans are summarized in this section. Using PART, OMB reviews NASA programs by Theme and provides its finding of relevance, quality, and effectiveness. The findings are incorporated into NASA investment decisions. NASA also commits to improvement actions in response to the findings, which are listed in the Theme sections of this document and included in the Annual Performance Report.

NASA strives to find new ways to use performance information to support decisions concerning strategy and budget. A continued focus for NASA in FY 2008 is to improve the policy, metrics, and analysis processes for cost and schedule performance monitoring and reporting, for both life cycle and contracts. The Major Program Annual Reports discussed in this section is one of the reporting tools used to determine how NASA performs this task. The detailed reports are located in the project sections of this document.

President's Management Agenda

The President's Management Agenda (PMA) commits the executive branch of the federal government to a series of reforms to improve efficiencies and effectiveness in the management of federal programs. The PMA initiative provides requirements and common sense management principles, and as such serves as a foundation to improve management in the critical areas of human capital, real property asset management, acquisitions (competitive sourcing), financial performance, E-Government (information technology), and budget-performance integration. OMB oversees the PMA effort, negotiates performance goals with each agency, and rates agency performance quarterly. NASA's most current ratings for the PMA initiatives are included at the end of this section.

NASA's commitment to PMA implementation continues to improve the Agency's ability to accomplish the NASA Mission and Strategic Goals. PMA commitments strengthen Agency performance in the target areas and have improved Agency strategic planning, program management, and overall performance. Key activities planned for FY 2008 include: providing enhanced workforce planning information to support program decisions; producing monthly financial statements within 30 days after the close of each month; ensuring that all NASA civil servants and contractors are appropriately trained in respective Information Technology (IT) Security roles and responsibilities; continuing the phase-in of the NASA Shared Services Center to realize the benefits from these competitively sourced business areas; improving the process for program/project performance tracking and reporting at the Agency-level Program Management Council; and improving real property asset management through developing an Agency-wide master plan and a five-year capital improvement plan.

The following sub-sections outline NASA's progress to date in implementing these key initiatives, and the Agency's FY 2008 plans to improve its management efficiency and effectiveness. Many of these plans are currently underway, building upon important past efforts.

NASA's President's Management Agenda Scorecard:

	Human Capital	Competitive Sourcing	Financial Performance	E-Government	Performance Improvement	Federal Real Property Management
STATUS	GREEN	GREEN	RED	YELLOW	GREEN	YELLOW
PROGRESS	GREEN	GREEN	YELLOW	GREEN	GREEN	YELLOW

Scorecard Status as of: December 31, 2007

Human Capital

Since the inception of the President's Management Agenda, NASA has worked with the Office of Personnel Management to transition the Agency from an often Center-specific workforce management approach to a more strategic, integrated, aligned, and automated Agency-wide approach. In particular, the Agency has attempted to tie workforce management more closely to NASA's Mission and Strategic Goals. The achievement of NASA's planned Human Capital PMA milestones will continue to take the Agency in this direction.

Throughout FY 2007 NASA maintained a "Green" rating for this initiative. In FY 2008, NASA will further refine the Agency's integrated workforce planning process, ensuring that Center resources are aligned with programs and projects, and enabling an effective workforce transition by completing the Shuttle-to-Constellation Workforce Mapping Project. Information generated from analyses conducted during this process will drive a large portion of the remaining Human Capital Program, including recruitment, training and development, information systems, and overall skills rebalancing activities. In particular, NASA will strengthen leadership development programs and continue emphasis on building leaders, building technical excellence, and building effective organizations. NASA will also update the recruitment strategy for the Agency, reflecting workforce planning analysis, and continue to strengthen the linkage between employee and organizational performance through the Agency's performance management program.

To enable more effective and efficient human resources operations, NASA will complete the integration of all Agency-wide human capital systems in the Human Capital Information Environment (HCIE). HCIE will deliver timely, useful, and comprehensive information for workforce planners, program/project managers and other stakeholders to assist in decision-making. NASA will implement the electronic Official Personnel Folder (eOPF) and ensure that all NASA employees have access to an accurate eOPF electronic record. NASA will continue to refine its efforts to assess and measure the efficiency and effectiveness of its overall Human Capital Program, including an innovative series of Center-by-Center assessments designed to gauge Center performance and provide opportunities for sharing best practices from across NASA's multiple installations.

Competitive Sourcing

NASA's current status is "Green" for the Competitive Sourcing initiative, based on the Office of Management and Budget's (OMB) latest assessment. One of the requirements for an agency to receive a "Green" rating for the Competitive Sourcing initiative is to develop and maintain a Green Plan that is approved by OMB. In response to OMB's guidelines, NASA submitted its updated Green Plan on August 3, 2007. Pursuant to the Green Plan, NASA has now completed two standard public-private competitions, the "Metallic Test Article Development and General Precision and Machining Services" at Langley Research Center (LaRC), and the NASA Shared Services Center (NSSC). To date, NASA has also reviewed or competed 3,552 of the 4,380 FTE originally designated as commercial in nature in the Agency's 2003 FAIR Act inventory.

In order for NASA to maintain its "Green" status in Competitive Sourcing, the Agency is also responsible for performing post-competition accountability reviews of the selected service providers in each competition for evidence of improved performance and reduced costs. The NSSC review was performed in August 2007, and the next LaRC review is scheduled to be conducted in May 2008. NASA continues with its phase-in of activities to the NSSC as scheduled to enable the Agency to achieve savings of $42 million over a 10-year period. NASA will continue to monitor performance and costs of the service providers of the Metallic Test Article Development and General Precision Machining Services and the NSSC to ensure accountability and improvement. On a continual, annual basis, NASA conducts competitions for science and technological research through NASA's Research Announcements and Announcements of Opportunity using the approved deviation for scientific and technological research, as reported in response to Section 647(b) of Division F of the Consolidated Appropriations Act for FY 2004 (P.L. 108-199). These competitive opportunities for science and technology research result in award of contracts and grants, involving a minimum 440 FTE Agency-wide, which provide NASA with the best value in world-class science research.

Financial Performance

During FY 2007, NASA made progress toward achieving the objectives for Improved Financial Performance, achieving a "Green" rating for Progress. Additionally, the Agency's independent financial auditors acknowledged progress and improvements in the areas of NASA's two material weaknesses, Financial Systems Analyses and Oversight and Property, Plant, and Equipment.

Among other actions in FY 2007, NASA:
- Upgraded the Core Financial System to resolve certain system configuration issues and to improve technical and functional system operations. A key feature of this upgrade provides better funds distribution control.
- Enhanced monthly monitoring and control procedures to promote solid Center account reconciliations and effective Agency oversight. By improving insight into Center-level financial transactions, these enhancements also expedite error detection and correction. As an example, this has resulted in substantial improvement in the reconciliation of the Agency's Fund Balance with Treasury account, where unknown differences between the U.S. Treasury and NASA have been eliminated, as noted in recent audit reports.
- Improved relevance and timeliness of financial reporting through implementation of a Change in Accounting Principle for capitalization of Property, Plant, and Equipment. This change acknowledges that much of the Agency's work is research and development and that, consistent with Federal Accounting Standards Advisory Board guidance, many program and project costs previously capitalized should be expensed in the period incurred. NASA has also modified its accounting practices to better identify assets at project inception and track the costs of these assets through project life cycles.
- Improved approach and processes for implementing Congressional requirements for identifying improper payments. Results of the Agency's Improper Payments Improvement Act (IPIA) program risk assessment showed that improper payment rates were less than .01 percent, and are significantly below OMB's materiality thresholds.

The Agency recognizes that more remains to be done to improve NASA's financial management performance in preparing financial statements compliant with Federal accounting standards, achieving an unqualified audit opinion on its financial statements, and resolving the material weaknesses in internal controls. NASA is focused on developing a comprehensive and realistic plan to resolve impediments to these objectives. NASA is currently preparing a Comprehensive Compliance Strategy that will establish the direction and specific steps to address auditability and internal control weaknesses, as well as improve overall financial management during FY 2008 and forward.

E-Government

In September 2007, NASA's Information Resources Management (IRM) Strategic Plan was updated to align with the Agency's Strategic Goals and to demonstrate performance against the 2006 IRM strategic goals. The NASA Chief Information Officer (CIO) has identified four revised IRM strategies to support the achievement of the Agency's Mission. These four strategies will also provide the foundation necessary for NASA to achieve its FY 2008 E-Government Implementation milestones.

The Agency's IT Security Division experienced marked success in the completion of Certification and Accreditation (C&A) of its systems and applications during FY 2007. In FY 2008, NASA intends to build on this momentum by executing the C&A continuous monitoring program, including annual testing of security controls. In addition, NASA intends to execute the Federal Desktop Core Configuration (FDCC) for its non-mission critical end user Windows desktops. Finally, NASA expects to show marked improvement in identifying and responding to vulnerabilities as the Agency-wide Vulnerability Management Program matures.

For Enterprise Architecture (EA), the Agency met 100 percent of its prior year IRM goals. For FY 2008, NASA plans to develop a comprehensive strategy and master plan to manage the Agency's IT infrastructure, enabling cross-Center collaboration and achieving efficiencies. This action requires expanding the CIO EA function to incorporate requirements and engineering analysis, technology integration, and defining standards. Finally, NASA plans to have 100 percent of enterprise architects FEAC certified, conduct 32 EA reviews on major IT investments, and meet or exceed the PMA "Maintaining Green" criteria for EA.

Improvements in the Agency's BY 2009 Exhibit 300 submission have resulted in acceptable business cases for all NASA's major IT investments and no business cases on the Management Watch list. Building on these successes, for FY08 the Agency is undergoing a major transformation of its IT management model, implementing significant changes to integrate people, processes, and information, enabling better support of the NASA Mission. The new IT strategic direction consolidates, integrates, simplifies and secures the enterprise IT infrastructure and applications needed to support these requirements.

In the first quarter of FY 2008 NASA raised its E-Gov PMA scorecard to "Green" in Progress and to "Yellow" in Status. This represents a major improvement from the Agency's FY 2007 E-Gov scorecard of "Red" in Progress and Status. NASA remains actively engaged in 16 of the original 24 E -Gov initiatives, plus the E-Authentication crosscutting initiative. In addition, the Agency is currently in formulation or in implementation for eight of the nine Federal Lines of Business initiatives. Additional information about NASA's FY 2008 and FY 2009 funding contributions and expected benefits for these E-Gov initiatives can be found in the supporting data section of this document.

Performance Improvement

NASA improves its management effectiveness by using performance data to inform budget development and execution decisions. The Government Performance and Results Act (GPRA) of 1993 introduced accountability for doing so through its implementation. However, GPRA requirements alone did not provide NASA with the leverage needed to round out linking performance and budget. The President's Management Agenda (PMA) Budget and Performance Integration (BPI) Initiative provided standards and deliverables, which have informed, complemented and linked NASA's on-going efforts and the GPRA requirements. The initiative provided the additional leverage to institutionalize into the fabric of the agency an overarching system that more effectively links strategy to performance to budget.

NASA was the first federal agency to receive a "Green" rating for BPI. NASA continues to be "Green" having demonstrated to OMB that it is guided by a single framework that integrates strategic and programmatic planning, budgeting, and performance management and reporting processes, referred to as the Planning, Programming, Budgeting, and Execution (PPBE) process. In this framework, past performance and current performance plans inform the budgeting process, and based on budgeted amounts, specific performance goals are set via the use of the PPBE process. For FY 2007, NASA received a "Green" rating on both status and progress.

In FY 2007, this initiative was renamed to the Performance Improvement Initiative (PII) to reflect the White House's commitment to improve the performance of federal programs. NASA supports this goal and works toward this end. In FY 2008, NASA will continue its performance improvement activities initiated in FY 2007. Specifically NASA continues the development of an integrated set of Agency-level metrics that includes both programmatic and institutional performance and improved reporting and analysis for lifecycle cost and schedule. NASA will also improve the process for program/project performance tracking and reporting at the Agency-level Program Management Council.

Federal Real Property Management

During FY 2007, NASA made continued progress toward achieving the objectives of the President's Management Agenda for Federal Real Property Management. OMB acknowledged NASA's progress toward improved real property management by maintaining its Status rating as "Green." Although NASA is currently "Yellow" in Progress, NASA expects to be able to re-gain a "Green" rating for Progress in the coming year.

NASA will continue its role as a leader in promoting efficient and economical use of its real property assets via its real property initiatives and the Agency's Real Property Asset Management Plan. NASA uses the Agency's Asset Management Plan as a tool to integrate real property considerations into the Agency's corporate decision-making process. NASA will continue as an active participant on the Federal Real Property Council, which guides and informs development of government-wide best practices.

NASA recognizes that there is much work left to be done. In FY 2008, NASA will complete the following actions:

- Perform a complete and accurate update of NASA inventory data to submit to the Federal Real Property Profile;
- Benchmark and continue to inform other federal agencies and federal research consortium members of the capabilities of NASA facilities identified in the Major Facility Inventory;
- Have measurable progress towards implementation of the common government-wide federal transfer screening process;
- Have measurable progress in the improvement of NASA asset condition, maintaining NASA assets as safe, secure, and environmentally sound;
- Initiate a web-based 20-year Capital Investment Program Plan for long-range planning established as an Agency-wide master plan;
- Expand enhanced use leasing and continue to bring in revenue and improve usage rates and facility conditions by leveraging the value of under-utilized, but necessary to retain, assets through innovative out-leasing and public-private ventures; and
- Provide annual updates and improvements to the real property asset management plan, including an Agency-wide master plan and a five-year capital improvement plan.

Specifically, in support of the PMA and its Asset Management Plan NASA will continue to develop and implement its plans for use of the "existing building" standards from U.S. Green Building Council Leadership in Energy and Environment Design (LEED), which will support sustainable management of existing assets. Further, NASA will finalize development of a web tool for updating the Mission Dependency Index (MDI), which is a metric used to communicate to management, the relative importance of a facility in terms of mission criticality. In identifying relative "mission worth" of facilities, MDI can be used to identify facilities of marginal value to the Agency.

Major Program Annual Report Summary

This report is provided to meet the requirements of section 103 of the National Aeronautics and Space Administration Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613; the Act). The FY 2008 Major Program Annual Report (MPAR) includes 12 annual updates for major projects in development. Report details are found in the individual project sections with a summary table provided below.

An annual report update is required for the following projects: the Gamma-ray Large Area Space Telescope (GLAST), the Kepler mission, the Herschel space Observatory, the Solar Dynamics Observatory (SDO), the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP), the Wide-field Infrared Survey Explorer (WISE), the Stratospheric Observatory for Infrared Astronomy (SOFIA), the Aquarius mission, the Glory mission, the Orbiting Carbon Observatory (OCO), the Mars Science Laboratory 2009, and the Lunar Reconnaissance Orbiter (LRO). Two projects, the Dawn and Phoenix missions, entered operations and are no longer included in these reports. No major projects received authority to proceed into development in 2007.

In the following table, the Base Year Development Cost and Current Development Cost columns are provided in direct cost dollars and reflect FY 2009 cost accounting changes, which reallocate Center and other indirect costs to separate accounts. The MPAR base year development cost estimates in the MPAR summary table are adjusted to reflect FY 2009 cost accounting in order to allow a direct comparison between the MPAR baseline and current development cost estimates. The MPAR is provided under FY 2009 accounting rules to correspond with the requested budget numbers.

Since the inception of this provision of the law, eight projects have exceeded Congressional thresholds on cost or schedule growth. At the time of the FY 2007 MPAR, three projects had exceeded the growth thresholds: Herschel, Kepler and NPP. Since the FY 2007 MPAR, two additional projects exceeded the cost growth threshold--Glory and OCO--and three projects--Aquarius, GLAST and SOFIA--have exceeded the six month Congressional schedule threshold as compared to their FY 2006 or FY 2007 baselines.

Glory has exceeded the 30 percent cost threshold, due to technical difficulties and performance issues with the contracted development of the Aerosol Polarimetry Sensor, which resulted in cost growth on the contract, leading to growth in development costs. OCO experienced difficulties with the contractor for its primary instrument. As a result of these difficulties, NASA removed the work from the contractor and decided to finish the instrument work in house at the Jet Propulsion Laboratory. This transition contributed to the cost and schedule growth reported here. Aquarius experienced a schedule slip of 10 months, resulting from schedule delays by its mission partner, Argentina. GLAST has experienced a schedule slip due to issues with the Command and Data Handling sub-system, schedule conflicts with the Department of Defense, and spacecraft contractor performance issues. The change in the date for full operational capability for the SOFIA project reflects a replan for this project, which also provides for earlier initial operational capability and science returns than previously planned.

Management and Performance

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (Months)
NPOESS Preparatory Project (NPP)	2006	592.9	2008	703.8	19	Launch Readiness	4/30/2008	6/30/2010	26
Glory Mission	2007	168.9	2008	220.9	31	Launch Readiness	12/31/2008	3/31/2009	3
Aquarius	2007	192.6	2008	203.3	6	Launch Readiness	7/1/2009	5/1/2010	10
Orbiting Carbon Observatory (OCO)	2007	186.5	2008	219.6	18	Launch Readiness	9/30/2008	12/31/2008	3
2009 Mars Science Lab	2007	968.6	2008	1,035.0	7	Launch Readiness	9/30/2009	9/30/2009	0
Stratospheric Observatory for Infrared Astronomy (SOFIA)	2007	919.5	2008	946.4	3	Full Operation (FOC)	12/30/2013	9/15/2014	9
Herschel	2006	117.0	2008	131.7	13	Launch Readiness	8/30/2007	10/30/2008	14
Gamma-ray Large Space Telescope (GLAST) Project	2006	403.3	2008	423.1	5	Launch Readiness	9/30/2007	5/30/2008	8
Kepler	2006	312.7	2008	390.2	25	Launch Readiness	6/30/2008	2/28/2009	8
Wide-Field Infrared Survey Explorer	2007	192.1	2008	190.9	-1	Launch Readiness	11/30/2009	11/30/2009	0
Solar Dynamics Observatory (SDO)	2006	623.7	2008	641.4	3	Launch Readiness	8/30/2008	12/30/2008	4
Lunar Reconnaissance Orbiter	2007	420.8	2008	421.0	0	Launch Readiness	10/30/2008	10/30/2008	0

FY 2008 Performance Plan Update Narrative

The enclosed FY 2008 Performance Plan has been updated to reflect any realignment and reprioritization of Agency programs and projects as a result of the FY 2007 and FY 2008 Appropriations. There are two program areas that have significantly changed performance commitments as a result of congressional redirection: Education and the Innovative Partnerships Program. Changes to the performance commitment are outlined within the individual APG. Eliminated APGs may be found at the end of this plan.

FY 2008 Performance Plan Update

Measure #	Description	Contributing Program (s)	Contributing Theme (s)
Strategic Goal 1	**Fly the Shuttle as safely as possible until its retirement, not later than 2010.**		
Outcome 1.1	**Assure the safety and integrity of the Space Shuttle workforce, systems and processes, while flying the manifest.**		
APG 8SSP01	Achieve zero Type-A (damage to property at least $1 million or death) or Type-B (damage to property at least $250 thousand or permanent disability or hospitalization of three or more persons) mishaps in FY2008.	Space Shuttle Program	Space Shuttle
APG 8SSP02	Complete 100 percent of all mission objectives for all Space Shuttle missions in FY2008 as specified in the Flight Requirements Document for each mission.	Space Shuttle Program	Space Shuttle
Outcome 1.2	**By September 30, 2010, retire the Space Shuttle.**		
APG 8SSP03	Develop a detailed schedule of last-need dates for all significant Space Shuttle program element capabilities.	Space Shuttle Program	Space Shuttle
APG 8SSP04	A 9 percent reduction (over FY2007 values) in the annual value of Shuttle production contracts for Orbiter, External Tank, Solid Rocket Boosters, Reusable Solid Rocket Motor, Space Shuttle Main Engine and Launch & Landing, while maintaining safe flight.	Space Shuttle Program	Space Shuttle
Strategic Goal 2	**Complete the International Space Station in a manner consistent with NASA's International partner commitments and the needs of human exploration.**		
Outcome 2.1	**By 2010, complete assembly of the U.S. On-orbit Segment; launch International Partner elements and sparing items required to be launched by the Shuttle; and provide on-orbit resources for research to support U.S. human space exploration.**		
APG 8ISS01	Based on the actual Space Shuttle flight rate, number of remaining Shuttle flights, and the discussions with the International Partners, update the agreed-to ISS assembly sequence and transportation plan as necessary.	International Space Station Program	International Space Station
APG 8ISS02	Accomplish a minimum of 90 percent of the on-orbit research objectives as established one month prior to a given increment.	International Space Station Program	International Space Station
APG 8ISS03	Per the final configuration agreed to by the International Partners, fly the ISS elements and logistics baselined for FY2008.	International Space Station Program	International Space Station
APG 8ISS04	Provide increased power capability by assembling the remaining Truss element as baselined in FY2008.	International Space Station Program	International Space Station
Outcome 2.2	**By 2009, provide the on-orbit capability to support an ISS crew of six crewmembers.**		
APG 8ISS05	Establish flight-ready status for the Water Recovery System (part of the U.S. Regenerative Environmental Control Life Support System).	International Space Station Program	International Space Station

FY 2008 Performance Plan Update

Measure #	Description	Contributing Program (s)	Contributing Theme (s)
APG 8ISS06	In concert with the International Partners, assure a continuous crew presence on the ISS.	International Space Station Program	International Space Station
Outcome 2.3	**Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.**		
APG 8AC01	Design, build, and deliver for flight two ISS experiments.	Exploration Technology Development	Advanced Capabilities
APG 8AC02	Design, build, and deliver for flight two Foton M3 experiments.	Exploration Technology Development	Advanced Capabilities
APG 8AC03	Conduct 30 ground-based investigations in the physical and biological sciences that promote the development of related microgravity research capabilities.	Exploration Technology Development	Advanced Capabilities
Strategic Goal 3	**Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.**		
Sub Goal 3A	**Study Earth from space to advance scientific understanding and meet societal needs.**		
Outcome 3A.1	**Progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.**		
APG 8ES01	Demonstrate progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition, based on measurements from presently orbiting NASA and non-NASA assets. Progress will be evaluated by external expert review.	Multiple Programs	Earth Science
Outcome 3A.2	**Progress in enabling improved predictive capability for weather and extreme weather events.**		
APG 8ES02	Demonstrate progress in enabling improved predictive capability for weather and extreme weather events. Progress will be evaluated by external expert review.	Multiple Programs	Earth Science
Outcome 3A.3	**Progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models.**		
APG 8ES03	Demonstrate progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models. Progress will be evaluated by external expert review.	Multiple Programs	Earth Science
APG 8ES04	Complete the Orbiting Carbon Observatory (OCO) Operational Readiness Review.	Earth System Science Pathfinder	Earth Science
Outcome 3A.4	**Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability.**		
APG 8ES05	Demonstrate progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability. Progress will be evaluated by external expert review.	Multiple Programs	Earth Science
APG 8ES06	Complete Global Precipitation Measurement (GPM) Mission Spacecraft Preliminary Design Review (PDR).	Earth Systematic Missions	Earth Science
Outcome 3A.5	**Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.**		

FY 2008 Performance Plan Update

Measure #	Description	Contributing Program (s)	Contributing Theme (s)
APG 8ES07	Demonstrate progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution. Progress will be evaluated by external expert review.	Multiple Programs	Earth Science
APG 8ES08	Launch the Ocean Surface Topography Mission (OSTM).	Earth Systematic Missions	Earth Science
APG 8ES09	Complete the Glory mission Operational Readiness Review (ORR).	Earth Systematic Missions	Earth Science
APG 8ES10	Complete the Aquarius Instrument Pre-ship Review.	Earth System Science Pathfinder	Earth Science
Outcome 3A.6	**Progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields.**		
APG 8ES11	Demonstrate progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields. Progress will be evaluated by external expert review.	Multiple Programs	Earth Science
Outcome 3A.7	**Progress in expanding and accelerating the realization of societal benefits from Earth system science.**		
APG 8ES12	Issue twelve reports with partnering organizations that validate using NASA research capabilities (e.g., observations and/or forecast products) could improve their operational decision support systems.	Applied Sciences	Earth Science
APG 8ES13	Increase the number of distinct users of NASA data and services.	Earth Science Research	Earth Science
APG 8ES14	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science Research	Earth Science
Sub Goal 3B	**Understand the Sun and its effects on Earth and the solar system.**		
Outcome 3B.1	**Progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.**		
APG 8HE01	Demonstrate progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress will be evaluated by external expert review.	Multiple Programs	Heliophysics
APG 8HE02	Complete Magnetospheric Multiscale (MMS) System Design Review (SDR).	Solar Terrestrial Probes	Heliophysics
Outcome 3B.2	**Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields.**		
APG 8HE03	Demonstrate progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields. Progress will be evaluated by external expert review.	Multiple Programs	Heliophysics
APG 8HE04	Complete Phase A for the Geospace Radiation Belt Storm Probes mission.	Living with a Star	Heliophysics
Outcome 3B.3	**Progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers.**		

FY 2008 Performance Plan Update

Measure #	Description	Contributing Program (s)	Contributing Theme (s)
APG 8HE05	Demonstrate progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers. Progress will be evaluated by external expert review.	Multiple Programs	Heliophysics
APG 8HE06	Complete Solar Dynamics Observatory (SDO) Integrated Observatory Performance Test.	Living with a Star	Heliophysics
Sub Goal 3C	**Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.**		
Outcome 3C.1	**Progress in learning how the Sun's family of planets and minor bodies originated and evolved.**		
APG 8PS01	Demonstrate progress in learning how the Sun's family of planets and minor bodies originated and evolved. Progress will be evaluated by external expert review.	Multiple Programs	Planetary Science
APG 8PS02	Complete the Mercury Surface, Space Environment, Geochemisry and Ranging (MESSENGER) Mercury Flyby 1.	Discovery	Planetary Science
APG 8PS03	Begin Juno instruments detailed design.	New Frontiers	Planetary Science
Outcome 3C.2	**Progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds.**		
APG 8PS04	Demonstrate progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds. Progress will be evaluated by external expert review.	Multiple Programs	Planetary Science
APG 8PS05	Begin 2009 Mars Science Laboratory (MSL) Assembly, Test, Launch Operations (ATLO).	Mars Exploration	Planetary Science
Outcome 3C.3	**Progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system.**		
APG 8PS06	Demonstrate progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system. Progress will be evaluated by external expert review.	Multiple Programs	Planetary Science
APG 8PS07	Land the Phoenix spacecraft on the Martian surface and begin science operations.	Mars Exploration	Planetary Science
Outcome 3C.4	**Progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence.**		
APG 8AC04	Develop and deliver the Radiation Assessment Detector (RAD) for the Mars Science Laboratory, scheduled to fly in 2009.	Human Research Program	Advanced Capabilities
APG 8PS08	Demonstrate progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence. Progress will be evaluated by external expert review.	Multiple Programs	Planetary Science

FY 2008 Performance Plan Update

Measure #	Description	Contributing Program (s)	Contributing Theme (s)
Sub Goal 3D	**Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.**		
Outcome 3D.1	**Progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity.**		
APG 8AS01	Demonstrate progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity. Progress will be evaluated by external expert review.	Multiple Programs	Astrophysics
APG 8AS02	Launch the Gamma-ray Large Area Space Telescope (GLAST).	Gamma-ray Large Space Telescope (GLAST) Program	Astrophysics
Outcome 3D.2	**Progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects recognized in the present universe.**		
APG 8AS03	Demonstrate progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects we recognize in the present universe. Progress will be evaluated by external expert review.	Multiple Programs	Astrophysics
APG 8AS04	Complete James Webb Space Telescope (JWST) Preliminary Design Review (PDR).	James Webb Space Telescope	Astrophysics
APG 8AS05	Complete Hubble Space Telescope Servicing Mission 4 (HST SM4) Pre-ship Review.	Hubble Space Telescope	Astrophysics
Outcome 3D.3	**Progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems.**		
APG 8AS04	Complete James Webb Space Telescope (JWST) Preliminary Design Review (PDR).	James Webb Space Telescope	Astrophysics
APG 8AS05	Complete Hubble Space Telescope Servicing Mission 4 (HST SM4) Pre-ship Review.	Hubble Space Telescope	Astrophysics
APG 8AS06	Demonstrate progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems. Progress will be evaluated by external expert review.	Multiple Programs	Astrophysics
Outcome 3D.4	**Progress in creating a census of extra-solar planets and measuring their properties.**		
APG 8AS07	Demonstrate progress in creating a census of extra-solar planets and measuring their properties. Progress will be evaluated by external expert review.	Multiple Programs	Astrophysics
APG 8AS08	Complete the Kepler spacecraft Integration and Test (I&T) phase.	Discovery	Astrophysics
Sub Goal 3E	**Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.**		
Outcome 3E.1	**By 2016, identify and develop tools, methods, and technologies for improving overall aircraft safety of new and legacy vehicles operating in the Next Generation Air Transportation System (projected for the year 2025).**		
APG 8AT01	Provide definition of an Integrated Resilient Aircraft Control (IRAC) architecture and capabilities, and identify technology implementation barriers for full IRAC capability.	Aviation Safety	Aeronautics Technology
APG 8AT02	Complete a feasibility study for assessment of active operator assistance in approach and landing task, including active attention management.	Aviation Safety	Aeronautics Technology

FY 2008 Performance Plan Update

Measure #	Description	Contributing Program (s)	Contributing Theme (s)
APG 8AT03	Develop a framework that integrates Aging Aircraft and Durability technologies to detect, predict, and mitigate aging/durability related hazards and insert current state-of-the -art methods in framework to establish a baseline.	Aviation Safety	Aeronautics Technology
APG 8AT04	Using aircraft landing gear system as a testbed, develop and validate Integrated Vehicle Health Management sensor fusion, fault detection, and isolation methods.	Aviation Safety	Aeronautics Technology
Outcome 3E.2	**By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the Next Generation Air Transportation System.**		
APG 8AT05	Conduct service-provider-based automated separation assurance simulation.	Airspace Systems	Aeronautics Technology
APG 8AT06	Demonstrate trajectory analysis technology for automated separation assurance.	Airspace Systems	Aeronautics Technology
Outcome 3E.3	**By 2016, develop multidisciplinary analysis and design tools and new technologies, enabling better vehicle performance (e.g., efficiency, environmental, civil competitiveness, productivity, and reliability) in multiple flight regimes and within a variety of transportation system architectures.**		
APG 8AT07	Develop and test component technology concepts used in conventional aircraft configurations that establish the feasibility of achieving Stage 3 -42 EPNdb (cumulative) noise reduction.	Fundamental Aeronautics	Aeronautics Technology
APG 8AT08	Develop and test component technology concepts for unconventional aircraft configurations that establish the feasibility of achieving short take-off and landings on runways less than 3000 feet.	Fundamental Aeronautics	Aeronautics Technology
APG 8AT09	Validate model engine stall control concepts using component test data obtained in test cell CE18 in order to extend rotorcraft engine operability range.	Fundamental Aeronautics	Aeronautics Technology
APG 8AT10	Develop a rotorcraft model, validated with data from gear noise and vibration testing, to predict reductions in gear vibration transmission.	Fundamental Aeronautics	Aeronautics Technology
APG 8AT11	Demonstrate a composite supersonic engine fan blade containment system that is 20 percent lighter than the High Speed Research Program metallic containment system and validate through laboratory tests.	Fundamental Aeronautics	Aeronautics Technology
APG 8AT12	Demonstrate a high fidelity analysis technique for assessing the impact of nozzle plume effects on the off body flow field of a supersonic aircraft and validate predicted results within 5 percent of flight data.	Fundamental Aeronautics	Aeronautics Technology
APG 8AT13	Characterize multi-functional advanced ablator systems in arcjet facilities to provide a database for material degradation models for hypersonic vehicles.	Fundamental Aeronautics	Aeronautics Technology
APG 8AT14	Evaluate state-of-the-art hypersonic flight simulation tools, ablator systems, and GNC technologies using data from sub-orbital SOAREX flight 1.	Fundamental Aeronautics	Aeronautics Technology
Outcome 3E.4	**Ensure the continuous availability of a portfolio of NASA-owned wind tunnels/ground test facilities, which are strategically important to meeting national aerospace program goals and requirements.**		
APG 8AT15	Develop a maintenance and investment strategy for NASA owned wind tunnels/ground test facilities to ensure their long-term health and operational availability.	Aeronautics Test Program	Aeronautics Technology

FY 2008 Performance Plan Update

Measure #	Description	Contributing Program (s)	Contributing Theme (s)
APG 8AT16	Develop a long-term, flight operations/test infrastructure vision and funded plan working with all the appropriate stakeholders, to assure that the plan reflects the priorities of the long-term needs of the Nation.	Aeronautics Test Program	Aeronautics Technology
Sub Goal 3F	**Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration.**		
Outcome 3F.1	**By 2008, develop and test candidate countermeasures to ensure the health of humans traveling in space.**		
APG 8AC05	Publish results of renal stone countermeasure experiments and evaluate for operational use.	Human Research Program	Advanced Capabilities
APG 8AC06	Complete study of a non-pharmacological countermeasure for bone loss in a spaceflight analog environment.	Human Research Program	Advanced Capabilities
APG 8AC07	Characterize the size distribution of lunar dust (from Apollo samples) in the inhalable size range (<10 micrometers), and begin toxicity testing with simulated lunar dust.	Human Research Program	Advanced Capabilities
APG 8AC08	Determine the stability of a controlled set of food/nutritional items and common medications, representative of the types and classes typically provided on space missions, after six months exposure to the space flight environment.	Human Research Program	Advanced Capabilities
Outcome 3F.2	**By 2010, identify and test technologies to reduce total mission resource requirements for life support systems.**		
APG 8AC09	Deliver two prototype life support systems: the Carbon Dioxide and Moisture Removal Amine System (CAMRAS); and the Sorbent Based Air Revitalization (SBAR) System.	Human Research Program	Advanced Capabilities
Outcome 3F.3	**By 2010, develop reliable spacecraft technologies for advanced environmental monitoring and control and fire safety.**		
APG 8AC10	Deliver the Vehicle Cabin Atmosphere Monitoring (VCAM) flight hardware in preparation for launch to ISS.	Exploration Technology Development	Advanced Capabilities
APG 8AC11	Deliver the Electronic Nose (E-Nose) flight hardware in preparation for launch to ISS	Exploration Technology Development	Advanced Capabilities
APG 8AC12	Launch the Smoke Aerosol Measurement Experiment (SAME) to ISS and initiate testing.	Exploration Technology Development	Advanced Capabilities
APG 8AC13	Deliver the Combustion Integrated Rack (CIR) and its insert, the Flame Extinguishment Experiment in preparation for launch to ISS.	Exploration Technology Development	Advanced Capabilities
Strategic Goal 4	**Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.**		
Outcome 4.1	**No later than 2014, and as early as 2010, transport three crewmembers to the International Space Station and return them safely to earth, demonstrating an operational capability to support human exploration missions.**		
APG 8CS01	Complete the Preliminary Design Review (PDR) for the Orion/Crew Exploration Vehicle (CEV).	Constellation Systems Program	Constellation Systems
APG 8CS02	Complete Critical Design Review (CDR) for the Ares I-1 flight demonstration test.	Constellation Systems Program	Constellation Systems
APG 8CS03	Complete the Preliminary Design Review (PDR) for Ares-I/Crew Launch Vehicle.	Constellation Systems Program	Constellation Systems
APG 8CS04	Complete the Critical Design Review (CDR) for the ground infrastructure/systems at the launch site.	Constellation Systems Program	Constellation Systems

FY 2008 Performance Plan Update

Measure #	Description	Contributing Program (s)	Contributing Theme (s)
APG 8CS05	Complete the System Design Review (SDR) for mission operations infrastructure and systems.	Constellation Systems Program	Constellation Systems
APG 8CS06	Complete the Preliminary Design Review (PDR) for the Extravehicular Activity (EVA) Systems.	Constellation Systems Program	Constellation Systems
Outcome 4.2	**By 2010, successfully transition applicable Shuttle components, infrastructure, and workforce to the Constellation Systems program.**		
APG 8CS07	Demonstrate progress towards the transition of Space Shuttle and International Space Station Infrastructure for utilization in Constellation Systems, including transfer of Mobile Launch Platform 1.	Constellation Systems Program	Constellation Systems
Strategic Goal 5	**Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.**		
Outcome 5.1	**Develop and demonstrate a means for NASA to purchase launch services from emerging launch providers.**		
APG 8IPP05	Demonstrate purchase of services from the emerging commercial space sector for microgravity research and training. (Purchase of services will be at a 40% reduced level from planned per the FY08 budget request.)	Innovative Partnerships Program	Innovative Partnerships Program
APG 8SFS01	Realize competitive rates from emerging U.S. launch providers and open the bidding process to a larger number of launch providers.	Launch Services	Space and Flight Support (SFS)
Outcome 5.2	**By 2010, demonstrate one or more commercial space services for ISS cargo and/or crew transport.**		
APG 8CS08	Complete the Flight Demonstration 1 Readiness Review leading up to demonstration flights in FY2009.	Constellation Systems Program	Constellation Systems
APG 8CS09	Complete the Flight Demonstration 2 Preliminary Design Review (PDR) leading up to demonstration flights in FY2009.	Constellation Systems Program	Constellation Systems
APG 8CS10	Complete the Flight Demonstration 3 System Requirements Review (SRR) leading up to demonstration flights in FY2009.	Constellation Systems Program	Constellation Systems
Outcome 5.3	**By 2012, complete one or more prize competitions for independently designed, developed, launched, and operated missions related to space science or space exploration.**		
APG 8IPP06	Demonstrate benefits of prize competitions by awarding at least one prize and communicating the resulting technology advancements.	Innovative Partnerships Program	Innovative Partnerships Program
Strategic Goal 6	**Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.**		
Outcome 6.1	**By 2008, launch a Lunar Reconnaissance Orbiter (LRO) that will provide information about potential human exploration sites.**		
APG 8AC14	Complete the Critical Design Review (CDR), Mission Readiness Review (MRR), and Payload Engineering Review (PER) for the Lunar Reconnaissance Orbiter.	Lunar Precursor Robotic Program	Advanced Capabilities
APG 8AC15	Complete the Critical Design Review (CDR) and Mission Readiness Review (MRR) for the Lunar Crater Observation and Sensing Satellite.	Lunar Precursor Robotic Program	Advanced Capabilities
Outcome 6.2	**By 2012, develop and test technologies for in situ resource utilization, power generation, and autonomous systems that reduce consumables launched from Earth and moderate mission risk.**		
APG 8AC16	Achieve authority to proceed for a medium lander mission to be launched in the 2010-2011 timeframe that would characterize the lunar surface environment.	Lunar Precursor Robotic Program	Advanced Capabilities

FY 2008 Performance Plan Update

Measure #	Description	Contributing Program (s)	Contributing Theme (s)
Outcome 6.3	**By 2013, sufficiently develop and test technologies for nuclear power systems to enable an informed selection of systems for flight development to provide power to a lunar outpost.**		
APG 8AC17	By 2008, demonstrate high efficiency power conversion systems in the laboratory at power levels in excess of 10 kilowatts that are relevant to future fission surface power systems.	Exploration Technology Development	Advanced Capabilities
Outcome 6.4	**Implement the space communications and navigation architecture responsive to science and exploration mission requirements.**		
APG 8CS11	Provide the Command, Control, Communication and Information (C3I) standards, validation processes and test systems designs, and demonstrate life cycle feasibility at the Ground Operations and Mission Operations Preliminary Design Reviews (PDRs).	Constellation Systems Program	Constellation Systems
APG 8SFS02	Implement technology initiatives consistent with approved baseline space communications and navigation architecture.	Space Communications	Space and Flight Support (SFS)
APG 8SFS03	Complete the Exploration Communications and Navigation System (ECANS) Preliminary Design Review (PDR).	Space Communications	Space and Flight Support (SFS)
Outcome 6.5	**No later than 2020, demonstrate the capability to conduct an extended human expedition to the lunar surface and lay the foundation for extending human presence across the solar system.**		
APG 8CS12	Develop and annually refine a lunar return architecture that has the maximum possible utility for later missions to Mars and other destinations.	Extended Lunar Stay Capability	Constellation Systems
APG 8CS13	Demonstrate progress towards the refinement of initial cargo launch vehicle conceptual designs to establish preliminary cargo launch vehicle system requirements.	Extended Lunar Stay Capability	Constellation Systems

FY 2008 Performance Plan Update

Cross-Agency Support Programs

Measure #	Description	Contributing Program (s)
Education Theme		
Outcome ED-1	**Contribute to the development of the Science, Technology, Engineering and Math (STEM) workforce in disciplines needed to achieve NASA's strategic goals, through a portfolio of programs.**	
APG 8ED01	Provide 100 NASA-supported courses offered at institutions of higher education targeted at the STEM skills needed by NASA.	Education
APG 8ED02	Serve 250 students, 150 faculty, and 40 institutions in designated EPSCoR states.	Education
APG 8ED03	Support 125 Minority Institutions and 4,500 underserved students in STEM education programs.	Education
Outcome ED-2	**Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers and faculty.**	
APG 8ED04	Maintain at FY07 levels (updated from "increase by 5%" which was planned per the FY08 budget request) the number of elementary and secondary student participants in NASA instruction and enrichment activities.	Education
APG 8ED05	Increase by 3 percent (updated from "5 percent" which was planned per the FY08 budget request) elementary and secondary educators' use of NASA resources in their classroom instruction.	Education
Outcome ED-3	**Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission.**	
APG 8ED06	Provide support to 100 museums and science centers across the country to actively engage the public in NASA events and activities.	Education
Advanced Business Systems (IEMP) Theme		
Outcome IEM-1	**By 2009, implement Agency business systems that provide timely, consistent and reliable business information for management decisions.**	
APG 8IEM01	Implement the Property, Plant and Equipment (PP&E) module of the Integrated Asset Management Project to provide integration between functional and financial processes for accountable personal property.	Integrated Enterprise Management Program
APG 8IEM02	Implement the Human Capital Information Environment to strategically plan and manage NASA's Human Capital resulting in the elimination of redundant systems and integrating the remaining Human Capital processes and systems.	Integrated Enterprise Management Program
APG 8IEM03	Implement Phase 2 of the Aircraft Management Module, including the Aircraft Logistics System, Aircraft Financial System Interface to NASA's Core Financial system and the Maintenance Management module to ensure safety of ground and flight operations and improve visibility into aircraft operations processes.	Integrated Enterprise Management Program
Outcome IEM-2	**By 2009, increase efficiency by implementing new business systems and reengineering Agency business processes.**	
APG 8IEM04	Reduce the number of quarterly corrective adjustments to financial statements from the 2006 baseline of 5948 steps to the 2008 goal of 3345 steps (a 44 percent reduction).	Integrated Enterprise Management Program
APG 8IEM05	Increase percentage of total travel booking completed on-line, from the 2006 baseline of 1.8 percent to the 2008 goal of 50 percent.	Integrated Enterprise Management Program

FY 2008 Performance Plan Update

Cross-Agency Support Programs

Measure #	Description	Contributing Program (s)
Innovative Partnerships Program Theme		
Outcome IPP-1	**Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and projects.**	
APG 8IPP01	Develop 12 (updated from "20" which was planned per the FY08 budget request) technology-related significant partnerships that create value for NASA's programs and projects. Track both quantitative dollar value and qualitative benefits to NASA (e.g., reduced volume or mass, improved safety).	Innovative Partnerships Program
APG 8IPP02	Complete 30 (updated from "50" which was planned per the FY08 budget request) technology transfer agreements with the commercial and academic community through mechanisms like licenses, software use agreements, facility use agreements, and Space Act Agreements.	Innovative Partnerships Program
APG 8IPP03	Fully implement an annual portfolio licensing approach that targets licensing goals of greatest value/benefit to NASA. Examples include licensing royalties and new technology products available to NASA. Royalties should be $2.4 million (updated from "$4 million" which was planned per the FY08 budget request) per year or greater.	Innovative Partnerships Program
APG 8IPP04	Complete and institutionalize an enhanced Intellectual Property (IP) management process that enables stronger use of NASA's IP to support NASA's strategies. Implement such IP management together with at least one (updated from "two" which was planned per the FY08 budget request) significant NASA programs or projects.	Innovative Partnerships Program
Shared Capability Assets Program Theme		
Outcome SC-1	**Establish and maintain selected Agency level shared capabilities, across multiple classes of assets (e.g., wind tunnels, vacuum chambers, etc.), to ensure that they will continue to be available to support the missions that require them.**	
APG 8SC01	Prioritize funding requirements and select classes of assets for inclusion in the Shared Capability Assets Program.	Shared Capability Assets Program
APG 8SC02	Identify re-investment/re-capitalization opportunities within and among classes of assets and execute the approved changes (e.g., reallocate funds, upgrade facilities, etc.).	Shared Capability Assets Program
APG 8SC03	Assets identified in FY2007 that no longer have requirements for use by NASA will be dispositioned (decision made on whether to place on standby, be mothballed, be demolished, etc).	Shared Capability Assets Program

FY 2008 Performance Plan Update

Uniform and Efficiency Measures

Measure #	Description
Advanced Capabilities Theme	
8AC18	Complete all development projects within 110% of the cost and schedule baseline.
8AC19	Increase the relative amount technology products transferred to Constellation Systems developers for mission application compared to the total budget.
8AC20	Reduce time within which NRA research grants are awarded, from proposal due date to selection, by 2.5% per year, with a goal of 135 days.
Astrophysics Theme	
8AS09	Complete all development projects within 110% of the cost and schedule baseline.
8AS10	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
8AS11	Peer-review and competitively award at least 90%, by budget, of research projects.
8AS12	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.
Aeronautics Technology Theme	
8AT17	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
8AT18	Increase the annual percentage of research funding awarded to Aeronautics University Partnerships.
Constellation Systems Theme	
8CS14	Complete all development projects within 110% of the cost and schedule baseline.
8CS15	Reduction in ground operations cost (through 2012) of the Constellation Systems based on comparison with the Space Shuttle Program.
Earth Science Theme	
8ES15	Complete all development projects within 110% of the cost and schedule baseline.
8ES16	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
8ES17	Peer-review and competitively award at least 90%, by budget, of research projects.
8ES18	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.
Heliophysics Theme	
8HE07	Complete all development projects within 110% of the cost and schedule baseline.
8HE08	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
8HE09	Peer-review and competitively award at least 90%, by budget, of research projects.
8HE10	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.
Advanced Business Systems (IEMP) Theme	
8IEM06	Complete all development projects within 110% of the cost and schedule baseline.
8IEM07	Reduce the number of financial processing steps/time to perform year end closing from the 2005 baseline of 120 steps to the 2008 goal of 20 steps (an 83% reduction).
International Space Station Theme	
8ISS07	Deliver at least 90% of scheduled operating hours for all operations and research facilities.

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Uniform and Efficiency Measures

Measure #	Description
8ISS08	Achieve an Annual Cost Performance Index (CPI), the ratio of the value of the work accomplished versus the actual cost of the work accomplished, of greater than or equal to one.
Planetary Science Theme	
8PS09	Complete all development projects within 110% of the cost and schedule baseline.
8PS10	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
8PS11	Peer-review and competitively award at least 90%, by budget, of research projects.
8PS12	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.
Space and Flight Support (SFS) Theme	
8SFS04	Achieve at least 98% Space Network proficiency for delivery of Space Communications services.
8SFS05	Achieve less than 3% of lost operating time on the NASA Integrated Services Network (NISN) available services.
8SFS06	Complete all development projects within 110% of the cost and schedule baseline.
Space Shuttle Theme	
8SSP05	Annually reduce the Space Shuttle sustaining engineering workforce for flight hardware and software, while maintaining safe flight.
8SSP06	Deliver at least 90% of scheduled operating hours for all operations and research facilities.

FY 2008 Performance Plan Update

Annual Performance Goals Eliminated For FY 2008

Measure #	Description	Contributing Program (s)	Contributing Theme (s)
APG 8ED07	Reduce turn around time by 10% from submission of supplementary curriculum products for formal review to online distribution.		Education
APG 8ED08	Reduce the cost per program participant by 5%.		Education

FY 2009 Performance Plan Narrative

NASA's six Strategic Goals are reflected below. Each is clearly defined and supported by Sub-goals (where appropriate), multi-year Outcomes, and Annual Performance Goals (APGs) that will enhance NASA's ability to measure and report the Agency's progress in achieving these Strategic Goals.

The majority of NASA's long-term performance commitments, the Outcomes, have remained the same from the FY 2008 Performance Plan. An additional Outcome within Sub-Goal 3F, with ensuing APGs, has been added to better measure the contribution of the Crew Health & Safety Program. The new programmatic content within the Earth Science and Planetary Science is reflected through APGs within Sub-Goals 3A and 3D, respectively.

The structure of FY 2009 Performance Plan reflects the new NASA account structure. There is the addition of the Agency Management and Operations (AM&O), Center Management and Operations (CM&O) and Institutional Investments (IINV) Themes within the Cross-Agency Support Programs section of this document. There are no performance commitments provided for the new Theme areas of CM&O and IINV. These are under development and will be provided in the FY 2010 budget request. The existing measures for the former Advanced Business Systems, Innovative Partnerships Program, and Shared Capabilities Assets Program Themes are reflected within the new AM&O Theme. Additional performance commitments are under development for the other content within the AM&O Theme, and hence will also not be provided until the FY 2010 budget request.

The table below provides a summary of all of the commitments identified by each of the Themes in the preceding sections. Further, this table reflects the addition of FY 2007 performance ratings for Outcomes and APGs, and trend information for Outcomes. Definitions for the ratings and trending are as follows:

Outcomes
Green: NASA achieved most APGs under this Outcome and is on-track to achieve or exceed this Outcome.
Yellow: NASA made significant progress toward this Outcome, however, the Agency may not achieve this Outcome as stated.
Red: NASA failed to achieve most of the APGs under this Outcome and does not expect to achieve this Outcome as stated.
White: This Outcome was cancelled by management directive or is no longer applicable based on management changes to the APGs.

APGs
Green: NASA achieved this APG.
Yellow: NASA failed to achieve this APG, but made significant progress and anticipates achieving it during the next fiscal year.
Red: NASA failed to achieve this APG and does not anticipate completing it within the next fiscal year.
White: This APG was canceled by management directive and NASA is no longer pursuing activities relevant to this APG, or the program did not have activities relevant to the APG during the fiscal year.

Other Trending Information
Blue: NASA exceeded (beyond a Green rating) performance expectations for this performance measure. NASA discontinued this rating as of FY 2005.
New: New program content, and the performance measure is new for FY 2009.
None: there are two separate conditions that this is used for:
- NASA previously conducted work in this area, but management did not include a performance measure for this work in FY 2007 Performance Plan.
- Missions or projects are formed or retire with common or related scientific or technology goals. The work is a logical shift in program content but requires a new measure to reflect the corresponding performance expectations.

FY 2009 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 1	**Fly the Shuttle as safely as possible until its retirement, not later than 2010.**						
Outcome 1.1	**Assure the safety and integrity of the Space Shuttle workforce, systems and processes, while flying the manifest.**			**Green**	**Green**	**Yellow**	**Green**
APG 9SSP1	Achieve zero Type-A (damage to property at least $1 million or death) or Type-B (damage to property at least $250 thousand or permanent disability or hospitalization of three or more persons) mishaps in FY 2009.	Space Shuttle Program	Space Shuttle				Green
APG 9SSP2	Complete 100 percent of all mission objectives for all Space Shuttle missions in FY 2009 as specified in the Flight Requirements Document for each mission.	Space Shuttle Program	Space Shuttle				Green
Outcome 1.2	**By September 30, 2010, retire the Space Shuttle.**			**None**	**None**	**None**	**Green**
APG 9SSP3	A 13 percent reduction in Space Shuttle annual value of Shuttle production contracts for Orbiter, External Tank, Solid Rocket Boosters, Reusable Solid Rocket Motor, Space Shuttle Main Engine and Launch & Landing, while maintaining safe flight.	Space Shuttle Program	Space Shuttle				None
APG 9SSP4	Reduce to twenty the number of dedicated Space Shuttle Kennedy Space Center (blocks of) facilities, while maintaining safe flight.	Space Shuttle Program	Space Shuttle				None
Strategic Goal 2	**Complete the International Space Station in a manner consistent with NASA's International partner commitments and the needs of human exploration.**						
Outcome 2.1	**By 2010, complete assembly of the U.S. On-orbit Segment; launch International Partner elements and sparing items required to be launched by the Shuttle; and provide on-orbit resources for research to support U.S. human space exploration.**			**None**	**Green**	**Green**	**Green**
APG 9ISS1	Based on the actual Space Shuttle flight rate, number of remaining Shuttle flights, and the discussions with the International Partners, update the agreed-to ISS assembly sequence and transportation plan as necessary.	International Space Station Program	International Space Station				Green
APG 9ISS2	Accomplish a minimum of 90 percent of the on-orbit research objectives as established one month prior to a given increment.	International Space Station Program	International Space Station				Green
APG 9ISS3	Per the final configuration agreed to by the International Partners, fly the ISS elements and logistics baselined for FY2009.	International Space Station Program	International Space Station				Green

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9ISS4	Provide increased ISS capability by assembling the remaining two Japanese Exploration Agency (JAXA) elements, the Exposed Facility (EF) and the Experiment Logistics Module-Exposed Section (ELM-ES), and the NASA EXPRESS Logistics Carriers (ELC) as baselined in FY 2009.	International Space Station Program	International Space Station				Green
Outcome 2.2	**By 2009, provide the on-orbit capability to support an ISS crew of six crewmembers.**			**None**	**None**	**None**	**Green**
APG 9ISS5	Install and make flight ready the following delivered ISS systems for 6 member crew capability in FY 2009: three crew quarters, Galley, Water Recovery System (WRS racks 1 and 2), second Treadmill with Vibration Isolation (TVIS2), and Waste Collection/Hygiene Compartment (WHC).	International Space Station Program	International Space Station				Green
APG 9ISS6	In concert with the International Partners, assure a continuous crew presence on the ISS.	International Space Station Program	International Space Station				Green
Outcome 2.3	**Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.**			**None**	**None**	**None**	**New**
APG 9AC1	Deliver 3 out of 4 of the following exploration technology payloads to SOMD for launch to the ISS: Multi-User Droplet Combustion Apparatus, Light Microscopy Module / Constrained Vapor Bubble, Boiling Experiment Facility (BXF), Space Acceleration Measurement System accelerometers for CIR, FIR and BXF.	Exploration Technology Development	Advanced Capabilities				New
APG 9AC2	Complete the development of 3 out of 4 of the following non-exploration payloads: Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions, Shear History Extensional Rheology Experiment, Advanced Plant Experiments on Orbit, Smoke Point in Coflow Experiment, Binary Critical Aggregation Test - 4.	Exploration Technology Development	Advanced Capabilities				New
APG 9AC3	Complete the selection of investigators for the BION (Russian collaboration) flight.	Exploration Technology Development	Advanced Capabilities				New

FY 2009 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 3	**Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.**						
Sub Goal 3A	**Study Earth from space to advance scientific understanding and meet societal needs.**						
Outcome 3A.1	**Progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.**			**Green**	**Green**	**Green**	**Green**
APG 9ES1	Demonstrate progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition (based on measurements from presently orbiting NASA and non-NASA assets). Progress will be evaluated by external expert review.	Multiple Programs	Earth Science				Green
APG 9ES2	Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	Earth System Science Pathfinder	Earth Science				Yellow
APG 9ES3	Develop missions in support of this Outcome, as demonstrated by completing the Glory mission Launch Readiness Review (LRR).	Earth Systematic Missions	Earth Science				Yellow
APG 9ES4	Develop mission in support of this Outcome, as demonstrated by completing Aquarius instrument integration and testing.	Earth System Science Pathfinder	Earth Science				None
APG 9ES5	Develop mission in support of this Outcome, as demonstrated by completing the CLARREO advanced concepts study.	Earth Systematic Missions	Earth Science				New
APG 9ES6	Conduct flight program in support of this Outcome as demonstrated by achieving mission success criteria for Aqua and CALIPSO.	Multiple Programs	Earth Science				None
Outcome 3A.2	**Progress in enabling improved predictive capability for weather and extreme weather events.**			**Green**	**Green**	**Green**	**Green**
APG 9ES7	Demonstrate progress in enabling improved predictive capability for weather and extreme weather events. Progress will be evaluated by external expert review.	Multiple Programs	Earth Science				Green
APG 9ES8	Develop missions in support of this Outcome, as demonstrated by completing the Global Precipitation Mission (GPM) Confirmation Review.	Earth Systematic Missions	Earth Science				None

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Systematic Missions	Earth Science				None
Outcome 3A.3	**Progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models.**			**Green**	**Green**	**Green**	**Green**
APG 9ES10	Demonstrate progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models. Progress will be evaluated by external expert review.	Multiple Programs	Earth Science				Green
APG 9ES11	Develop missions in support of this Outcome, as demonstrated by completing the Landsat Data Continuity Mission (LDCM) Critical Design Review (CDR).	Earth Systematic Missions	Earth Science				White
APG 9ES12	Develop missions in support of this Outcome, as demonstrated by completing the DESDynI advanced concept study.	Earth Systematic Missions	Earth Science				New
APG 9ES2	Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	Earth System Science Pathfinder	Earth Science				Yellow
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Systematic Missions	Earth Science				None
Outcome 3A.4	**Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability.**			**Green**	**Green**	**Yellow**	**Green**
APG 9ES13	Demonstrate progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability. Progress will be evaluated by external expert review.	Multiple Programs	Earth Science				Green
APG 9ES14	Develop missions in support of this Outcome, as demonstrated by completing the SMAP advanced concepts study.	Earth Systematic Missions	Earth Science				New
APG 9ES8	Develop missions in support of this Outcome, as demonstrated by completing the Global Precipitation Mission (GPM) Confirmation Review.	Earth Systematic Missions	Earth Science				None
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Systematic Missions	Earth Science				None

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome 3A.5	**Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.**			**Green**	**Green**	**Yellow**	**Yellow**
APG 9ES15	Demonstrate progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution. Progress will be evaluated by external expert review.	Multiple Programs	Earth Science				Green
APG 9ES16	Develop mission in support of this Outcome, as demonstrated by completing the ICESat II advanced concepts study.	Earth Systematic Missions	Earth Science				New
APG 9ES2	Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	Earth System Science Pathfinder	Earth Science				Yellow
APG 9ES3	Develop missions in support of this Outcome, as demonstrated by completing the Glory mission Launch Readiness Review (LRR).	Earth Systematic Missions	Earth Science				Yellow
APG 9ES4	Develop mission in support of this Outcome, as demonstrated by completing Aquarius instrument integration and testing.	Earth System Science Pathfinder	Earth Science				None
APG 9ES6	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua and CALIPSO.	Multiple Programs	Earth Science				None
Outcome 3A.6	**Progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields.**			**None**	**Green**	**Green**	**Green**
APG 9ES11	Develop missions in support of this Outcome, as demonstrated by completing the Landsat Data Continuity Mission (LDCM) Critical Design Review (CDR).	Earth Systematic Missions	Earth Science				White
APG 9ES12	Develop missions in support of this Outcome, as demonstrated by completing the DESDynI advanced concept study.	Earth Systematic Missions	Earth Science				White
APG 9ES17	Demonstrate progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields. Progress will be evaluated by external expert review.	Multiple Programs	Earth Science				Green
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Systematic Missions	Earth Science				None

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome 3A.7	**Progress in expanding and accelerating the realization of societal benefits from Earth system science.**			**Green**	**Green**	**Green**	**Green**
APG 9ES18	Issue twelve reports with partnering organizations that validate using NASA research capabilities (e.g., observations and/or forecast products) could improve their operational decision support systems.	Applied Sciences	Earth Science				Green
APG 9ES19	Increase the number of distinct users of NASA data and services.	Earth Science Research	Earth Science				None
APG 9ES20	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science Research	Earth Science				None
Sub Goal 3B	**Understand the Sun and its effects on Earth and the solar system.**						
Outcome 3B.1	**Progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.**			**Green**	**Green**	**Green**	**Green**
APG 9HE1	Demonstrate progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress will be evaluated by external expert review.	Multiple Programs	Heliophysics				Green
APG 9HE2	Develop missions in support of this Outcome, as demonstrated by completing the Magnetospheric Multiscale (MMS) Spacecraft Preliminary Design Review (PDR).	Solar Terrestrial Probes	Heliophysics				Red
APG 9HE3	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	Living with a Star	Heliophysics				Green
APG 9HE4	Develop missions in support of this Outcome, as demonstrated by completing the Explorer down-select.	Heliophysics Explorer Program	Heliophysics				Green
APG 9HE5	Conduct flight program in support of this outcome, as demonstrated by achieving mission success criteria for STEREO, AIM, THEMIS and IBEX.	Multiple Programs	Heliophysics				None
Outcome 3B.2	**Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields.**			**Green**	**Green**	**Green**	**Green**

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9HE2	Develop missions in support of this Outcome, as demonstrated by completing the Magnetospheric Multiscale (MMS) Spacecraft Preliminary Design Review (PDR).	Solar Terrestrial Probes	Heliophysics				Red
APG 9HE3	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	Living with a Star	Heliophysics				Green
APG 9HE4	Develop missions in support of this Outcome, as demonstrated by completing the Explorer down-select.	Heliophysics Explorer Program	Heliophysics				Green
APG 9HE6	Demonstrate progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields. Progress will be evaluated by external expert review.	Multiple Programs	Heliophysics				Green
APG 9HE7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for AIM and THEMIS.	Multiple Programs	Heliophysics				None
Outcome 3B.3	**Progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers.**			**None**	**None**	**Green**	**Green**
APG 9HE3	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	Living with a Star	Heliophysics				Green
APG 9HE8	Demonstrate progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers. Progress will be evaluated by external expert review.	Multiple Programs	Heliophysics				Green
APG 9HE9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for STEREO.	Multiple Programs	Heliophysics				None
Sub Goal 3C	**Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.**						
Outcome 3C.1	**Progress in learning how the Sun's family of planets and minor bodies originated and evolved.**			**Green**	**Green**	**Green**	**Green**
APG 9PS1	Demonstrate progress in learning how the Sun's family of planets and minor bodies originated and evolved. Progress will be evaluated by external expert review.	Multiple Programs	Planetary Science				Green

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9PS2	Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	New Frontiers	Planetary Science				White
APG 9PS3	Develop missions in support of this Outcome, as demonstrated by completing the GRAIL mission Preliminary Design Review (PDR).	Discovery	Planetary Science				None
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Mars Exploration	Planetary Science				Green
Outcome 3C.2	**Progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds.**			**Green**	**Green**	**Green**	**Green**
APG 9PS2	Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	New Frontiers	Planetary Science				White
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Mars Exploration	Planetary Science				Green
APG 9PS5	Demonstrate progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds. Progress will be evaluated by external expert review.	Multiple Programs	Planetary Science				Green
APG 9PS6	Develop missions in support of this Outcome, as demonstrated by selecting the next Scout mission.	Mars Exploration	Planetary Science				None
APG 9PS7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	Mars Exploration	Planetary Science				None
Outcome 3C.3	**Progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system.**			**Green**	**Green**	**Green**	**Green**
APG 9PS2	Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	New Frontiers	Planetary Science				White

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Mars Exploration	Planetary Science				Green
APG 9PS6	Develop missions in support of this Outcome, as demonstrated by selecting the next Scout mission.	Mars Exploration	Planetary Science				None
APG 9PS7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	Mars Exploration	Planetary Science				None
APG 9PS8	Demonstrate progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system. Progress will be evaluated by external expert review.	Multiple Programs	Planetary Science				Green
Outcome 3C.4	**Progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence.**			**Green**	**Green**	**Green**	**Green**
APG 9PS10	Develop missions in support of this Outcome, as demonstrated by selecting instruments for the first Lunar Science Research mission.	Planetary Science Research	Planetary Science				New
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Mars Exploration	Planetary Science				Green
APG 9PS7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	Mars Exploration	Planetary Science				None
APG 9PS9	Demonstrate progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence. Progress will be evaluated by external expert review.	Multiple Programs	Planetary Science				Green
Sub Goal 3D	**Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.**						
Outcome 3D.1	**Progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity.**			**Green**	**Green**	**Green**	**Green**
APG 9AS1	Demonstrate progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity. Progress will be evaluated by external expert review.	Multiple Programs	Astrophysics				Green

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9AS2	Develop missions in support of this Outcome, as demonstrated by releasing the Joint Dark Energy Mission (JDEM) Announcement of Opportunity (AO).	Physics of the Cosmos	Astrophysics				None
Outcome 3D.2	**Progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects recognized in the present universe.**			**Blue**	**Green**	**Yellow**	**Green**
APG 9AS3	Demonstrate progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects we recognize in the present universe. Progress will be evaluated by external expert review.	Multiple Programs	Astrophysics				Green
APG 9AS4	Develop missions in support of this Outcome, as demonstrated by completing the James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Critical Design Review (CDR).	Cosmic Origins	Astrophysics				Green
APG 9AS5	Develop missions in support of this Outcome, as demonstrated by beginning Stratospheric Observatory for Infrared Astronomy (SOFIA) open-door testing.	Cosmic Origins	Astrophysics				None
Outcome 3D.3	**Progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems.**			**Green**	**Green**	**Yellow**	**Green**
APG 9AS4	Develop missions in support of this Outcome, as demonstrated by completing the James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Critical Design Review (CDR).	Cosmic Origins	Astrophysics				Green
APG 9AS5	Develop missions in support of this Outcome, as demonstrated by beginning Stratospheric Observatory for Infrared Astronomy (SOFIA) open-door testing.	Cosmic Origins	Astrophysics				None
APG 9AS6	Demonstrate progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems. Progress will be evaluated by external expert review.	Multiple Programs	Astrophysics				Green
Outcome 3D.4	**Progress in creating a census of extra-solar planets and measuring their properties.**			**Green**	**Green**	**Yellow**	**Yellow**
APG 9AS7	Demonstrate progress in creating a census of extra-solar planets and measuring their properties. Progress will be evaluated by external expert review.	Multiple Programs	Astrophysics				Green

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9AS8	Develop missions in support of this Outcome, as demonstrated by completing Kepler Launch Readiness Review (LRR).	Exoplanet Exploration	Astrophysics				Green
Sub Goal 3E	**Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.**						
Outcome 3E.1	**By 2016, identify and develop tools, methods, and technologies for improving overall aircraft safety of new and legacy vehicles operating in the Next Generation Air Transportation System (projected for the year 2025).**			**None**	**None**	**Green**	**Green**
APG 9AT1	Demonstrate a 10% improvement in estimation accuracy of integrated gas path sensing and diagnostics for aircraft engine health.	Aviation Safety	Aeronautics				None
APG 9AT2	Conduct a spin test to verify enhanced disk rim attachment strength at component level and show 10% life improvement over criteria established in 2007.	Aviation Safety	Aeronautics				None
APG 9AT3	Assess and deliver findings on initial multi-modal presentation formats and interaction methods for uncertainty display concepts and virtual visual environments with statistically significant reductions in communication errors, mental workload, and flight technical error, as well as increases in usability and situation awareness compared with baseline capability.	Aviation Safety	Aeronautics				None
APG 9AT4	Design and evaluate preliminary concepts in on-line integrity monitoring (99% failure detection with less than 1% false positives) for adaptive control systems through simulation tests.	Aviation Safety	Aeronautics				None
Outcome 3E.2	**By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the Next Generation Air Transportation System.**			**None**	**None**	**Green**	**Green**
APG 9AT5	Complete trajectory analysis for service provider-based automated separation assurance with time-based metering with 2-3 times increase in capacity without reduction of baseline metering accuracy or separation violations.	Airspace Systems	Aeronautics				None

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9AT6	Develop algorithms to generate robust, optimized solutions for surface traffic planning and control. Evaluations will include benefits in both nominal and off-nominal conditions under increased Airportal traffic density and consider environmental constraints and aircraft operator schedule preferences.	Airspace Systems	Aeronautics				None
Outcome 3E.3	**By 2016, develop multidisciplinary analysis and design tools and new technologies, enabling better vehicle performance (e.g., efficiency, environmental, civil competitiveness, productivity, and reliability) in multiple flight regimes and within a variety of transportation system architectures.**			**None**	**None**	**Green**	**Green**
APG 9AT10	Complete the CFD pretest predictions of performance and operability of a high Mach fan for a TBCC propulsion system and compare to fan test data from the GRC W8 facility.	Fundamental Aeronautics	Aeronautics				None
APG 9AT7	Develop a database for alternative hydrocarbons using accepted testing standards, then characterize the fuels (freezing point, break point, etc) in comparison to current Jet-A.	Fundamental Aeronautics	Aeronautics				None
APG 9AT8	Develop and validate transmission tools and technologies to support variable speed drive systems using data from several transmission test cells at GRC.	Fundamental Aeronautics	Aeronautics				None
APG 9AT9	Demonstrate an adjoint-based design method for configuration shaping; also establish the capability to design and analyze supersonic vehicles that achieve efficiency improvements within 10% of the defined targets including engine plume effects and verify the results using wind tunnel and flight experiments.	Fundamental Aeronautics	Aeronautics				None
Outcome 3E.4	**Ensure the continuous availability of a portfolio of NASA-owned wind tunnels/ground test facilities, which are strategically important to meeting national aerospace program goals and requirements.**			**None**	**None**	**None**	**Green**
APG 9AT11	To sustain the required aeronautics test facilities force measurement capability for the nation, implement a centralized force balance capability by FY 2009.	Aeronautics Test Program	Aeronautics				None
Sub Goal 3F	**Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration.**						
Outcome 3F.1	**By 2008, develop and test candidate countermeasures to ensure the health of humans traveling in space.**			**Green**	**Green**	**Green**	**Green**

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9AC4	Develop an operational protocol that meets the standards of the Office of the Chief Health and Medical Officer for a countermeasure to lower the risk of renal stone formation due to increased bone loss during long duration missions in microgravity to below 1%.	Human Research Program	Advanced Capabilities				Green
APG 9AC5	Validate a ground analog fractional-gravity test methodology to assess whether 1/6th g is protective of physiological systems, including bone loss, and if not, what countermeasures are needed	Human Research Program	Advanced Capabilities				Green
APG 9AC6	Provide recommendations for optimized EVA suit weight, pressure, center of gravity and kinematics.	Human Research Program	Advanced Capabilities				None
Outcome 3F.2	**By 2010, identify and test technologies to reduce total mission resource requirements for life support systems.**			**Green**	**Green**	**Green**	**Green**
APG 9AC7	Evaluate three alternative distillation technologies for primary water processing as part of closed loop water recovery systems.	Exploration Technology Development	Advanced Capabilities				None
Outcome 3F.3	**By 2010, develop reliable spacecraft technologies for advanced environmental monitoring and control and fire safety.**			**Green**	**None**	**Green**	**Green**
APG 9AC8	Complete the System Design Review for the Colorimetric Solid Phase Extraction Water Biocide Monitor.	Exploration Technology Development	Advanced Capabilities				None
Outcome 3F.4	**By 2012, identify and develop tools, methods, and technologies for assessing, improving and maintaining the overall health of the astronaut corps, for mission lengths up to 180 days in microgravity or 1/6 G.**						
APG 9SFS1	Publish volume 5 of the Spacecraft Maximum Allowable Concentrations (SMACs) and volume 3 of the Spacecraft Water Exposure Guidelines (SWEGs).	Crew Health & Safety	Space and Flight Support (SFS)				None
APG 9SFS2	Thirty-seven percent of current and former astronaut medical requirements data will be captured in a comprehensive medical data management infrastructure.	Crew Health & Safety	Space and Flight Support (SFS)				None
APG 9SFS3	Capture 100% of medical and environmental data required by Medical Operations in queriable form.	Crew Health & Safety	Space and Flight Support (SFS)				None

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 4	**Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.**						
Outcome 4.1	**No later than 2015, and as early as 2010, transport three crewmembers to the International Space Station and return them safely to Earth, demonstrating an operational capability to support human exploration missions.**			**Green**	**Green**	**Green**	**Yellow**
APG 9AC11	Deliver a prototype 5-meter diameter ablative heat shield for Orion to the Constellation Systems Program	Exploration Technology Development	Advanced Capabilities				None
APG 9CS1	Complete the Critical Design Review (CDR) for the Orion / Crew Exploration Vehicle (CEV).	Constellation Systems Program	Constellation Systems				Yellow
APG 9CS12	Complete the Preliminary Design Review (PDR) for the Constellation Program flight capability (PDR #1).	Constellation Systems Program	Constellation Systems				None
APG 9CS2	Complete the Critical Design Review (CDR) for the Ares I Upper Stage (US) element.	Constellation Systems Program	Constellation Systems				Yellow
APG 9CS3	Complete the Critical Design Review (CDR) for the Pad B Launch Complex development within the Ground Operations Project.	Constellation Systems Program	Constellation Systems				Green
APG 9CS4	Complete the Preliminary Design Review (PDR) of the Mission Control Center System (MCCS) within the Mission Operations Project.	Constellation Systems Program	Constellation Systems				Green
APG 9CS5	Complete the Preliminary Design Review (PDR) for the Extravehicular Activity (EVA) Space Suit Element for CEV.	Constellation Systems Program	Constellation Systems				Green
APG 9CS6	Complete the launch and flight analysis of the CEV Pad Abort 1 (PA-1) test.	Constellation Systems Program	Constellation Systems				Yellow
APG 9CS7	Complete the launch and flight analysis of the Ares 1-X sub-orbital test.	Constellation Systems Program	Constellation Systems				None
APG 9SFS3	In FY 2009, maintain agency rocket propulsion test core competencies (both infrastructure and critical skills) at appropriate levels to meet Constellation testing requirements and integrate these with other NASA programs, commercial partners, and DoDrequirements and capabilities.	Rocket Propulsion Testing	Space and Flight Support (SFS)				None
APG 9SFS4	Coordinate rocket propulsion test activities to support Constellation rocket propulsion testing milestones by providing an agency level Rocket Propulsion Test Plan.	Rocket Propulsion Testing	Space and Flight Support (SFS)				None

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome 4.2	**By 2010, successfully transition applicable Shuttle components, infrastructure, and workforce to the Constellation Systems program.**						**New**
APG 9CS8	Demonstrate progress towards the transition of Space Shuttle and Space Station workforce and infrastructure for utilization in Constellation, including the transfer of the Vertical Assembly Building, configuration of Launch Complex 39-B and the Mobile Launch Platform 1 for the Ares 1-X test.	Constellation Systems Program	Constellation Systems				None
Strategic Goal 5	**Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.**						
Outcome 5.1	**Develop and demonstrate a means for NASA to purchase launch services from emerging launch providers.**			**Green**	**Green**	**Green**	**Green**
APG 9IPP5	Demonstrate the purchase of services from the emerging commercial space sector for microgravity research and training.	Innovative Partnerships Program	Agency Management and Operations				New
APG 9SFS5	Establish a contractual mechanism or agreement to provide technical exchanges between NASA's Launch Services Program and emerging launch vehicles/providers to enhance early launch success.	Launch Services	Space and Flight Support (SFS)				Green
Outcome 5.2	**By 2010, demonstrate one or more commercial space services for ISS cargo and/or crew transport.**			**Green**	**Green**	**Green**	**Green**
APG 9CS10	Have at least three funded and unfunded Partners receiving technical assistance through the COTS Assistance Team (CAT) and making progress toward orbital demonstrations of commercial crew and cargo systems.	Constellation Systems Program	Constellation Systems				Yellow
APG 9CS9	Have at least one Partner complete a minimum of one orbital demonstration flight in FY 2009.	Constellation Systems Program	Constellation Systems				Yellow
Outcome 5.3	**By 2012, complete one or more prize competitions for independently designed, developed, launched, and operated missions related to space science or space exploration.**			**None**	**None**	**None**	**Green**
APG 9IPP6	Demonstrate benefits of prize competitions by awarding at least one prize and communicating the resulting technology advancements.	Innovative Partnerships Program	Agency Management and Operations				Green
Strategic Goal 6	**Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.**						
Outcome 6.1	**By 2008, launch a Lunar Reconnaissance Orbiter (LRO) that will provide information about potential human exploration sites.**			**Green**	**None**	**Green**	**Green**

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9AC12	Launch the Lunar Reconnaissance Orbiter. (LRO)	Lunar Precursor Robotic Program	Advanced Capabilities				Green
APG 9AC13	Launch the Lunar Crater Observation and Sensing Satellite. (LCROSS)	Lunar Precursor Robotic Program	Advanced Capabilities				Green
Outcome 6.2	**By 2012, develop and test technologies for in situ resource utilization, power generation, and autonomous systems that reduce consumables launched from Earth and moderate mission risk.**			**Green**	**Green**	**Green**	**Green**
APG 9AC14	Demonstrate in field tests a proof-of-concept pressurized rover with EVA suitports that could enable surface exploration beyond the vicinity of the lunar outpost and improve EVA work efficiency.	Exploration Technology Development	Advanced Capabilities				None
Outcome 6.3	**By 2013, sufficiently develop and test technologies for nuclear power systems to enable an informed selection of systems for flight development to provide power to a lunar outpost.**			**Green**	**White**	**Green**	**Green**
APG 9AC15	Demonstrate full-scale radiator panels in the laboratory at temperatures and heat transfer rates relevant to the reference 40-kilowatt fission surface power system for the lunar outpost.	Exploration Technology Development	Advanced Capabilities				Green
Outcome 6.4	**Implement the space communications and navigation architecture responsive to science and exploration mission requirements.**			**Green**	**Green**	**Green**	**Green**
APG 9SFS6	Complete TDRS Replenishment Preliminary Design Review (PDR).	Space Communications and Navigation	Space and Flight Support (SFS)				New
APG 9SFS7	Re-compete the Space Network, Near Earth Network and NISN operations and maintenance contracts to provide uninterrupted support of those networks.	Space Communications and Navigation	Space and Flight Support (SFS)				Green
APG 9SFS8	Complete a consolidated network modernization plan for all SCaN networks to meet existing and future science and exploration mission requirements.	Space Communications and Navigation	Space and Flight Support (SFS)				Green
Outcome 6.5	**No later than 2020, demonstrate the capability to conduct an extended human expedition to the lunar surface and lay the foundation for extending human presence across the solar system.**						**None**

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Measure #	Description	Contributing Program (s)	Contributing Theme (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9AC16	Begin successful science data collection from the Lunar Reconnaisance Orbiter (LRO) in support of human lunar missions.	Lunar Precursor Robotic Program	Advanced Capabilities				Green
APG 9AC17	Begin successful science data collection from the Lunar Crater Observation and Sensing Satellite (LCROSS) in support of human lunar missions.	Lunar Precursor Robotic Program	Advanced Capabilities				Green
APG 9CS11	Conduct the Lunar Capabilities SRR to define the lunar mission architecture transportation requirements.	Extended Lunar Stay Capability	Constellation Systems				None

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Cross-Agency Support Programs

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Center Management and Operations Theme						
Outcome CMO-1	**Under development for release in 2010.**					**New**
APG 9CMO1	Under development for release in 2010.					New
Education Theme						
Outcome ED-1	**Contribute to the development of the Science, Technology, Engineering and Math (STEM) workforce in disciplines needed to achieve NASA's strategic goals, through a portfolio of investments.**		**None**	**Green**	**Green**	**Green**
APG 9ED1	Support the development of 60 new or revised courses targeted at the STEM skills needed by NASA.					None
APG 9ED2	Serve 132 institutions in designated EPSCoR states.					None
APG 9ED3	Engage 8,500 underrepresented and underserved students in NASA higher education programs.					None
APG 9ED4	Increase the percentage of higher education program participants who have participated in NASA elementary or secondary programs by an additional ten percent above the FY 2007 baseline of eighteen percent.					None
APG 9ED5	Achieve thirty five percent of student participants in FY 2009 NASA higher education programs, will be employed by NASA, aerospace contractors, universities, and other educational institutions.					None
APG 9ED6	Achieve thirty five percent of undergraduate students in FY 2009 NASA higher education programs, move on to advanced education in NASA-related disciplines.					None
Outcome ED-2	**Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers and faculty.**		**None**	**Green**	**None**	**Green**
APG 9ED10	Achieve fifty percent or greater level of interest in science and technology careers among elementary and secondary students participating in NASA education programs.					None
APG 9ED7	Increase the percentage of elementary and secondary educators, who receive NASA content-based STEM resources materials or participate in short-duration activities that use these materials in the classroom by four percent above the FY 2007 baseline of fifty five percent.					None
APG 9ED8	Increase the number of elementary and secondary student participants in NASA instructional and enrichment activities by 10% above the FY 2007 baseline of 408,774.					None
APG 9ED9	Assure seventy percent of elementary and secondary educators who participate in NASA training programs use NASA resources in their classroom instruction, an increase in the FY 2007 baseline of sixty two percent.					None

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Cross-Agency Support Programs

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome ED-3	**Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission.**		**None**	**None**	**None**	**Green**
APG 9ED11	Assure that at least 350 museums and science centers across the country actively engage the public through NASA content.					None
APG 9ED12	Assure that twenty percent of the 460 museums and science centers that participate in NASA networks, use NASA resources in programs and exhibits.					None
Agency Management and Operations Theme						
Outcome IEM-1	**By 2012, implement Agency business systems that provide timely, consistent and reliable business information for management decisions.**		**None**	**None**	**None**	**Green**
APG 9IEM1	Implement all reports into the Human Capital Information Environment and stabilize the project and environment.	Agency IT Services				None
APG 9IEM2	Implement the federal eTravel initiative to provide a standardized, comprehensive tool to support online booking, travel planning, travel expense reimbursement, payment processing, credit card reconciliation, and management reporting for NASA.	Agency IT Services				None
Outcome IEM-2	**Increase efficiency by implementing new business systems and reengineering Agency business processes.**		**None**	**None**	**Green**	**Green**
APG 9IEM3	Reduce the number of quarterly corrective adjustments to financial statements from the 2006 baseline of 5948 steps to the 2009 goal of 2509 steps (a 58% reduction).	Agency IT Services				Green
APG 9IEM4	Improve the timeliness of the funds distribution process (time from receipt of apportionment to distribution of funds to Centers) from 65 days to the 2009 goal of 12 days.	Agency IT Services				None
APG 9IEM5	Achieve cost savings, expected to increase annually with a 2009 goal of $19.3M, resulting from the integration of financial and asset management systems, a reduction in the number of redundant property, plant and equipment (PP&E) systems and process improvements that enable NASA to better manage PP&E assets.	Agency IT Services				None
Outcome IPP-1	**Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and projects.**		**Blue**	**Green**	**Green**	**Green**
APG 9IPP1	Develop twelve technology-related significant partnerships that create value for NASA's programs and projects. Track both quantitative dollar value and qualitative benefits to NASA (e.g. reduced volume or mass, improved safety).	Innovative Partnerships Program				Green

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Cross-Agency Support Programs

Measure #	Description	Contributing Program (s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9IPP2	Complete thirty technology transfer agreements with the commercial and academic community through such mechanisms as licenses, software use agreements, facility use agreements, and Space Act Agreements.	Innovative Partnerships Program				Green
APG 9IPP3	Fully implement a new system for managing NASA's technology transfer and partnership information, that is more user friendly and less costly than the current NASA Technology Transfer System (NTTS).	Innovative Partnerships Program				None
APG 9IPP4	Infuse technologies from the IPP portfolio into NASA's programs and projects, with at least twelve documented infusion successes.	Innovative Partnerships Program				None
Outcome SC-1	**Establish and maintain selected Agency level shared capabilities, across multiple classes of assets (e.g., wind tunnels, vacuum chambers, etc.), to ensure that they will continue to be available to support the missions that require them.**		**None**	**None**	**None**	**Green**
APG 9SC1	Prioritize funding requirements and select classes of assets for inclusion in the Shared Capability Assets Program.	Strategic Capabilities Assets Program				Green
APG 9SC2	Identify re-investment/re-capitalization opportunities within and among classes of assets and execute the approved changes (e.g., reallocate funds, upgrade facilities, etc.).	Strategic Capabilities Assets Program				Green
APG 9SC3	Assets identified in FY 2008 that no longer have requirements for use by NASA will be dispositioned (decision made on whether to place on standby, be mothballed, be demolished, etc.).	Strategic Capabilities Assets Program				None
Institutional Investments Theme						
Outcome IINV-1	**Under development for release in 2010.**					**New**
APG 9IINV1	Under development for release in 2010.					New

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Uniform and Efficiency Measures

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Advanced Capabilities Theme					
APG 9AC18	Complete all development projects within 110% of the cost and schedule baseline.				White
APG 9AC19	Increase the amount of research beam time for space radiation experiments at NSRL, hence science data collection, by reducing the non-science overhead to 25% from 33% for set up, tuning and maintenance.				None
APG 9AC20	Given an annual constant dollar technology funding, demonstrate improvements in the EVA Work Efficiency Index for humans and robots working cooperatively to deploy the power system infrastructure for the lunar outpost. Work Efficiency Index = (Time to complete a task using humans and robots) / (Time to complete a task using humans only).				None
Astrophysics Theme					
APG 9AS12	Complete all development projects within 110% of the cost and schedule baseline.				Red
APG 9AS13	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green
APG 9AS14	Peer-review and competitively award at least 95%, by budget, of research projects.				Green
APG 9AS15	Reduce time within which eighty percent of NRA research grants are awarded, from proposal due date to selection, by five percent per year, with a goal of 130 days.				Green
Aeronautics Theme					
APG 9AT12	Deliver at least 94% of "on-time availability" for all operations and research facilities				Yellow
Constellation Systems Theme					
APG 9CS12	Complete all development projects within 110% of the cost and schedule baseline.				White
APG 9CS13	Reduction in ground operations cost (through 2012) of the Constellation Systems based on comparison with the Space Shuttle Program.				None
Education Theme					
APG 9ED13	Reduce the dollar invested per number of people reached via e-education technologies from FY 2008 amounts.				None
APG 9ED14	Reduce the cost per K-12 program participant over FY2007 amounts by 1%.				None
Earth Science Theme					
APG 9ES21	Complete all development projects within 110% of the cost and schedule baseline.				White
APG 9ES22	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green
APG 9ES23	Peer-review and competitively award at least 90%, by budget, of research projects.				Green
APG 9ES24	Reduce time within which eighty percent of NRA research grants are awarded, from proposal due date to selection, by five percent per year, with a goal of 130 days.				Red

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Uniform and Efficiency Measures

Measure #	Description	Multi-year Outcome ratings			
		FY 04	FY 05	FY 06	FY 07
Heliophysics Theme					
APG 9HE10	Complete all development projects within 110% of the cost and schedule baseline.				Yellow
APG 9HE11	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green
APG 9HE12	Peer-review and competitively award at least 95%, by budget, of research projects.				Green
APG 9HE13	Reduce time within which eighty percent of NRA research grants are awarded, from proposal due date to selection, by five percent per year, with a goal of 130 days.				Red
Agency Management and Operations Theme					
APG 9IEM8	Complete all development projects within 110% of the cost and schedule baseline.				None
APG 9IEM9	Reduce the number of financial processing steps/time to perform year end closing from the 2005 baseline of 120 steps to the 2008 goal of 20 steps (an 83% reduction).				None
APG 9IPP7	For technology partnerships, leverage IPP funding by bringing at least an additional $1.80 (one dollar and eighty cents) for each $1 (one dollar) of IPP funds.				None
International Space Station Theme					
APG 9ISS7	Achieve an Annual Cost Performance Index (CPI), the ratio of the value of the work accomplished versus the actual cost of the work accomplished, of greater than or equal to one.				None
APG 9ISS8	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green
Planetary Science Theme					
APG 9PS11	Complete all development projects within 110% of the cost and schedule baseline.				Red
APG 9PS12	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green
APG 9PS13	Peer-review and competitively award at least 95%, by budget, of research projects.				Green
APG 9PS14	Reduce time within which eighty percent of NRA research grants are awarded, from proposal due date to selection, by five percent per year, with a goal of 130 days.				Red
Space and Flight Support (SFS) Theme					
APG 9SFS10	Achieve at least 99% Space Network proficiency for delivery of Space Communications services.				Green
APG 9SFS11	Complete all development projects within 110% of the cost and schedule baseline.				White
APG 9SFS12	Ratio of Launch Services program cost per mission to average spacecraft cost, reduced to 6.3 percent.				None
Space Shuttle Theme					

FY 2009 Performance Plan

Uniform and Efficiency Measures

Measure #	Description	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9SSP5	Annually reduce the Space Shuttle sustaining engineering workforce for flight hardware and software, while maintaining safe flight.				Green
APG 9SSP6	Deliver at least 90% of scheduled operating hours for all operations and research facilities.				Green

NASA's annual Performance and Accountability Report (PAR) meets relevant U.S. government reporting requirements, including the *Government Performance and Results Act* of 1993, the *Chief Financial Officers Act* of 1990, and the *Federal Financial Management Improvement Act* of 1996. The PAR provides a summary of the Agency's financial position and its progress towards achieving NASA's performance measures (i.e., Strategic Goals and Sub-goals, Outcomes, and Annual Performance Goals).

NASA's Participation in the Performance and Accountability Report Pilot Program

For FY 2007, NASA chose to participate in the Office of Management and Budget's (OMB's) PAR pilot program, as described in OMB Circular A-136. This pilot entails producing three reports as an alternative to the consolidated PAR:

- An Agency Financial Report (AFR), which provides NASA's financial statements and accompanying notes, an audit of the financial statements, a summary of materials weaknesses and management challenges, as well as corrective actions, and an overview of the year's performance achievements. NASA issued this report on November 15, 2007.
- An Annual Performance Report (APR), presented here, detailing NASA's performance towards achieving the FY 2007 Performance Plan.
- A Performance Highlights document, which is a public-outreach summary of NASA's performance, financial, and management achievements and challenges. NASA issued this document on February 1, 2008.

The AFR and Performance Highlights document, as well as NASA's FY 2009 Budget Estimates with accompanying APR, are available on the Web at www.nasa.gov/news/budget/index.html.

APR Contents

Strategic Goals, Performance Measures, and Organization

NASA's 2006 Strategic Plan established six Strategic Goals, with six Sub-goals supporting Strategic Goal 3. Progress towards achieving the Strategic Goals are measured using multi-year Outcomes and supporting Annual Performance Goals, as outlined in the Agency's annual Performance Plan.

NASA is organized into four Mission Directorates and an equivalent organization called Cross-Agency Support Programs:

- The **Science Mission Directorate (SMD)** conducts the scientific exploration of Earth, the Sun, the solar system, and the universe. Large, strategic missions are complemented by smaller missions, including ground-, air-, and orbiting space-based observatories, deep-space automated spacecraft, and planetary orbiters, landers, and surface rovers. This Directorate also develops increasingly refined instrumentation, spacecraft, and robotic techniques in pursuit of NASA's science goals.

- The **Aeronautics Research Mission Directorate (ARMD)** conducts fundamental research in aeronautical disciplines and develops capabilities, tools, and technologies that will enhance significantly aircraft performance, environmental compatibility, and safety, as well as the capacity, flexibility, and safety of the future air transportation system.
- The **Exploration Systems Mission Directorate (ESMD)** develops systems and supports research and technology development to enable sustained and affordable human and robotic space exploration. This Directorate will develop the robotic precursor missions, human transportation elements, and life support systems for the near-term goal of lunar exploration.
- The **Space Operations Mission Directorate (SOMD)** directs spaceflight operations, space launches, and space communications and manages the operation of integrated systems in low Earth orbit and beyond, including the International Space Station (ISS). This Directorate also is laying the foundation for future missions to the Moon and Mars by using the ISS as an orbital outpost where astronauts can gather vital information that will enable safer and more capable systems for human explorers.
- **Cross-Agency Support Programs (CASP)** consists of four mission-support areas—Education, Advanced Business Systems (performed by the Integrated Enterprise Management Program), the Innovative Partnerships Program, and the Strategic Capabilities Assets Program—that serve all the Strategic Goals. Together, these areas ensure that NASA has the workforce, technologies, capabilities, and facilities needed to achieve NASA's current and future objectives.

Management for these organizations resides at NASA Headquarters. NASA's Centers support the Agency's space exploration objectives, scientific initiatives, and aeronautics research.

The Mission Directorates and CASP pursue the Agency's performance measures, presented in the FY 2007 Performance Plan, as shown below. Details of activities for each Strategic Goal are provided in the following pages.

Responsible Mission Directorate or Equivalent	Theme	Strategic Goals and Sub-goals	Outcomes
SMD	Earth–Sun System (now Earth Science and Heliophysics*)	Strategic Goal 3: Sub-goal 3A (Earth Science) Sub-goal 3B (Heliophysics)	3A.1–3A.7 3B.1–3B.3
	Solar System Exploration (now Planetary Science*)	Strategic Goal 3: Sub-goal 3C	3C.1–3C.4
	The Universe (now Astrophysics*)	Strategic Goal 3: Sub-goal 3D	3D.1–3D.4
ARMD	Aeronautics Technology	Strategic Goal 3: Sub-goal 3E	3E.1–3E.4
ESMD	Constellation Systems	Strategic Goal 4 Strategic Goal 5	4.1–4.2 5.2
	Exploration Systems Research & Technology (now Advanced Capabilities*)	Strategic Goal 5 Strategic Goal 6	5.3 6.1–6.3
	Human Systems Research & Technology (now Advanced Capabilities*)	Strategic Goal 3: Sub-goal 3F	3F.1–3F.3
SOMD	Space Shuttle	Strategic Goal 1	1.1–1.2
	International Space Station	Strategic Goal 2	2.1–2.2
	Space and Flight Support	Strategic Goal 5 Strategic Goal 6	5.1 6.4
CASP	Education	Contribute to all Strategic Goals	ED-1–ED-3
	Advanced Business Systems		IEM-1–IEM-2
	Innovative Partnerships Program		IPP-1
	Strategic Capabilities Assets Program		SC-1

* Changes effective with the release of NASA's FY 2008 Budget Estimates.

Measuring NASA's Performance

Performance System

NASA managers calculate ratings for multi-year Outcome and APG performance based on a number of factors, including internal and external assessments.

Internally, NASA monitors and analyzes each program's adherence to budgets, schedules, and key milestones. These analyses are provided during monthly reviews at the Center, Mission Directorate, and Agency levels to communicate the health of the program. (Program's are identified in NASA's annual budget estimates, available at http://www.nasa.gov/news/budget/index.html.) Based on the ratings, managers formulate appropriate follow-up actions.

External advisors, like the NASA Advisory Council, the National Research Council, and the Aerospace Safety Advisory Panel, assess program content and direction. Also, experts from the science community, coordinated by the Science Mission Directorate, review NASA's progress toward meeting performance measures under Sub-goals 3A through 3D.

During the fiscal year, a third of the Agency's Themes also participate in OMB's Program Assessment Rating Tool (PART) evaluation, which is a rigorous and interactive program assessment that involves both internal and external reviewers.

After weighing the input from various reviews for relevance, quality, and performance, NASA managers determine a program's progress toward achieving its respective multi-year and annual Government Performance and Results Act performance measures. NASA rates these as follows:

Multi-year Outcome Rating Scale

Green	NASA achieved most APGs under this Outcome and is on-track to achieve or exceed this Outcome.
Yellow	NASA made significant progress toward this Outcome, however, the Agency may not achieve this Outcome as stated.
Red	NASA failed to achieve most of the APGs under this Outcome and does not expect to achieve this Outcome as stated.
White	This Outcome was canceled by management directive or is no longer applicable based on management changes to the APGs.

APG Rating Scale

Green	NASA achieved this APG.
Yellow	NASA failed to achieve this APG, but made significant progress and anticipates achieving it during the next fiscal year.
Red	NASA failed to achieve this APG and does not anticipate completing it within the next fiscal year.
White	This APG was canceled by management directive and NASA is no longer pursuing activities relevant to this APG, or the program did not have activities relevant to the APG during the fiscal year.

Other Trending Information

Blue	NASA exceeded (beyond a Green rating) performance expectations for this performance measure. NASA discontinued this rating as of FY 2005.
None	Although NASA may have conducted work in this area, management did not include a performance measure for this work in the fiscal year's performance plan.
8.3.1 Green	In prior years where data is available, NASA notes the applicable Outcome or APG reference number and rating to provide a Theme's performance trends. The annual Performance Report or Performance and Accountability Report for an indicated performance year provide the full text and explanations. In some cases, an Outcome or APG may track to more than one performance measures in past performance years.

During FY 2007, NASA reviewed the trending information for Outcomes to ensure completeness and made revisions where necessary. NASA incorporated the revised trending information in this Annual Performance Report.

PART Assessments

The PART assessments ask approximately 25 questions about a Theme's performance and management. Based on answers provided by the Theme, OMB applies a percentile score that yields the following ratings:

- **Effective (85–100%):** This is the highest rating a program can achieve. Programs rated Effective set ambitious goals, achieve results, are well-managed and improve efficiency.
- **Moderately Effective (70–84%):** In general, a program rated Moderately Effective has set ambitious goals and is well-managed. Moderately Effective programs likely need to improve their efficiency or address other problems in the programs' design or management in order to achieve better results.
- **Adequate (50–69%):** This rating describes a program that needs to set more ambitious goals, achieve better results, improve accountability or strengthen its management practices.
- **Ineffective (0–49%):** Programs receiving this rating are not using tax dollars effectively. Ineffective programs have been unable to achieve results due to a lack of clarity regarding the program's purpose or goals, poor management, or some other significant weakness.
- **Results Not Demonstrated:** This rating indicates that a program has not been able to develop acceptable performance goals or collect data to determine whether it is performing.

Summaries of all PART ratings to date are provided in the following Strategic Goal and Cross-Agency Support Program write-ups. For more detailed information about a Theme's PART status and follow-up actions, please go to "PART Status and Improvement Plans" section of this APR (Man-133) or visit ExpectMore.gov (www.whitehouse.gov/omb/expectmore/agency/026.html).

Other Assessments

Discussions of other assessments, including the President's Management Agenda and Major Program Annual Report, relevant to the Agency's performance are available in the "Management and Performance" section of NASA's FY 2009 Budget Estimates.

Cost of Performance

Although NASA allocates budgets and tracks costs for each of the Mission Directorates, the Agency also analyzes the cost of pursuing each of its Strategic Goals and Sub-goals, referred to as the Cost of Performance.

To measure the cost of performance, NASA maps the Mission Directorate's costs (i.e., Lines of Business as presented in the FY 2007 Agency Financial Report Addendum Statement of Net Cost) to the Strategic Goals and Sub-goals via Themes and programs. In 2003, NASA created Themes as a bridge to connect related Agency programs and projects to the Mission Directorates or equivalents that manage the programs. Themes group together similar programs, such as the programs that conduct Earth science or support the Agency's spaceflight missions, into budgeting categories. NASA uses Themes and programs to track performance areas, with Themes often contributing to a single Strategic Goal or Sub-goal, with a few exceptions.

To determine the Agency's cost of performance for each Strategic Goal and Sub-goal, NASA analyzes the initial fiscal year operating plan to determine the portion of each Mission Directorate budget allocated to each Theme and/or program, thus tying it to a particular Strategic Goal or Sub-goal. NASA analysts then use NASA's financial statements, in particular the Statement of Net Cost to allocate Line of Business expenditures to the Themes and then Strategic Goals and Sub-Goals based on the relationships determined in the initial Operating Plan.

Strategic Goal 1

Fly the Shuttle as safely as possible until its retirement, not later than 2010.

	Green	Yellow	Red	White
2 Outcomes	2 (100%)	0	0	0
6 APGs	5 (83%)	0	0	1 (17%)

Cost of Performance (in millions)
$4,049

Responsible Mission Directorate

Space Operations (SOMD)

Contributing Theme

Space Shuttle

Theme Description

The Space Shuttle Theme manages the Space Shuttle, currently the only U.S. launch capability providing human access to space, and the only vehicle that can support the assembly of the International Space Station (ISS). NASA will phase-out the Space Shuttle in 2010 when its role in ISS assembly is complete.

PART Assessment Rating						
Theme	**Last Year Assessed**	**Overall Rating**	**Program Purpose and Design**	**Strategic Planning**	**Program Management**	**Program Results/ Accountability**
Space Shuttle	2005	Adequate	100%	89%	50%	33%

The Space Shuttle has supported NASA's Mission for over 25 years, carrying crews and cargo to low Earth orbit, performing repair, recovery, and maintenance missions on orbiting satellites, providing a platform for conducting science experiments, and supporting construction of the International Space Station (ISS). As required by Strategic Goal 1, NASA will retire the Shuttle fleet by 2010, making way for the new generation of launch and crew exploration vehicles being developed under Strategic Goal 4. Until then, the Agency will demonstrate NASA's most critical value—safety—by promoting engineering excellence, maintaining realistic flight schedules, and fostering internal forums where mission risks and benefits can be discussed and analyzed freely.

Benefits

The Shuttle is recognized around the world as a symbol of America's space program and the Nation's commitment to space exploration. NASA's Space Shuttle Program has inspired generations of schoolchildren to pursue dreams and careers in science, technology, engineering, and mathematics. The Space Shuttle Program also provides direct benefits to the Nation by advancing national security and economic interests in space and spurring technology development in critical areas such as navigation, computing, materials, and communications. Furthermore, due to its heavy-lift capacity, the Shuttle is the only vehicle capable of completing assembly of the ISS in a manner consistent with NASA's International Partner commitments and exploration research needs. The remaining Shuttle flights will be dedicated to ISS construction and a Hubble Space Telescope service mission.

A primary public benefit of retiring the Shuttle is to redirect resources toward new programs, such as the Orion Crew Exploration Vehicle and the Ares launch vehicles being developed by the Constellation Systems Theme, needed to send humans to the Moon and beyond. NASA will use the knowledge and assets developed over nearly three decades of Shuttle operations to build a new generation of vehicles designed for missions beyond low Earth orbit. As the Shuttle fleet approaches its retirement year, the Agency gradually is directing Shuttle personnel, assets, and knowledge toward the development and support of new hardware and technologies that will support Constellation Systems vehicle. For the American public, this means continuity in the access to space and sustained U.S. leadership in technology development and civilian space exploration.

Risks to Achieving Strategic Goal 1

The Space Shuttle Program faces two main challenges. First, NASA must maintain the skilled workforce and critical assets needed to safely complete the Shuttle manifest. Second, NASA must manage the process of retiring the Shuttle and transitioning and dispositioning Shuttle capabilities when they are no longer needed for safe mission execution.

The Space Shuttle transition and retirement effort is one of the largest that the Agency has undertaken in its history. The Space Shuttle Program's assets are significant; the program occupies over 640 facilities, uses over 990,000 line items of hardware and equipment, and employs over 1,700 civil servants, with more than 15,000 work-year equivalents employed by the prime contractors. In addition, the program employs over 3,000 additional indirect workers through Center general and administrative and service accounts. The total equipment acquisition value is over $12 billion, spread across hundreds of locations. The total facilities replacement cost is approximately $5.7 billion, which accounts for approximately one-fourth of the value of the Agency's total facility inventory. The program has over 1,500 active suppliers, and 3,000 to 4,000 qualified suppliers geographically located throughout the country.

Because of the size, complexity, and dispersion of the Space Shuttle Program's assets, Transition and Retirement will require careful planning so as to not interfere with safe mission execution and not greatly impact other Agency activities. In addition to the sheer size of asset disposition activities, the Agency must manage and protect those Shuttle capabilities that are needed to complete the Agency's Strategic Goal of completing assembly of the ISS by the end of FY 2010 using as few Shuttle flights as possible. As ISS assembly is completed and the Space Shuttle Program's mission comes to a close, Constellation Systems development activities will continue to ramp up. Use of certain legacy capabilities can reduce the time and resources necessary to achieve initial operational capability of the new designs. The Space Shuttle Program plays a key role in coordinating the smooth transition from current Shuttle operations to Constellation Systems, thereby enabling new U.S. human spaceflight capabilities that will extend exploration and permanent human presence beyond low Earth orbit to the Moon, Mars, and beyond.

FY 2008 Performance Forecast

- The Space Shuttle is manifested to fly five missions in FY 2008: four assembly and logistics flights to the ISS and a fifth servicing mission to the Hubble Space Telescope. During the flights to the ISS, the Shuttle will deliver major International Partner elements, including the European Space Agency's Columbus European Laboratory Module, portions of the Kibo Japanese Experiment Module, and Canada's Special Purpose Dexterous Manipulator.
- The Space Shuttle Program will reach several major transition milestones. Among these include transitioning to Constellation Systems major facilities at the Kennedy Space Center, including two of the four high bays in the Vehicle Assembly Building and Launch Pad 39B.

Outcome 1.1: Assure the safety and integrity of the Space Shuttle workforce, systems and processes while flying the manifest.

FY04	FY05	FY06	FY 2007
8.3.1 Green	6.1 Green	1.1 Yellow	**Green**

The Space Shuttle Program successfully completed three missions—STS-116, STS-117, and STS-118—and accomplished all primary mission objectives. The program achieved its Annual Performance Goals despite events that could have caused setbacks: significant damage to the external tank of STS-117 caused by a hailstorm at the Kennedy Space Center, while the Shuttle was on the pad awaiting launch; and the threat posed by Hurricane Dean to operations at the Johnson Space Center during the STS-118 mission.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Achieve zero Type-A (damage to property at least $1M or death) or Type-B (damage to property at least $250K or permanent disability or hospitalization of 3 or more persons) mishaps in FY 2007.	4SSP2 Yellow	5SSP1 Green	6SSP1 Red	**7SSP1 Green**
Complete 100 percent of all mission objectives for all Space Shuttle missions in FY 2007 as specified in the Flight Requirements Document for each mission.	None	None	None	**7SSP2 Green**

Outcome 1.2: By September 30, 2010, retire the Space Shuttle.

FY04	FY05	FY06	FY 2007
None	None	None	**Green**

In November 2006, NASA published the Human Space Flight Transition Plan, which outlines the Agency's approach to safely managing the remaining manifested Space Shuttle flights, completing ISS assembly, and developing new human space flight transportation systems under the Constellation Systems Program. Through joint budget development, workforce sharing, and joint review boards, including the Transition Control Board and the Joint Integrated Control Board, the Space Shuttle and Constellation Systems programs identified a number of assets for transfer or disposition. In the area of joint utilization, Shuttle and Constellation Systems are coordinating use of Launch Complex 39-B at the Kennedy Space Center to support the Ares I-X test flight and launch-on-need support for the Hubble Space Telescope servicing mission (STS-125), the Vehicle Assembly Building at the Kennedy Space Center for Ares I-X and Space Shuttle processing, and the Michoud Assembly Facility in Louisiana for Shuttle external tank production and Orion and Ares I upper stage production. NASA also began close-out activities for Shuttle capabilities no longer needed for mission execution or Constellation Systems development, including facilities for producing Space Shuttle main engine components and facilities at the White Sands Test Facility used for testing orbiter maneuvering system rocket engines.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Demonstrate continued progress in identifying, evaluating, documenting, and dispositioning Space Shuttle program resources for phase-out or transition.	None	None	None	**7SSP3 Green**

Efficiency Measures

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete all development projects within 110% of the cost and schedule baseline.	4SSP4 Yellow	5SSP4 Yellow	6SSP2 White	**7SSP4 White**
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	None	5SSP5 Green	6SSP3 Green	**7SSP5 Green**
While ensuring the safety of ongoing flight operations and by working with exploration development programs, reduce Space Shuttle sustaining engineering hours, annual value of Space Shuttle production contracts, and the number of dedicated Space Shuttle facilities, where possible.	None	None	None	**7SSP6 Green**

Why NASA rated APG 7SSP4 White: SOMD was not scheduled to complete any development projects in the Space Shuttle Theme during FY 2007, so NASA has postponed this Efficiency Measure until a later fiscal year.

Strategic Goal 2

Complete the International Space Station in a manner consistent with NASA's International Partner commitments and the needs of human exploration.

	Green	Yellow	Red	White
2 Outcomes	2 (100%)	0	0	0
7 APGs	6 (86%)	0	0	1 (14%)

Cost of Performance (in millions)
$1,769

Responsible Mission Directorate

Space Operations (SOMD)

Contributing Theme

International Space Station (ISS)

Theme Description

The ISS Theme manages ISS launch processing activities, on-orbit assembly and maintenance, and research payload and experiment delivery to orbit. The program works with NASA's International Partners to maintain and improve ISS capabilities such as appropriate crew presence and available facilities.

PART Assessment Rating

Theme	Last Year Assessed	Overall Rating	Program Purpose and Design	Strategic Planning	Program Management	Program Results/ Accountability
International Space Station	2004	Moderately Effective	100%	100%	88%	47%

Built and operated using state of the art science and technology, the ISS—and by extension Strategic Goal 2—is a vital part of NASA's program of exploration. The ISS provides an environment for developing, testing, and validating the next generation of technologies and processes needed to support Sub-goal 3F, Strategic Goal 4, and NASA's objective to return to the Moon and send human explorers deeper into space.

Benefits

The ISS is a testbed for exploration technologies and processes. Its equipment and location provide a one-of-a-kind platform for Earth observations, microgravity research, and investigations of the long-term effects of the space environment on human beings. The ISS also enables research in fundamental physics and biology, materials sciences, and medicine. Crewmembers test processes for repairing equipment in microgravity, conducting spacewalks, and keeping systems operational over long periods of time—capabilities critical to future missions.

When completed, the ISS will be the largest crewed spacecraft ever built. Many nations provide the resources and technologies that keep the ISS flying, and these international partnerships have increased cooperation and goodwill among participating nations.

Risks to Achieving Strategic Goal 2

The primary risks to Strategic Goal 2 are: the Space Shuttle Program's ability to complete the ISS manifest and to successfully complete assembly operations; the ability of the ISS Program to acquire the necessary spares to be launched on the Shuttle before retirement; and delivery and operability of the systems that support the six crew capability.

FY 2008 Performance Forecast

- In October 2007, NASA launched the Harmony Node 2 module on STS-120. It will serve as a passageway between the U.S. Destiny Laboratory and two modules to be launched in the future: the Japanese Kibo Experiment Module and the European Columbus Laboratory.
- In winter 2008, STS-122 will deliver Columbus, the first European Space Agency (ESA)-supplied ISS module. Columbus will provide additional research space.
- NASA will deliver to the ISS the Kibo pressurized section aboard STS-123 (scheduled for launch in winter 2008) and the Kibo pressurized module and Japanese Remote Manipulator System aboard STS-124 (scheduled for launch in spring 2008). These will be the first major Japanese ISS elements delivered on-orbit. When completed, Kibo will be the largest ISS module, providing both pressurized and unpressurized research facilities.
- NASA, also aboard STS-123, will deliver the Canadian Special Purpose Dexterous Manipulator, or Dextre, a multi-jointed arm that will have greater freedom of mobility than the ISS's Canadarm2 robotic arm.
- In fall 2008, STS-126 will deliver a complement of habitability hardware to enable the six crew capability.

Outcome 2.1: By 2010, complete assembly of the U.S. On-orbit Segment; launch International Partner elements and sparing items required to be launched by the Shuttle; and provide on-orbit resources for research to support U.S. human space exploration.

FY04	FY05	FY06	FY 2007
8.4.1 Green	8.1 Green	2.1 Green	**Green**
	8.2 Green		

With support from Shuttle flights STS-116 (ISS construction mission 12A.1), STS-117 (13A), and STS-118 (13A.1), NASA continued work on the ISS solar array and truss sections, preparing the ISS for arrival of new major elements in FY 2008. In July 2007, astronaut Clay Anderson successfully activated the Oxygen Generation System (OGS), part of the ISS's Environmental Control and Life Support System (ECLSS) located in the Destiny Laboratory. An addition to the Elekron system located in the Russian Zvezda module, the OGS is critical to supporting future six-crewmember operations.

NASA reached an agreement with the International Partners on the final ISS configuration and assembly sequence, setting a path toward assembly completion in FY 2010.

NASA also continued regular logistical resupply using both Shuttle missions and support from Russian Soyuz and Progress missions.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Based on the actual Space Shuttle flight rate, number of remaining Shuttle flights, and the discussions with the International Partners, update the agreed to ISS assembly sequence and transportation plan as necessary.	4ISS3 Green	5ISS3 Green	None	**7ISS1 Green**
Accomplish a minimum of 90% of the on-orbit research objectives as established one month prior to a given increment.	4ISS4 Green	5ISS4 Yellow	6ISS3 Yellow	**7ISS2 Green**
Per the final configuration agreed to by the International Partners, fly the ISS elements and logistics baselined for FY 2007.	4ISS5 Green	5ISS5 Yellow	6ISS1 Green	**7ISS3 Green**

Outcome 2.2: By 2009, provide the on-orbit capability to support an ISS crew of six crewmembers.

FY04	FY05	FY06	FY 2007
None	None	None	**Green**

NASA is on track to support six-crewmember operations in FY 2009. ISS crew successfully activated the OGS (see Outcome 2.1 above). A team at Kennedy Space Center modified Harmony (Node 2) to receive a second treadmill, which will provide needed exercise facilities for a larger crew. Harmony was launched successfully in fall 2007 and is integrated onto the ISS. NASA also is preparing other habitability hardware for launch in FY 2008: the Water Recovery System, a Treadmill with Vibration Isolation System, extra crew quarters, the Waste Collection/Hygiene Compartment, the Total Organic Carbon Analyzer, and galley. NASA also made progress in developing plans for training, crew composition and rotation, and Russian Soyuz launch timetable associated with effectively maintaining and using a six-crewmember complement.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Establish flight-ready status for the urine processing capability (part of the U.S. Regenerative Environmental Control Life Support System).	None	None	None	**7ISS4 Green**
In concert with the International Partners, assure a continuous crew presence on the ISS.	4ISS6 Green	5ISS6 Green	None	**7ISS5 Green**

Efficiency Measures

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete all development projects within 110% of the cost and schedule baseline.	4ISS7 Green	5ISS8 Green	6ISS5 Green	**7ISS6 White**
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	None	5ISS9 Green	7ISS6 Green	**7ISS7 Green**

Why NASA rated APG 7ISS6 White: SOMD was not scheduled to complete any development projects in the ISS Theme during FY 2007, so NASA has postponed this Efficiency Measure until a later fiscal year.

Strategic Goal 3: Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.

NASA divided Strategic Goal 3 into a series of Strategic Sub-goals to adequately address the broad range of activities covered by the goal. All of the performance measures (multi-year Outcomes and APGs) associated with Strategic Goal 3 can be found under Sub-goals 3A through 3F.

Sub-goal 3A

Study Earth from space to advance scientific understanding and meet societal needs.

	Green	Yellow	Red	White
7 Outcomes	6 (86%)	1 (14%)	0	0
15 APGs	11 (73%)	2 (13%)	1 (7%)	1 (7%)

Cost of Performance (in millions)
$1,397

Responsible Mission Directorate

Science

Contributing Theme

Earth Science (ES)

Theme Description

The Earth Science Theme conducts research and technology development to advance Earth observations from space, improve understanding of the Earth system, and demonstrate new remote sensing science and technologies for future operational systems.

PART Assessment Rating

Theme	Last Year Assessed	Overall Rating	Program Purpose and Design	Strategic Planning	Program Management	Program Results/ Accountability
Earth-Sun System Research	2005	Moderately Effective	100%	100%	84%	74%

Note: NASA divided the Earth–Sun System Theme into two Themes as of the FY 2008 Budget Estimates. Earth Science now is responsible for Sub-goal 3A and Heliophysics is responsible for Sub-goal 3B.

Earth is a dynamic system. Its land, oceans, atmosphere, climate, and gravitational fields are changing constantly. Some of these changes, especially short-duration and localized phenomena like hurricanes and earthquakes, are regionally significant and pose immediate hazards to humans. Other changes, like climate variability, take longer to have effects—which spread over large regions, including the entire Earth—that are revealed through long-term observations and modeling. To achieve Sub-goal 3A, NASA's Earth Science programs help researchers better understand the causes and consequences of these changes through data gathered by Earth-observing satellites, aircraft, and balloons. Using advanced computer systems, program scientists analyze and model the data into useful Earth science information and distribute it to end users around the world.

Benefits

NASA's Earth Science Division is central to three Presidential initiatives that serve the public:

- The Climate Change Research Initiative, established in 2001 to study global climate change and to provide a forum for public debate and decision-making about how the United States monitors and responds to climate change;
- The Climate Change Science Strategic Plan (July 24, 2003) with special emphasis on global observations; and
- The U.S. Ocean Action Plan, released in 2004 as part of a Bush Administration effort to ensure that benefits derived from oceans and other bodies of water will be available to future generations.

To support these initiatives, NASA and its partners—other government agencies, academia, non-profit organizations, industry, and international organizations—conduct vital research that helps the Nation manage environmental and agricultural resources and prepare for natural disasters. In the course of conducting this research, NASA applies the resulting data and knowledge with the Agency's operational partners to improve their decision-making in societal need areas such as public health, aviation, water management, air quality, and energy.

The Earth Science programs also help NASA achieve the Agency's other Strategic Goals and overall Mission:

- Earth observing satellites provide meteorological information used by NASA, the National Oceanic and Atmospheric Administration (NOAA) and the Department of Defense in providing weather forecasts that are used to fulfill their Agency mandates.
- Measurement and analysis techniques, demonstrated first in Earth orbit and applied first to Earth studies, may help advance exploration and understanding of other planets in the solar system.

Risks to Achieving Sub-goal 3A

Long-term climate observations remain at risk due to National Polar-orbiting Operational Environmental Satellite System (NPOESS) restructuring. The resulting gaps in systematic observations and/or reduced accuracy and stability in operational future observations may compromise the effectiveness of NASA's Earth Science program performance. Advancement of climate science and its resulting societal benefits require both the new Earth observations provided by advanced instruments pioneered by NASA and high-quality auxiliary measurements from proven instrumentation flown by NOAA on operational missions such as NPOESS and Geostationary Operational Environmental Satellites (GOES). Recent changes to the NOAA operational systems jeopardize the availability of the high quality operational measurements needed for NASA to achieve Sub-goal 3A. If NASA is given the responsibility of replacing these measurements without concomitant resources, the full suite of new and operational measurements will not be achieved and the effectiveness of the NASA Earth Science program will be significantly compromised.

FY 2008 Performance Forecast

NASA has completed concept studies led by NASA Centers for all the Earth Science Decadal Survey (*Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*, published by the National Academies in 2007) missions and led community science workshops for the four missions described for implementation in the first, most immediate-priority group. As a result, NASA is prepared to implement the Decadal Survey as resources become available.

NASA continues to work with NOAA and the NPOESS program under the guidance of the Office of Science and Technology Policy (OSTP) to develop plans for the mitigation of the impacts of the NPOESS re-structuring. Planning efforts have been successful in identifying viable solutions and the required resources, which might be implemented in FY 2009.

A Senior Review in 2007 evaluated 10 of the 11 operating spacecraft in the Earth Systematic Missions Program to determine mission extensions and resources required for mission operations (Aura, still in its prime mission through July 2010, was the sole exception). Most of the spacecraft already are in their extended mission phase, and are slated to operate through the end of 2009.

Outcome 3A.1: Progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.

FY 04	FY 05	FY 06	FY 2007
None	None	3A.1 Green	**Green**

Polar stratospheric clouds (PSCs) play a central role in the springtime depletion of ozone particles over polar regions. These particles spur chemical reactions that release bromine and chlorine from stable compounds found in the atmosphere into chemically reactive forms responsible for ozone destruction. These same chemical reactions store nitrogen, also found in the stable compounds present in PSCs. The PSCs can sediment to lower altitudes, removing nitrogen from higher altitudes and delaying the reformation of these stable compounds—further exacerbating ozone depletion. NASA's Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO), launched in April 2006, can collect PSC data in areas not lit by the Sun, delivering the first routine daily observations across the wintertime Antarctic stratosphere and providing a more accurate view of PSC distribution. In a study published in 2007, scientists stated that CALIPSO observations for the 2006 Antarctic winter and spring provided more accurate PSC representations in global models, which are critical to forecasting the recovery of ozone for a future stratospheric state. This is particularly important for the Arctic, where winter temperatures hover near the threshold where PSCs form, with future stratospheric cooling potentially leading to enhanced cloud formation and substantially greater ozone loss.

A key instrument aboard the Terra and Aqua spacecrafts—the Moderate Resolution Imaging Spectroradiometer (MODIS)—makes measurements of aerosol and cloud properties. Recently, the MODIS science team expanded their data products through a new aerosol algorithm called "Deep Blue," which provides much-improved measurements of aerosols over bright surfaces such as deserts. As a result, MODIS aerosol data products now include large continental areas previously not available. Deep Blue has proven itself to be such an improvement that the U.S. Navy has incorporated this aerosol retrieval algorithm in their operational atmospheric forecasting system.

Scientists using MODIS and other instrument measurements of aerosol properties found apparent increases in aerosol particle size in the vicinity of clouds. They assumed the aerosol size increase was caused by relative humidity gradients near cloud edges. Radiative transfer (the process of energy transfer in the form of electromagnetic radiation through the atmosphere) modeling of visible light in three-dimensions showed light scattered out from the sides of clouds can scatter off ambient aerosols and cause those aerosols to appear artificially large to satellite remote sensing. Quantifying this effect is important to gain a more certain estimation of aerosol properties and their impact on Earth's radiation/energy budget, the balance of incoming energy from the Sun and out-going long-wave (thermal) and reflected short-wave energy from Earth. For example, the processes associated with the radiation/energy budget keep Earth's overall temperature relatively constant. If the budget becomes unbalanced, such as through increased greenhouse warming caused by aerosols, Earth's global temperature will rise.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Demonstrate progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition. Progress will be evaluated by external expert review.	None	None	6ESS7 Green	**7ESS1 Green**

3A.2: Progress in enabling improved predictive capability for weather and extreme weather events.

FY04	FY05	FY06	FY 2007
None	None	3A.2 Green	**Green**

New NASA research is providing clues about how the seemingly subtle movement of air within and around the eye of hurricanes provides energy to keep this central "powerhouse" functioning. Using data captured from satellites during field experiments, scientists discovered air patterns that changed the way they would predict a storm's strength. The spinning flow of air parcels, or vortices, in the eye can carry warm, moist eye air into the eyewall, the thunderstorms that separate the eye from the rest of the hurricane. This acts as a turbocharger for the hurricane heat engine. The new results improve understanding of the mechanisms that play significant roles in hurricane intensity.

To gain insight into the behavior of Atlantic hurricanes and understand the forces that cause differences in interannual character of these storms, NASA launched a field experiment—the NASA African Monsoon Multidisciplinary Activities (NAMMA)—to study the birth of hurricanes off the African coast. Many of the powerful late-fall storms that take aim at the United States, Gulf Coast, and eastern seaboard are born over Africa. The goal of this field experiment was to fly high-altitude research aircraft into the maw of early cloud disturbances to discover the precise mechanisms by which a storm's spin becomes organized. In addition, scientists gained a better understanding of how the Saharan Air Layer (an intensely dry, warm and sometimes dust-laden layer of the atmosphere that often overlays the cooler, more-humid surface air of the Atlantic Ocean) or dust might curb the development of these clouds into hurricanes. The major NAMMA research topics included the formation and evolution of tropical hurricanes in the eastern and central Atlantic, the composition and structure of the Saharan Air Layer, and whether or not aerosols affect cloud precipitation and influence cyclone development. The study provided improved physical understanding of tropical hurricanes, helping researchers create better computer models of hurricane development and intensification, and thereby producing more skillful forecasts.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Demonstrate progress in enabling improved predictive capability for weather and extreme weather events. Progress will be evaluated by external expert review.	None	None	6ESS7 Green	**7ESS2 Green**

3A.3: Progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models.

FY04	FY05	FY06	FY 2007
None	None	3A.3 Green	**Green**

NASA research on terrestrial productivity, land cover, and carbon cycling rely on high-quality satellite remote-sensing data products. Validation of these data products thus is critical and provides an important means for characterizing errors and uncertainties in remote-sensing measurements that affect model results. During FY 2007, NASA investigators summarized ongoing global land product validation in a special journal issue. Papers described validation of the major data products that are used to analyze terrestrial processes, land cover, and carbon cycling, and provided recommendations for the best use of current products while informing the design of future missions.

Scientists working within NASA's Land Cover and Land Use Change Program analyzed changes in carbon stocks in regrowing forests of the U.S. Pacific Northwest and Northwestern Russia. Forests in both regions, which are regrowing after regional disturbances, influence the exchange of greenhouse gases between land and the atmosphere. Significantly different regional, historical trends influence forest ownership and management practices that affect potential carbon storage. Results of this analysis indicate that over the next 50 years, carbon accumulation on lands managed for timber production in both regions will follow historic patterns.

Researchers have hypothesized that warming would lengthen the growing season in northern ecosystems and increase the probability of fire, leading to a positive feedback between warming, fires, carbon loss, and future climate change. A new multi-factor analysis—examining greenhouse gases, aerosols, black carbon deposition on snow and sea ice, and post-fire changes in surface albedo (or reflectivity)—of the long-term effects of a well-characterized northern forest fire indicates that the net radiative forcing may be negative. Radiative forcing is the difference between incoming and outgoing radiation energy in Earth's climate system. When the radiative forcing is negative, the climate system cools. The analysis also showed that multi-decadal increases in surface albedo had a larger impact than the fire-emitted greenhouse gases. This study illustrates the importance of interdisciplinary, multi-factor analysis and the need to examine effects over decades-to-centuries time scales.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Demonstrate progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models. Progress will be evaluated by external expert review.	None	None	6ESS7 Green	**7ESS3 Green**
Complete Landsat Data Continuity Mission (LDCM) Confirmation Review.	None	None	None	**7ESS4 White**
Complete Orbiting Carbon Observatory (OCO) Assembly, Test and Launch Operations (ATLO) Readiness Review.	None	None	None	**7ESS6 Yellow**

Why NASA rated APG 7ESS4 White: NASA canceled this APG due to a mandated change in the procurement approach.

Why NASA did not achieve APG 7ESS6: Technical and schedule performance issues with the OCO instrument subcontractor resulted in a four-month launch delay. Consequently, SMD adjusted all major milestones, including the ATLO Readiness Review, to accommodate the new launch date.

Plans for achieving 7ESS6: As part of the rebaselined schedule, SMD plans to conduct the OCO ATLO Readiness Review in January 2008. SMD continues to monitor all its development projects to maintain cost and schedule baselines.

3A.4: Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability.

FY04	FY05	FY6	FY 2007
None	None	3A.4 Yellow	**Green**

NASA's Gravity Recovery and Climate Experiment (GRACE) satellite, launched March 22, 2002, is the first satellite remote-sensing mission to observe groundwater storage variability at regional scales. Groundwater is a vital resource for irrigation and domestic consumption. Without it, agricultural productivity would decrease significantly in many parts of the world, including the central plains of the United States. Researchers routinely use wells to monitor groundwater storage variability at local scales, but that approach is impractical for regional- to continental-scale monitoring. GRACE is unique among remote-sensing satellites in that it relies on observations of Earth's gravity field to infer oceanic and atmospheric circulations and terrestrial water cycling. Using numerical models to separate the contributions to terrestrial water storage variability, including soil moisture and snow, GRACE observations infer groundwater storage variations. Upon analyzing GRACE data, researchers estimated groundwater storage changes in the Mississippi River basin and its four major sub-basins. NASA-supported researchers now are applying their technique to other regions of the world where well observations are unavailable to document water declines.

To ensure the accuracy of data, it is important to constantly assess researchers' ability to measure, monitor, and model various aspects of Earth's water balance (e.g., precipitation, evaporation, soil moisture, snow runoff, atmospheric water content). Estimates of water balance over the past century show variations in the size of various water reservoirs and fluxes. Since water spends a relatively short time in the atmosphere, an annual water balance of the atmosphere should result in a balance of water entering and leaving the atmosphere. However, estimates of water balance quantities over the past century vary enough to suggest that the data collection or modeling method may have been inaccurate. A recent study by NASA-funded researchers evaluated the relative agreement between observation estimates and model estimates. They found that on average, annual estimates of precipitation and evaporation are out of balance. There are inconsistencies between the estimates of the water vapor content of the atmosphere and estimates of precipitation minus evaporation. The study points out that in order to uncover trends in water balance quantities, for example due to climate change, scientists require a two-fold enhancement of their ability to estimate the terms of the water balance and improved quantification of the ocean evaporation.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Demonstrate progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability. Progress will be evaluated by external expert review.	None	None	6ESS7 Green	**7ESS5 Green**

3A.5: Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.

FY04	FY05	FY06	FY 2007
None	None	3A.5 Yellow	**Yellow**

Scientists at NASA's Goddard Space Flight Center and the University of Colorado developed an innovative technique for using data from the GRACE satellite to estimate, with unprecedented detail, the growth and shrinkage of major drainage systems in the Greenland and Antarctic ice sheets. In Greenland, these results show significant ice loss in the southeastern section of the ice sheet, and modest losses elsewhere, while the interior has been growing. While the results show that between 2003 and 2005 the ice sheet loss was offset partially by a gain in the interior sheet, they still indicate enhanced ice loss in Greenland since the mid-1990s. These results are consistent with those from altimetry measurements from the Ice Cloud and Land Elevation Satellite (ICESat).

Scientists also showed, using passive microwave satellite data, that winter sea ice extent has significantly accelerated its decline during the last three winters (2005–2007) in a manner consistent with predictions related to greenhouse warming. In the 26 years prior to 2005, the satellite data showed that the sea ice cover in the Northern Hemisphere during winter maximum declined at the rate of approximately two percent per decade, which was modest compared to the nearly 10 percent per decade decline in the extent of the summer sea ice minimum. However, shrinkage appears to have increased significantly in winter 2005, as the ice cover at winter maximum has been consistently low and is about six percent lower than average since then. Such phenomenon is consistent with the expected warming induced by greenhouse gases, which are supposed to be most detectable during dark winter when effects of long-wave radiation are most dominant.

Why NASA did not achieve Outcome 3A.5: Performance toward this Outcome continues to be a concern due to uncertainties in climate data continuity and delays and technical issues related to the NPOESS Preparatory Project (NPP) mission. Although the NASA-developed NPP spacecraft and the NASA-supplied Advanced Technology Microwave Sounder (ATMS) instrument have been successfully delivered and tested and the ATMS is integrated onto the NPP spacecraft, significant technical and schedule problems have caused delays with the development and delivery of the NPOESS-developed Visible/Infrared Imager/Radiometer Suite (VIIRS) instrument. The performance of the instrument will not meet all of NASA's NPP Level 1 requirements and, therefore, will impact key climate research measurements of ocean color and atmospheric aerosols.

Contractor performance also poses risks to both the NPP and Glory missions. Performance issues have been causing cost and schedule overruns, which impact not only the timely implementation of the systematic Earth Observation missions, but the overall success of the flight program.

Plans for achieving 3A.5: In order to improve contractor performance and limit further cost and schedule overruns, NASA implemented management changes on the Glory mission. Management changes also were approved by the Tri-Agency (NASA, NOAA, Department of Defense) Executive Committee and implemented by the Integrated Program Office (IPO) on NPOESS.

Program funding ensures NASA support to the IPO technical management personnel, funding for the competitively selected NPP science team, and the continued NPP project requirements. NASA continues to work with partner agencies to utilize the assessment information developed by the NPP project and science team in developing a joint mitigation strategy and implementation plan.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Demonstrate progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution. Progress will be evaluated by external expert review.	None	None	6ESS7 Green	**7ESS7 Green**
Complete Glory mission Pre-Ship Review.	None	None	None	**7ESS8 Yellow**
Complete Ocean Surface Topography Mission (OSTM) Critical Design Review (CDR).	None	None	None	**7ESS9 Green**

Why NASA did not achieve APG 7ESS8: SMD did not complete the Glory mission Pre-Ship Review. The contractor, Raytheon Space and Airborne Systems, experienced delays in developing the Aerosol Polarimetry Sensor (APS) instrument, resulting in a decision to move the instrument work to a different development facility. This caused an estimated six-month delay to the APS delivery. There are no significant technical issues with the development of this instrument.

Plans for achieving APG 7ESS8: SMD is revising project plans and scope to optimize the schedule and manpower for the late delivery of the APS. The Pre-Ship Review is scheduled for January 2009. SMD continues to monitor all its development projects to maintain cost and schedule baselines.

3A.6: Progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields.

FY04	FY05	FY06	FY 2007
None	None	3A.6 Green	**Green**

Accurate global topography has been the goal of explorers and surveyors for millennia because of its importance to understanding the environment and enabling societal development. The Shuttle Radar Topography Mission (SRTM) provided the first uniform high-resolution map of global topography with only 10 days of on-orbit measurement in February 2000. Although NASA released all SRTM data within two years of the SRTM mission, studies continue to characterize and improve the SRTM digital topographic data. In FY 2007, NASA-supported researchers produced a final report on the mission, its technology, its operations, the error distribution, processing, and some of the many and varied science applications.

The Aceh Earthquake and subsequent tsunami exposed the shortcomings of estimating earthquake magnitude and, therefore, tsunami potential from seismic data. Rapid assessment of conditions that could produce a tsunami is especially important for coastal communities near an earthquake epicenter because of short time between the earthquake and the subsequent tsunami. NASA-supported Global Positioning System (GPS) networks could be used in real time to estimate tsunami potential and provide input to tsunami models. NASA is moving ahead with further testing of the concept of regional GPS networks through collaborative efforts with EarthScope, state-operated networks, and international partners.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Demonstrate progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields. Progress will be evaluated by external expert review.	None	None	6ESS7 Green	**7ESS10 Green**

3A.7: Progress in expanding and accelerating the realization of societal benefits from Earth system science.

FY 04	FY 05	FY 06	FY 2007
None	None	3A.7 Green	**Green**

The Applied Sciences Program conducts projects to demonstrate, prototype, and validate the use of Earth science products in decision making, benefiting areas like public health, aviation, water management, and disaster management. Through reports that document the improvement in decision making enabled by the use of Earth science, the program enables the routine, sustained use of NASA data products. The program is developing a new, regionally-based activity to focus specifically on the Gulf of Mexico. In addition, the program is developing a new strategic plan, which will address emerging issues such as decision-support needs for climate change and the incorporation of social and economic sciences into applications of satellite observations.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Issue twelve reports with partnering organizations that validate that using NASA research capabilities (e.g., observations and/or forecast products) could improve their operational decision support systems.	None	None	None	**7ESS11 Green**
Complete five studies on plans to transition the results of NASA research and development, including scientific spacecraft and instruments, models, and research results, with potential to improve future operational systems of partner agencies.	None	None	None	**7ESS12 Green**

Efficiency Measures

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Deliver at least 90% of scheduled operating hours for all operations and research facilities. (This APG is repeated under Sub-goal 3B.)	None	5SEC14 Yellow	None	**7ESS22 Green**
Peer-review and competitively award at least 80%, by budget, of research projects. (This APG is repeated under Sub-goal 3B.)	4ESA8 Green	5SEC16 Green	None	**7ESS23 Green**
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	None	**7ESS24 Red**

Why NASA did not achieve Efficiency Measure 7ESS24: Earth–Sun System research grant selection notifications were significantly delayed in FY 2007 as a result of several factors that resulted in an increase rather than a decrease to processing times. The 15-percent reduction in the Research and Analysis budget in FY 2006, maintained in FY 2007 under the year-long continuing resolution, delayed selection decisions. Additionally, due to several large triennial programs being competed in FY 2007 and the increasing pressure for funding, the number of selection notifications (599) for the Earth–Sun System Theme was 61-percent greater than in FY 2006 (373).

Plans for achieving 7ESS24: SMD is implementing a number of measures to reduce processing times and expects to make significant progress. These measures include finding greater efficiencies in the manner in which panel reviews are constructed, reassessing the steps taken to conduct the proposal review process, and instituting job sharing to afford greater support and back-up contingencies for program officers. Furthermore, it is SMD's goal to adjust the timing of review panels to achieve greater efficiency. However, it should be noted that processing times for Earth Science will likely show an increase every third or fourth year, when the program conducts several large reviews at the start of a cycle. Although staggering the scheduling of these reviews would speed processing times, doing so would have programmatic impacts and will have to be carefully considered.

Sub-goal 3B

Understand the Sun and its effect on Earth and the solar system.

	Green	Yellow	Red	White
3 Outcomes	3 (100%)	0	0	0
11 APGs	8 (73%)	2 (18%)	1 (9%)	0

Cost of Performance (in millions)
$964

Responsible Mission Directorate

Science (SMD)

Contributing Theme

Earth–Sun System (ESS)

Theme Description

The Earth–Sun System Theme conducts research and technology development to advance Earth observations from space, improve understanding of the Earth system, and demonstrate new technologies for future operational systems. It also explores the Sun's connection with, and effects on, the solar system to better understand Earth and Sun as an integrated system, protect technologies on Earth, and safeguard human space explorers.

PART Assessment Rating						
Theme	Last Year Assessed	Overall Rating	Program Purpose and Design	Strategic Planning	Program Management	Program Results/ Accountability
Earth–Sun System	2005	Moderately Effective	100%	100%	84%	74%

Note: NASA divided the Earth–Sun System Theme into two Themes as of the FY 2008 Budget Estimate. Earth Science now is responsible for Sub-goal 3A and Heliophysics is responsible for Sub-goal 3B.

Life on Earth is linked to the behavior of the Sun. The Sun's energy output is fairly constant, yet its spectrum and charged particle output are highly variable on numerous timescales. Moreover, short-term events like solar flares and coronal mass ejections (CMEs) can change drastically solar radiation emissions over the course of a single second. All of the solar system's classical nine planets orbit within the outer layers of the Sun's atmosphere, and some planetary bodies, like Earth, have an atmosphere and magnetic field that interacts with the solar wind. While Earth's magnetic field protects life, it also acts as a battery, storing energy from solar wind until it is released, modifying "space weather" that can disrupt communications, navigation, and power grids, damage satellites, and threaten the health of astronauts.

To achieve Sub-goal 3B, Heliophysics Theme researchers study the Sun and its influence on the solar system as elements of a single, interconnected Earth–Sun system using a group of spacecraft that form an extended network of sensors that allow the investigation of the magnetic sun and its effect on the planets and the solar system. Using data from these spacecraft, NASA seeks to understand the fundamental physics behind Sun–planet interactions and study space environmental hazards.

Benefits

Society is increasingly dependent on technologies that are vulnerable to solar activity and space weather events, so the need to predict solar events and mitigate their effect is critical to the public's safety, security, and the Nation's economy.

This predictive capability is critical to NASA's human and robotic space missions as well. Better understanding and improved observations of solar events and of heliophysics will provide the information needed to develop early warning systems and technologies that will protect astronauts, spacecraft, and the systems that support both from hazardous space radiation.

Risks to Achieving Sub-goal 3B

Of primary cost concern for the Heliophysics Division is the reduction of Expendable Launch Vehicle (ELV) options. Over the course of the last decade, the Delta II has been the workhorse for SMD, its loss leaving only larger and costlier Evolved ELVs (Delta IV, Atlas V) for many of the missions identified in the NASA Science Plan, or much smaller launch vehicles with significantly reduced capabilities. NASA is aggressively exploring options to maintain a vital flight program.

The previous concern regarding the aging set of Heliophysics spacecraft has been mitigated for some kinds of observations by the launches of Solar–B (Hinode), the Solar TErrestrial RElations Observatory (STEREO), the Time History of Events and Macroscale Interactions during Substorms (THEMIS) spacecraft, and the Aeronomy of Ice in the Mesosphere (AIM) spacecraft in 2006–2007. Additionally, the Interstellar Boundary Explorer (IBEX) mission is scheduled to launch in 2008. It has passed its Critical Design and Mission Operations Reviews, and is currently undergoing Integration and Testing (I&T). The Solar Dynamics Observatory (SDO) also is planned for launch in 2008. All major SDO instrumentation has been delivered for integration. Progress on mesosphere-ionosphere-thermosphere science goals remains to be addressed.

FY 2008 Performance Forecast

- The Heliophysics Theme will conduct a Senior Review in spring 2008 to evaluate the scientific merit of its suite of operating missions in order to determine funding profiles for FY 2009 and beyond.
- Heliophysics anticipates completion of the research phase for the Polar mission, which will bring its operational phase to an end in spring 2008. Launched in 1996, the Polar mission imaged aurorae and measured the entry of plasma into the polar magnetosphere and the geomagnetic tail, the flow of plasma to and from the ionosphere, and the deposition of particle energy in the ionosphere and upper atmosphere.
- The Heliophysics Research Program will open competition for new research awards, resulting in about 70 new awards.
- NASA will complete development of SDO, working towards launch in December 2008. SDO will image the Sun to study how the solar magnetic field is structured and how its energy is converted and released into the heliosphere in the forms of solar wind, energetic particles, and variations in solar irradiance.
- Heliophysics will continue formulation for the Magnetospheric Multiscale (MMS) mission based on replanning conducted in FY 2007 (see below). MMS is a four-spacecraft mission to study magnetic reconnection in key boundary regions of Earth's magnetosphere, providing better understanding of this primary process by which energy is transferred from the solar wind to Earth's magnetosphere.
- Heliophysics will continue formulation for the Radiation Belt Storm Probes (RBSP) mission. RBSP is a two-spacecraft mission to investigate how populations of charged particles in the Earth's magnetosphere are formed or changed in response to the variable inputs of energy from the Sun.
- Heliophysics will also initiate Phase A on a solar probe mission and will initiate Phase B on the Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL) Geospace Mission of Opportunity balloon campaign.
- NASA will conduct I&T on the IBEX mission in preparation for a summer 2008 launch. IBEX will study the properties of the interstellar boundaries that separate the heliosphere—the immense "bubble" containing the solar system, the solar wind, and the entire solar magnetic field—from the interstellar medium that exists beyond the edge of the solar system.

Outcome 3B.1: Progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.

<table>
<tr><th>FY04</th><th>FY05</th><th>FY06</th><th>FY 2007</th></tr>
<tr><td>5.6.1
Green</td><td>15.4
Green</td><td rowspan="5">3B.1
Green</td><td rowspan="5">Green</td></tr>
<tr><td>5.6.2
Blue</td><td>15.5
Green</td></tr>
<tr><td>5.6.3
Green</td><td>15.6
Green</td></tr>
<tr><td>5.7.1
Green</td><td>15.7
Green</td></tr>
<tr><td>5.7.2
Green</td><td>15.8
Green</td></tr>
</table>

NASA-funded scientists answered key questions about how the interaction of magnetic fields produce the explosive releases of energy seen in solar flares, storms in Earth's magnetosphere, and many other powerful cosmic events. This process, called "magnetic reconnection," involves the merging of magnetic fields from disparate sources. Magnetic reconnection in Earth's magnetosphere is one of the mechanisms responsible for the aurorae, releasing in minutes energy that has been stored in the magnetic field over a period of days to months. The Heliophysics Great Observatory missions probed several reconnection sites during the past year, encountering the energetic jetting plasmas produced by reconnection on several occasions and measuring the boundaries of the structures themselves. Scientists confirmed that the rate at which the magnetic fields in geospace are able to reconnect is related to the orientation and relative strength of the participating magnetic and electric fields, and the rate was observed to increase as the pressure of the solar wind increases. Scientists found conclusive evidence for prolonged (at least five hours) reconnection in the solar wind. Spacecraft observed reconnection jets on the Sun at open field regions at the solar poles with much (approximately 40 times) higher frequency than had been previously observed. These jets may contribute to the high-speed solar wind. Scientists found an explanation as to why up to half of the energy released during solar flares is in the form of energetic electrons; the electrons are able to preferentially gain speed (kinetic energy) by repeatedly reflecting, or bouncing, off of the ends of contracting "magnetic islands" that form as the magnetic field lines reconnect. Most importantly, the Cluster mission observed the electron diffusion region where electrons become unmagnetized, allowing the reconnection to proceed and grow to be 10 times as large as previously thought.

NASA- and National Science Foundation-supported scientists discovered what shapes and powers the chromosphere, a thin region of the Sun's atmosphere. The chromosphere is a significant source of variations in the Sun's ultraviolet radiation that may contribute to climate change on Earth. The chromosphere is sandwiched between the cooler solar surface and the considerably hotter outer atmosphere, called the corona. Why the Sun's chromosphere is much hotter than the visible surface of the star has been a puzzle for decades. In the past, scientists proposed sound waves and the ever-changing solar magnetic field as potential drivers of this counter-intuitive temperature structure. The new results show that both have a part to play, offering a significant leap in the understanding of one of the Sun's remaining great mysteries. By analyzing the motions of structures within the solar atmosphere, the scientists observed that near strong knots of magnetic field, sound waves from the interior of the Sun leak out and propagate upward into the solar atmosphere. The magnetic field knots release wave energy from the solar interior, permitting the sound waves to travel through thin fountains upward and into the solar chromosphere. These magnetic fountains release a lot more energy into the chromosphere than researchers had previously thought, resulting in higher atmospheric temperature.

<table>
<tr><th>FY 2007 Annual Performance Goals</th><th>FY04</th><th>FY05</th><th>FY06</th><th>FY 2007</th></tr>
<tr><td rowspan="4">Demonstrate progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress will be evaluated by external expert review.</td><td>4SEC11
Green</td><td>5SEC9
Blue</td><td>6ESS11
Green</td><td rowspan="4">7ESS13
Green</td></tr>
<tr><td>None</td><td>None</td><td>6ESS12
Green</td></tr>
<tr><td>4SEC14
Green</td><td>5SEC12
Blue</td><td>6ESS14
Green</td></tr>
<tr><td>4SEC15
Green</td><td>5SEC13
Green</td><td>6ESS15
Green</td></tr>
<tr><td>Deliver Solar Dynamics Observatory (SDO) instruments to spacecraft for integration.</td><td>None</td><td>5SEC2
Green</td><td>6ESS17
Green</td><td>7ESS14
Yellow</td></tr>
<tr><td>Complete Magnetospheric MultiScale (MMS) instrument suite Preliminary Design Review (PDR).</td><td>None</td><td>None</td><td>None</td><td>7ESS15
Red</td></tr>
<tr><td>Award Geospace Missions Radiation Belt Mapper [now named Radiation Belt Storm Probes (RBSP)] Phase A instrument contracts.</td><td>None</td><td>5SEC4
White</td><td>6ESS18
Green</td><td>7ESS16
Green</td></tr>
<tr><td>Successfully launch Time History of Events and Macroscale Interactions during Substorms (THEMIS) spacecraft.</td><td>None</td><td>5SEC3
Green</td><td>None</td><td>7ESS17
Green</td></tr>
<tr><td>Release Explorer Program Announcement of Opportunity (AO).</td><td>None</td><td>None</td><td>None</td><td>7ESS18
Green</td></tr>
</table>

Why NASA did not achieve APG 7ESS14: The delivery of two of the three SDO instruments was delayed due to unanticipated technical difficulties in the data interfaces between the Helioseismic and Magnetic Imager (HMI) and the Atmospheric Imaging Assembly (AIA) and the spacecraft's command and data handling system. Both instruments use the new technology of 4000 x 4000 charge-coupled detectors to take high-resolution video for HMI and images for AIA of the Sun. The difficulties are attributed to both the charge coupled detectors and new, untested electronics technology and software that would allow SDO to transfer data at 130 Megabits per second with very high accuracy.

Plans for achieving 7ESS14: The HMI instrument was delivered in November 2007. The AIA instruments were delivered in December 2007. SMD continues to monitor all its development projects to maintain cost and schedule baselines.

Why NASA did not achieve APG 7ESS15: NASA replanned the MMS mission to resolve the discrepancy between mission requirements and the available budget. Progress on mission milestones was delayed during the the replanned schedule, but this replanning allowed the mission to go forward intact, without major performance degradation.

Plans for achieving 7ESS15: The MMS was approved for transition to Phase B in November 2007. The MMS instrument suite PDR is scheduled for completion in FY 2009.

Outcome 3B.2: Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields.

FY04	FY05	FY06	FY 2007
1.3.2 Green	15.2 Green	3B.2 Green	**Green**
1.3.3 Green	15.3 Green		

NASA scientists revealed new information on the source and generation mechanisms for the electromagnetic waves responsible for the acceleration of particles to high energies near Earth. The waves are radio signals with narrow-band tones that rise in frequency over a period of a few seconds. Called the "dawn chorus," the wave signal resembles that of birds heard at a distance. Although the signals had been detected for several decades, scientists knew very little about the actual source of the dawn chorus and how the waves themselves were created. For example, a "chorus" is most often detected on Earth's morning side, but it was not clear why. By measuring tiny differences in the arrival time of chorus signals at multiple spacecraft, scientists were able to deduce that the source region is quite compact and located near the magnetic equator at distances beyond 15,000 miles. Furthermore, this region is very likely to be the source for a large class of other, but similar, wave phenomena that propagate downward to be observed as aurorae. These studies enable scientists to learn more about how radio waves propagate in an electrified gas, which will be helpful to future applications of radio technology.

The Cluster mission observed superheated bubbles of gas growing and popping at the location where the solar wind meets Earth's magnetic field. The mission scientists theorized that these bubbles in space may collectively form Earth's bow shock, which is found where the solar wind rams into Earth's magnetic field, similar to the bow wave in front of a ship. This bow shock slows down and deflects the bulk of the incoming solar wind around Earth's magnetic field. Previously, scientists did not know how charged particles in space could be capable of creating such a bow shock. Using Cluster data, the scientists found that the bubbles, which may be caused by the energy that piles up at the bow shock, pushed particles from the solar wind to the side, effectively stopping the particles' movement towards Earth. Understanding how Earth's bow shock forms and dissipates energy will help scientists better understand certain aspects of space weather in the nearby space environment.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Deliver Solar Dynamics Observatory (SDO) instruments to spacecraft for integration.	None	5SEC2 Green	6ESS17 Green	**7ESS14 Yellow**
Complete Magnetospheric MultiScale (MMS) instrument suite Preliminary Design Review (PDR).	None	None	None	**7ESS15 Red**
Award Geospace Missions Radiation Belt Mapper Phase A instrument contracts.	None	5SEC4 White	6ESS18 Green	**7ESS16 Green**
Release Explorer Program Announcement of Opportunity (AO).	None	None	None	**7ESS18 Green**
Demonstrate progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields. Progress will be evaluated by external expert review.	4SEC10 Blue 4SEC13 Green	5SEC8 Green 5SEC11 Green	6ESS10 Green 6ESS13 Green	**7ESS19 Green**

Why NASA did not achieve APG 7ESS14: The delivery of two of the three SDO instruments was delayed due to unanticipated technical difficulties in the data interfaces between the HMI and the AIA and the spacecraft's command and data handling system. Both instruments use the new technology of 4000 x 4000 charge-coupled detectors to take high-resolution video for HMI and images for AIA of the Sun. The difficulties are attributed to both the charge coupled detectors and new, untested electronics technology and software that would allow SDO to transfer data at 130 Megabits per second with very high accuracy.

Plans for achieving 7ESS14: The HMI instrument was delivered in November 2007. The AIA instruments were delivered in December 2007. SMD continues to monitor all its development projects to maintain cost and schedule baselines.

Why NASA did not achieve APG 7ESS15: NASA replanned the MMS mission to resolve the discrepancy between mission requirements and the available budget. Progress on mission milestones was delayed during the replanned schedule, but this replanning allowed the mission to go forward intact, without major performance degradation.

Plans for achieving 7ESS15: NASA approved MMS for transition to Phase B in November 2007. The MMS instrument suite PDR is scheduled for completion in FY 2009.

Outcome 3B.3: Progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers.

FY04	FY05	FY06	FY 2007
1.3.1 Green	15.1 Green	3B.3 Green	**Green**

A new space weather forecast method, based on data from the Solar and Heliospheric Observatory (SOHO) spacecraft, permits - for the first time - up to an hour of warning prior to the arrival of the most dangerous particles of a solar storm at Earth. According to radiation safety experts at Johnson Space Center, once verified, the technique may help NASA reduce the exposure to radiation by more than 20 percent compared to current methods and may allow astronauts to venture farther from shelter. Solar storms consist of electrons and ions, the latter of which pose a grave danger to space-borne electronics and to humans outside Earth's protective magnetic field. Electrons arrive first, signaling the later arrival and intensity of the ions. Previously, there was no adequate method to predict when and at what intensities the ions arrive.

In a parallel development, the Wind mission showed that the Sun's radio waves also can be used as an indicator of an approaching solar storm. NASA scientists discovered that coronal mass ejections capable of producing radiation storms "scream" in radio waves as they slam through the solar wind. Since the radio signal moves at the speed of light while the particles that will produce the storm follow behind, the signal provides an early warning that allows astronauts and satellite operators to prepare for the impending storm. CMEs can bring intense radiation storms that can damage satellites and cause short- and long-term health effects in unprotected astronauts.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Deliver Solar Dynamics Observatory (SDO) instruments to spacecraft for integration.	None	5SEC2 Green	6ESS17 Green	**7ESS14 Yellow**
Award Geospace Missions Radiation Belt Mapper Phase A instrument contracts.	None	5SEC4 White	6ESS18 Green	**7ESS16 Green**
Demonstrate progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers. Progress will be evaluated by external expert review.	4SEC8 Green 4SEC9 Green	5SEC6 Green 5SEC7 Green	6ESS8 Green 6ESS9 Green	**7ESS20 Green**

Why NASA did not achieve APG 7ESS14: The delivery of two of the three SDO instruments was delayed due to unanticipated difficulties in the data interfaces between the HMI and the AIA and the spacecraft's command and data handling system. Both instruments use the new technology of 4,000 x 4,000 charge-coupled detectors to take high-resolution video for HMI and images for AIA of the Sun. The difficulties are attributed to both the charge coupled detectors and new, untested electronics technology and software that would allow SDO to transfer data at 130 Megabits per second with very high accuracy.

Plans for achieving 7ESS14: The HMI instrument was delivered on November 2007. The AIA instruments were delivered in December 2007.

Efficiency Measures

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete all development projects within 110% of the cost and schedule baseline.	4ESS1 Green	5SEC14 Red	6ESS24 Red	**7ESS21 Yellow**
Deliver at least 90% of scheduled operating hours for all operations and research facilities. (This APG is repeated under Sub-goal 3A.)	None	5SEC15 Yellow	6ESS25 Green	**7ESS22 Green**
Peer-review and competitively award at least 80%, by budget, of research projects. (This APG is repeated under Sub-goal 3A.)	4ESA8 Green	5SEC16 Green	6ESS26 Green	**7ESS23 Green**

Why NASA did not achieve APG 7ESS21: The THEMIS mission exceeded its schedule baseline by 13 percent. The launch vehicle provider requested a four-month launch delay to resolve a second-stage oxidizer tank anomaly on the Delta launch vehicle.

Plans for achieving 7ESS21: The THEMIS mission launched in February 2007. SMD continues to monitor all its development projects to maintain cost and schedule baselines. Cost control is now a significant central tenet of SMD's management and future missions are being held to stricter standards than in the recent past.

Sub-goal 3C

Advance scientific knowledge of the solar system, search for evidence of life, and prepare for human exploration.

	Green	Yellow	Red	White
4 Outcomes	4 (100%)	0	0	0
13 APGs	10 (77%)	0	2 (15%)	1 (8%)

Cost of Performance (in millions)
$1,325

Responsible Mission Directorate

Science (SMD)

Contributing Theme

Solar System Exploration (SSE)

Theme Description

The Solar System Exploration Theme seeks to understand how the solar system formed and evolved, and whether there might be life in the solar system beyond Earth.

PART Assessment Rating						
Theme	**Last Year Assessed**	**Overall Rating**	**Program Purpose and Design**	**Strategic Planning**	**Program Management**	**Program Results/ Accountability**
Solar System Exploration	2006	Effective	100%	100%	91%	74%

To achieve Sub-goal 3C, the Solar System Exploration (now Planetary Science) Theme uses robotic science missions to investigate alien and extreme environments throughout the solar system. These missions help scientists understand how the planets of the solar system formed, what triggered the evolutionary paths that formed rocky terrestrial planets, gas giants, and small, icy bodies, and how terrestrial bodies originated, evolved, and their habitability. The data from these missions guide scientists in the search for life and its precursors beyond Earth and provide information to help NASA plan future human missions into the solar system.

Benefits

NASA's robotic science missions are paving the way for understanding the origin and evolution of the solar system and to identify past and present habitable locations. With this knowledge, the Theme also is potentially enabling human space exploration by studying and characterizing alien environments and identifying possible resources that will enable safe and effective human missions to the Moon and beyond.

Robotic explorers gather data to help scientists understand how the planets formed, what triggered different evolutionary paths among planets, and how Earth formed, evolved, and became habitable. To search for evidence of life beyond Earth, scientists use this data to map zones of habitability, study the chemistry of alien worlds, and unveil the processes that lead to conditions necessary for life.

Through the Near Earth Object Observation Program, NASA identifies and categorizes asteroids and comets that come near Earth. Every day, a hundred tons of interplanetary particles drift down to Earth's surface, mostly in the form of dust particles. Approximately every 100 years, rocky or iron asteroids larger than 50 meters crash to Earth, causing damage like craters and tidal waves, and about every few hundred thousand years, an asteroid larger than a kilometer threatens Earth. In the extremely unlikely event that such a large object threatens to collide with Earth, NASA's goal is to provide an early identification of these hazardous objects as far in advance as possible (perhaps years).

Risks to Achieving Sub-goal 3C

Of primary cost concern is the reduction in ELV launch options. Over the course of the last decade, the Delta II has been the workhorse for SMD. Its loss leaves only larger and costlier Evolved ELVs (Delta IV, Atlas V) for many of the missions identified in the NASA Science Plan or much smaller launch vehicles with significantly reduced capabilities. NASA is aggressively exploring options to maintain a vital flight program, including the development of dual payload launch capability and alternate launch providers for mid-range planetary payloads.

FY 2008 Performance Forecast

- Phoenix is scheduled to land in Mars's northern arctic plain on May 25, 2008. Using a suite of instruments and a robotic arm, Phoenix will sample the atmosphere, take stereo images, and analyze the Martian soil and ice sitting just below the top soil layer. The goal of the mission is to help determine whether life ever arose on Mars, characterize the atmosphere and geology, and collect information important to future human exploration.
- The Mars Science Laboratory (MSL) will begin assembly, test, and launch operations in early 2008, in preparation for its launch readiness date in September 2009. The MSL rover will collect samples from Martian soil and rocks to search for the chemical building blocks of life and determine the planet's habitability.
- The MESSENGER spacecraft will complete the first of three flybys of Mercury in January 2008. In 2011, MESSENGER will become the first spacecraft to orbit Mercury, a planet of extremes that holds vital clues to how the solar system formed and evolved.
- Heading towards the outer reaches of the solar system, New Horizons will pass the orbit of Saturn in summer 2008 on its long trek to the double planet Pluto and its moon Charon. Pluto is part of the icy Kuiper Belt, a zone of planetary embryos and debris left over from when the solar system was forming more than four billion years ago.
- The Juno mission will complete its Preliminary Design Review (PDR)/Non-Advocate Review and enter its implementation phase, with the target of reaching launch readiness in summer 2011. Juno will study Jupiter's interior structure and dynamics, atmospheric composition, and magnetosphere to provide a better understanding of this archetypal gas giant and the origin of Earth's solar system and solar systems around other stars.
- Two spacecraft that have completed their missions will be re-tasked as Discovery Missions of Opportunity. The Deep Impact Extended Investigation of Comets (DIXI) will use the existing Deep Impact spacecraft—which sent an impactor into comet Tempel 1 on July 4, 2005—to conduct a flyby of comet Hartley 2 in October 2010. Along the way, the spacecraft will observe planets orbiting several nearby bright stars as part of the Extrasolar Planet Observation and Characterization (EPOCH) investigation. The Stardust spacecraft—which returned a capsule containing samples of comet Wild 2 in January 2006—will conduct a flyby of Tempel 1 as part of the New Exploration of Tempel 1 (NExT) investigation. The spacecraft will study changes to the comet nucleus since Deep Impact observed it in 2005. Stardust will reach Tempel 1 in 2011.

Outcome 3C.1: Progress in learning how the Sun's family of planets and minor bodies originated and evolved.

FY04	FY05	FY06	FY 2007
5.1.2 Green	3.2 Green	3C.1 Green	**Green**
5.1.3 Green	3.3 Green		

Using precise radar measurements taken from the ground and data from NASA's Mariner 10 spacecraft (which operated from 1973 through 1975), researchers determined that tiny Mercury likely has a molten core. Because Mercury is so small, most scientists expected its core to have cooled and solidified long ago and that its magnetic field may have been "frozen" into the planet when the core cooled. Researchers found that the mantle is separated from a core that is at least partially molten. The state of the planet's core depends greatly on the core's chemical composition, and that composition can provide important clues about the processes involved in planet formation. NASA's MESSENGER spacecraft, which completed its second Venus flyby in June 2007 as it journeys to the innermost planet, will collect much more detailed data on Mercury.

Despite decades of research, scientists have not calculated a precise rotation period for Saturn. Previously, they determined the rotation period using Voyager and Cassini magnetometer data. While these data agreed, they were measuring the rotation of Saturn's magnetosphere. Using gravitational data from NASA's Cassini spacecraft, researchers determined a new rotation period that is tied more directly to the mass of the planet. The new period of 10 hours 32 minutes is less than the previously determined period of 10 hours 39 minutes. While this difference seems small, it has important implications for understanding Saturn's atmosphere: the speed of the planet's surface winds, which had seemed anomalous using the previous rotation period calculation, are reduced, and the model for Saturn's atmosphere now fits more closely with models for other planets.

Using Mars Reconnaissance Observer (MRO) observations, researchers delineated the locations of phyllosilicates, the alteration products of minerals sustaining contact with water. The data show that these minerals are widespread in the highlands of Mars, but restricted to the most ancient areas dating to the Noachian era, the oldest of three periods during which the Mars surface formed. The research provides new and important information about early Mars, the interaction of water with the crust, and consequences of the evolution of the planet's interior.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Demonstrate progress in learning how the Sun's family of planets and minor bodies originated and evolved. Progress will be evaluated by external expert review.	4SSE12 Yellow	5SSE7 Green	6SSE7 Green	**7SSE1 Green**
Perform MErcury Surface, Space ENvironment, GEochemistry, and Ranging mission (MESSENGER) second Venus flyby.	None	None	6SSE28 White	**7SSE2 Green**
Complete Juno Preliminary Design Review (PDR).	None	None	None	**7SSE3 White**

Why NASA rated APG 7SSE3 White: In 2006, NASA postponed the Juno PDR after altering the New Frontiers Program budget and shifting the Juno launch date to a 2010–2011 timeframe. Because NASA did not issue a revised FY 2007 Performance Plan with the FY 2008 Budget Estimates and, therefore, was unable to revise this APG before the beginning of the FY 2007 performance year, management chose to cancel the measure. The Juno PDR is scheduled for May 2008.

Outcome 3C.2: Progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds.

FY04	FY05	FY06	FY 2007
5.2.3 Green	3.7 Green	3C.2 Green	**Green**
5.2.4 Green	3.8 Green		

Although research has not revealed complex organics on Mars, data gathered in 2003 found methane, a basic organic compound. Since most of the methane in Earth's atmosphere is generated by living organisms, researchers hoped that the finding indicated the presence of bacteria living in Mars' ice. In an assessment completed in FY 2007, researchers found the most probable source of methane is a process called low-temperature serpentinization, observed on Earth's ocean floor, where liquid water chemically alters basalt to produce methane. Low-temperature serpentinization occurring in liquid water reservoirs under Mars' surface would produce minerals called serpentines, as well as approximately 200,000 tons of methane every year. The researchers also found that one of the least likely scenarios for the current presence of Martian methane is delivery by a comet or meteorite.

Using observations by the Cassini spacecraft of Saturn's moon Enceladus, scientists detected geysers containing water-vapor and the decomposition products of water, as well as small amounts of molecular nitrogen and methane. This suggests that the interior of Enceladus is warm enough to contain liquid water and that is, or once was, favorable to catalytic chemistry that would permit the synthesis of complex organic compounds. This makes Enceladus an exciting subject for further research to discover if this moon could possibly be hospitable to primitive life and to reveal how such a small, icy body could have a warm core.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Demonstrate progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds. Progress will be evaluated by external expert review.	4SSE17 Green	5SSE12 Green	6SSE12 Green	**7SSE4 Green**
	4SSE18 Green	5SSE13 Green	6SSE13 Green	
	4SSE19 Green	5SSE14 Green	6SSE14 Green	
	4MEP9 Green	5MEP7 Green	6SSE15 Green	
	4MEP10 Blue	5MEP8 Blue	6SSE16 Green	
	4MEP11 Blue	5MEP9 Green	6SSE17 Green	
	4MEP12 Green	5MEP10 Green	6SSE18 Green	
	4MEP13 Green	5MEP11 Yellow	6SSE19 Yellow	

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete 2009 Mars Science Laboratory Critical Design Review (CDR).	None	5MEP4 Yellow	6SSE25 Green	**7SSE5 Green**

Outcome 3C.3: Progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system.

FY04	FY05	FY06	FY 2007
5.3.1 Green	2.1 Green	3C.3 Green	**Green**
5.3.2 Blue	2.2 Green		
5.3.3 Blue	2.3 Green		
5.4.1 Green	2.5 Green		
5.4.2 Green	2.6 Green		
5.2.2 Green	3.6 Green		

Several icy moons in the outer solar system possess oceans beneath an ice shell that could harbor life. A new study using data from the Cassini spacecraft suggests that tiny Enceladus, a moon of Saturn, possesses such an ocean. The south pole of Enceladus is warmer and is the site of geysers and fractures. Cassini observations showed that fractures along the surface move backwards and forwards, generating heat from friction. These motions come from Enceladus being squeezed and stretched by Saturn's gravitational field as the moon orbits. However, the motions are too small to explain the observed heat if Enceladus were solid throughout, suggesting that Enceladus has an ocean beneath the surface. If the geysers are in contact with the ocean, a future mission could sample material to look for signs of life simply by flying through a geyser plume (see Outcome 3C.4 for more about chemical compounds found on Enceladus).

Ongoing MRO mapping and analysis of sedimentary deposits in Holden crater on Mars found well-bedded deposits emplaced during two distinct wet intervals during the Noachian era, the oldest of three periods during which Mars's surface formed. During the first of these wet intervals, there was a lake in the crater that included the deposition of phyllosilicates. The second interval was shorter lived and related to flooding occurring when water impounded in the nearby Uzboi Vallis breached the crater rim and drained into the Holden crater. Access to these deposits, perhaps during a future landed mission, could yield important information about the conditions within these ancient lake environments and whether they may have been habitable.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Demonstrate progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system. Progress will be evaluated by external expert review.	4MEP14 Green	5MEP12 Green	6SSE20 Yellow	**7SSE6 Green**
Successfully launch Phoenix 2007 spacecraft.	None	None	None	**7SSE7 Green**

Outcome 3C.4: Progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence.

FY04	FY05	FY06	FY 2007
5.5.1 Blue	2.7 Green	3C.4 Green	**Green**
1.4.1 Green	3.9 Green		
1.4.2 Green	3.10 Green		

NASA's Near Earth Object Observation Program conducts surveys to identify and characterize potentially hazardous objects, like comets and asteroids, coming within Earth's vicinity. External experts estimated that there are approximately 1,100 near-Earth objects of at least one kilometer in size. In 2006, NASA commissioned a study by external experts to reexamine this population estimate based on the distribution of objects found. The revised estimate, completed in FY 2007, indicates that this population may be closer to 940. To date, researchers have identified 788 near-Earth objects larger than one kilometer. Based on the revised estimate, researchers have identified about 84 percent of near-Earth objects larger than one kilometer, placing NASA within six percent of achieving the goal of finding 90 percent of these objects by December 2008.

The Mars Global Surveyor, which launched in 1996 and went silent in November 2006, provided a record of newly formed impact craters on the surface of Mars over seven years. NASA is using this record, the first measurement of actual impact rate on Mars, to validate that model predictions are accurate to within a factor of two of the measurements. NASA uses these model predictions to help identify safe landing sites for robotic and human missions to the Red Planet.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Demonstrate progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence. Progress will be evaluated by external expert review.	4SSE10 Green	5SSE5 Green	6SSE5 Green	**7SSE8 Green**
	4MEP15 Blue	5MEP13 Green	6SSE21 Green	
	4MEP16 Blue	5MEP14 Yellow	6SSE22 Green	
Begin Mars Reconnaissance Orbiter (MRO) primary science phase.	None	5MEP2 Green	6SSE23 Green	**7SSE9 Green**

Efficiency Measures

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete all development projects within 110% of the cost and schedule baseline.	4SSE1 Yellow	5SSE15 Yellow	6SSE29 Red	**7SSE10 Red**
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	None	5SSE16 Green	6SSE30 Green	**7SSE11 Green**
Peer-review and competitively award at least 80%, by budget, of research projects.	4SSE2 Green	5SSE17 Green	6SSE31 Green	**7SSE12 Green**
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	6SSE32 Green	**7SSE13 Red**

Why NASA did not achieve APG 7SSE10: NASA successfully launched the Phoenix and Dawn missions during FY 2007. The Phoenix mission was completed on schedule and exceeded its cost baseline by only three percent. However, the Dawn mission exceeded its schedule baseline by 54 percent and its cost baseline by 27 percent.

Unresolved technical and schedule issues driven by delayed hardware deliveries compromised the 2006 launch opportunity for the Dawn mission, leading NASA to cancel the mission in December 2005. After extensive reviews and replanning, NASA restarted the mission in March 2006, with a new launch date of June 2007. Launch vehicle and telemetry support issues caused NASA to delay the launch from June to September 2007.

Plans for achieving 7SSE10: The Dawn mission was successfully launched on September 26, 2007, completing the work affecting this measure in FY 2007. SMD continues to monitor all its development projects to maintain cost and schedule baselines.

Cost control is now a central tenet of SMD's management, and future missions are being held to stricter standards than in the recent past. When SMD reviews projects at key decision points, descope options are given primary consideration in addressing any cost growth. SMD took such action recently on the Kepler project, for which a cost increase was mitigated by shortening the mission duration by six months and by holding the contractor's fee as reserve on the project.

Why NASA did not achieve APG 7SSE13: Due to increasing pressure for funding, the number of selection notifications (445) was 35-percent greater than in FY 2006 (330). Rather than showing progress toward the FY 2007 goal of selecting proposals within 259 days of the proposal due date, the Planetary Science Theme's processing times increased to 314 days.

Plans for achieving 7SSE13: SMD is implementing a number of measures to reduce processing times and expects to make significant progress. These measures include finding greater efficiencies in the manner in which panel reviews are constructed, reassessing the steps taken to conduct the proposal review process, and instituting job-sharing to afford greater support and back-up contingencies for program officers. Furthermore, it is SMD's goal to adjust the timing of review panels to achieve greater efficiency.

Sub-goal 3D

Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.

	Green	Yellow	Red	White
4 Outcomes	3 (75%)	1 (25%)	0	0
16 APGs	14 (88%)	1 (6%)	1 (6%)	0

Cost of Performance (in millions)
$1,467

Responsible Mission Directorate

Science (SMD)

Contributing Theme

The Universe

Theme Description

The Universe Theme seeks to understand the origin, evolution, and destiny of the universe, galaxies, stars, and planets, determine the physical and chemical processes that govern the universe, and search for Earth-like planets beyond the solar system. The Theme also seeks to understand the conditions that support life.

PART Assessment Rating

Theme	Last Year Assessed	Overall Rating	Program Purpose and Design	Strategic Planning	Program Management	Program Results/ Accountability
Astrophysics (formerly the Universe)	2007	Adequate	100%	100%	75%	47%

Through Sub-goal 3D, the Universe (now Astrophysics) Theme seeks to answer some of humankind's enduring questions: How did the universe begin? Will the universe have an end? Are humans alone in the universe?

Using ground-based telescopes and space missions, NASA enables research to understand the structure, content, and evolution of the universe. This research provides information about humankind's origins and the fundamental physics that govern the behavior of matter, energy, space, and time. NASA-supported researchers look far into the universe, towards the beginning of time, to see galaxies forming. They also search for Earth-like planets around distant stars, determine if life could exist elsewhere in the galaxy, and investigate the processes that formed Earth's solar system.

Benefits

The study of the universe benefits the Nation's scientific research community by focusing research and advanced technology development on optics, sensors, guidance systems, and power and propulsion systems. Some of these technologies find their way into the commercial and defense sectors.

Research into the origins and nature of the universe contributes to "the expansion of human knowledge . . . of phenomena in the atmosphere and space," a charter objective in the 1958 Space Act. NASA's astrophysics missions—particularly the three Great Observatories: the Hubble Space Telescope, the Spitzer Space Telescope, and the Chandra X-ray Observatory—have provided researchers with new ways of looking at the universe so that they can expand knowledge about cosmic origins and fundamental physics. The interesting and beautiful images from these observatories also are educational tools to help spark student interest in science, technology, engineering, and mathematics and serve to prominently illustrate the role of the United States in scientific exploration.

Risks to Achieving Sub-goal 3D

For 2008, the launch of the Gamma-ray Large Area Space Telescope (GLAST) mission, successful completion of Hubble Servicing Mission #4, and successful completion of the Preliminary Design Review for the James Webb Space Telescope are all critical milestones and must be reached for a successful year. The Hubble Servicing Mission launch date is beyond the Theme's ability to control, but delays could result in cost impacts to the budget.

Maintaining cost and schedule on the Kepler and Wide-field Infrared Survey Explorer (WISE) missions, each scheduled for a 2009 launch, also is critical. SMD continues to monitor the projects' performance to ensure adherence to plans.

Finally, the Astrophysics Theme must release an announcement of opportunity for a Dark Energy Mission and begin mission formulation. The interagency and potentially international collaborative aspects of this mission add schedule risk to the initiation of mission formulation. Partners must agree on the nature of the announcement of opportunity and the incorporated roles and responsibilities of the partners. SMD is committed to managing the early study phases for a Dark Energy Mission to ensure a mission architecture consistent with available resources.

FY 2008 Performance Forecast

- The missions managed by the Astrophysics Research Program—including Chandra, Spitzer, Swift, and the Wilkinson Microwave Anisotropy Probe (WMAP)—will continue high-quality astrophysics research consistent with NASA's goals.
- The GLAST launch is planned for mid-2008. After two months of on-orbit checkout, the mission will begin science operations. GLAST will help scientists study the most energetic and exotic phenomena, including pulsars and black holes, to provide insight into the birth and early evolution of the universe.
- The Kepler spacecraft will undergo Integration and Testing, preparing it for launch in fall 2008. Kepler will be the first spacecraft designed to search for Earth-like planets that are up to 600 times less massive than the Jupiter-like gas giants found by other telescopes.
- The James Webb Space Telescope (JWST) will undergo Preliminary Design Review (PDR)/Non-Advocate Review in spring 2008. Upon successful completion, the program will transition from formulation to development. JWST is a next-generation, space-based, infrared observatory that will take over where Spitzer and the Hubble Space Telescope leave off.
- Based on recommendations from the National Research Council, NASA is restructuring the Beyond Einstein Program. The program will begin formulation of the Joint Dark Energy Mission (JDEM), while other mission options remain in technology development.
- The Herschel and Planck missions will be launched together by the European Space Agency in 2008. Herschel will study the formation and evolution of stars and galaxies in the early universe, and Planck will characterize radiation from the cosmic microwave background.
- Flight testing will continue on the Stratospheric Observatory for Infrared Astronomy (SOFIA), an astronomical telescope installed in a 747 aircraft. The program partners also will continue to develop critical observatory sub-systems and instruments.

Outcome 3D.1: Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.

<table>
<tr><th>FY04</th><th>FY05</th><th>FY06</th><th>FY 2007</th></tr>
<tr><td>5.10.1
Green</td><td>5.1
Green</td><td rowspan="4">3D.1
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<tr><td>5.11.1
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During FY 2007, scientists released findings supporting the existence of dark matter and that the Newtonian gravity familiar on Earth and in the solar system also works on the huge scales of galaxy clusters. Some scientists have proposed alternative theories for gravity where it is stronger on intergalactic scales than predicted by Newton and Einstein, removing the need for dark matter. In August 2006, however, researchers released findings from observations by Chandra and other telescopes of a tremendous collision of two large clusters of galaxies that cannot be explained by alternate theories. The hot gas (normal matter) in the collision was slowed by a drag force while the dark matter, which does not interact directly with itself or the gas through gravity, was not slowed. This produced the separation of the dark and normal matter seen in the data. If hot gas was the most massive component in the clusters, as proposed by alternative gravity theories, the data would not have shown such a separation. In May 2007, astronomers using Hubble discovered a ghostly ring of dark matter that formed during a collision of two other massive galaxy clusters. Computer simulations of galaxy cluster collisions show that when two clusters smash together, the dark matter falls to the center of the combined clusters and sloshes back out. As the dark matter moves outward, it begins to slow down under the pull of gravity and pile up, like cars bunched up on a freeway. Although scientists cannot see dark matter, they can infer its existence in galaxy clusters by observing how its gravity bends the light of more distant background galaxies. The dark matter pile up looks like concentric ripples created when a stone is dropped in water.

Using the new Japanese Suzaku satellite, NASA scientists and their international partners collected a startling new set of black hole observations, revealing details of twisted space and warped time never before seen with such precision. The observations clocked the speed of a black hole's spin rate and measured the angle at which matter pours into the void. They also provided evidence for a wall of X-ray light pulled back and flattened by gravity. The findings rely on a special feature in the light emitted close to the black hole, called the "broad iron K line," once doubted by some scientists because of poor resolution in earlier observations but now unambiguously revealed as a true measure of a black hole's crushing gravitational force. Researchers can use this technique in future X-ray missions.

Scientists using Hubble discovered that dark energy is not a new constituent of space, but rather has been present for most of the universe's history. Dark energy is a mysterious repulsive force that causes the universe to expand at an increasing rate. Scientists found that dark energy was already boosting the expansion rate of the universe as long ago as nine billion years. This picture of dark energy is consistent with Einstein's prediction that a repulsive form of gravity emanates from empty space. Data from Hubble provide supporting evidence into the nature of dark energy and help scientists begin ruling out some competing explanations that predict that the strength of dark energy changes over time.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Demonstrate progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity. Progress will be evaluated by external expert review.	4SEU9 Green 4SEU10 Green 4SEU11 Blue 4SEU12 Green 4SEU13 Green 4SEU14 Green 4SEU16 Green	5SEU4 Green 5SEU5 Blue 5SEU6 Green 5SEU7 Green 5SEU8 Yellow 5SEU9 Blue 5SEU11 Blue	6UNIV8 Green 6UNIV9 Green 6UNIV10 Green 6UNIV11 Green 6UNIV12 Green 6UNIV13 Green 6NIV15 Green	**7UNIV1 Green**
Complete Gamma-ray Large Area Space Telescope (GLAST) Operations Readiness Review (ORR).	None	5SEU1 Yellow	6UNIV19 Yellow	**7UNIV2 Yellow**
Complete Hubble Space Telescope Servicing Mission 4 (SM4) Test Readiness Review.	None	None	None	**7UNIV3 Green**
Complete James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Preliminary Design Review (PDR).	None	None	6UNIV20 Red	**7UNIV4 Green**

Why NASA did not achieve APG 7UNIV2: NASA delayed the GLAST launch due to continued slips in completing the Command and Data Handling subsystem, spacecraft testing schedule conflicts with Department of Defense projects, and spacecraft contractor performance issues.

Plans for achieving 7UNIV2: The GLAST Operational Readiness Review and launch are scheduled for mid-2008. SMD continues to monitor all its development projects to maintain cost and schedule baselines.

Outcome 3D.2: Progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects recognized in the present universe.

FY04	FY05	FY06	FY 2007
5.8.1 Blue	4.1 Green	3D.2 Yellow	**Green**

The brightest stellar explosion ever recorded may be a long-sought new type of supernova, according to observations by NASA's Chandra X-ray Observatory and ground-based optical telescopes. The discovery of the supernova, known as SN 2006gy, provides evidence that the death of such massive stars is fundamentally different from theoretical predictions. Supernovas usually occur when massive stars exhaust their fuel and collapse under their own gravity. In the case of SN 2006gy, astronomers think that the core of the massive star produced so much gamma ray radiation that some of the energy from the radiation converted into particle and anti-particle pairs. The resulting drop in energy caused the star to collapse under its own huge gravity. After the violent collapse, runaway thermonuclear reactions eventually caused the star to explode, spewing the remains into space. Astronomers now believe that it was not uncommon for first stars to collapse into supernovas, rather than black holes as theorized. This finding has huge implications for the formation of the early universe, since supernovas scatter newly made elements around the galaxy while the massive gravitational pull of black holes permanently lock elements away.

The massive star that produced SN 2006gy apparently expelled a large amount of mass prior to exploding. This large mass loss is similar to that seen from Eta Carinae, a massive star in the Milky Way galaxy, raising suspicion that Eta Carinae may be poised to explode as a supernova. While SN 2006gy is the brightest supernova observed, it is in a galaxy some 240 million light years away. Eta Carinae, however, is only 7,500 light years away. Astronomers are keeping an eye on the massive star in hopes that it will put on a spectacular—and informative—show considerably closer to home.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete Hubble Space Telescope Servicing Mission 4 (SM4) Test Readiness Review.	None	None	None	**7UNIV3 Green**
Complete James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Preliminary Design Review (PDR).	None	None	6UNIV20 Red	**7UNIV4 Green**
Demonstrate progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects we recognize in the present universe. Progress will be evaluated by external expert review.	4SEU15 Green 4SEU17 Green 4ASO9 Blue	5SEU10 Green 5SEU12 Green 5ASO5 Green	6UNIV14 Green 6UNIV16 Yellow 6UNIV17 Green	**7UNIV5 Green**

3D.3: Progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems.

FY04	FY05	FY06	FY 2007
5.8.3 Green	4.3 Green	3D.3 Yellow	**Green**

More than 200 years ago, the philosopher Immanuel Kant first proposed that planets are born from disks of dust and gas that swirl around stars. Despite having detected hundreds of extrasolar planets and many debris disks, astronomers had never observed a planet and a debris disk aligned in the same plane around the same star. In FY 2007, Hubble and ground-based observatories provided the long sought-after confirmation: a planet with its disk. The Jupiter-like gas giant, first detected in 2000, orbits the nearby Sun-like star Epsilon Eridani, located 10.5 light-years from Earth. Epsilon Eridani still retains its disk because it is young, only 800 million years old. The observations also helped astronomers determine the planet's true mass, which they calculated as 1.5 times Jupiter's mass.

Astronomers, using data from Spitzer, laid down the cosmic equivalent of yellow "caution" tape around super-hot stars called O-stars, marking the zones where cooler stars are in danger of having their developing planets blasted away. These are zones (inside of 1.6 light-years, or nearly 10 trillion miles, of an O-star) where ultraviolet radiation from a super-hot star heats and evaporates the potentially planet-forming gas and dust within a debris disk, then winds from the star blow the material away. The findings are helping astronomers pinpoint the types of environments where planets—from massive gas giants to small terrestrial planets like Earth—are most likely to form.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete Hubble Space Telescope Servicing Mission 4 (SM4) Test Readiness Review.	None	None	None	**7UNIV3 Green**
Complete James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Preliminary Design Review (PDR).	None	None	6UNIV20 Red	**7UNIV4 Green**
Demonstrate progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems. Progress will be evaluated by external expert review.	4ASO10 Green 4ASO11 Green	5ASO6 Green 5ASO7 Green	6UNIV1 Green 6UNIV2 Green	**7UNIV6 Green**

Outcome 3D.4: Progress in creating a census of extra-solar planets and measuring their properties.

FY04	FY05	FY06	FY 2007
5.1.4 Green	3.4 Green	3D.4 Yellow	**Yellow**

Researchers using Spitzer learned what the weather is like on two distant, exotic worlds. One team of astronomers used the infrared telescope to map temperature variations over the surface of a giant gas planet, HD 189733b, revealing that it likely is whipped by roaring winds. Another team determined that the gas planet HD 149026b is the hottest yet discovered. The two planets are "hot Jupiters," sizzling, gas giants that zip closely around their parent stars. Roughly 50 of the more than 200 known planets outside the solar system are hot Jupiters. Astronomers believe that all hot Jupiters are tidally locked like the Moon, so that one side of the planet always faces the star. The observations revealed that temperatures on HD 189733b are fairly even, ranging from a balmy 1,200º Fahrenheit on the dark side to 1,700º Fahrenheit on the sunlit side. Since the planet's overall temperature variation is somewhat mild, astronomers believe winds must be spreading the heat from the sunlit side to the dark side. On the other hand, temperatures on HD 149026b reach a scorching 3,700º Fahrenheit, even hotter than some low-mass stars. Because the planet is so hot, astronomers believe that the heat is not being spread around and that the dark side is probably much cooler. The oddball planet likely reflects almost no starlight, instead absorbing all of the heat. That means that HD 149026b might be the blackest planet known, in addition to the hottest.

Hubble's powerful vision allowed astronomers to study for the first time the layer-cake structure of the atmosphere of a Jupiter-sized extrasolar planet, called HD 209458b. HD 209458b orbits so close to its star and gets so hot that its upper layer of hot hydrogen gas is streaming into space, making the planet appear to have a comet-like tail. The Hubble data show how intense ultraviolet radiation from the parent star heats the gas in the upper atmosphere, inflating the atmosphere like a balloon. The gas is so hot that it moves very fast and escapes the planet's gravitational pull at a rate of 10,000 tons a second. Previous observations revealed oxygen, carbon, and sodium in the planet's atmosphere, as well as a huge hydrogen upper atmosphere.

Why NASA did not achieve Outcome 3D.4: The Astrophysics Theme's performance towards this Outcome continues to be "Yellow" due primarily to the inability to ramp up flight developments in previously planned planet-finding and characterizing missions. Science progress is good, but the scale of investments needed to start new missions, coupled with the Theme's decreasing overall budget and other significant commitments, resulted in previously envisioned missions slipping beyond the budget horizon.

Plans for achieving 3D.4: The Astrophysics Theme solicited mission concept studies for planet-finding and characterizing missions that would be more affordable. The proposals, which were due in November 2007, will be evaluated in FY 2008.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Demonstrate progress in creating a census of extra-solar planets and measuring their properties. Progress will be evaluated by external expert review.	4ASO12 Blue	5ASO8 Green	6UNIV3 Green	**7UNIV7 Green**
	4ASO13 Green	5ASO9 Blue	6UNIV4 Green	
	4ASO14 Green	5ASO10 Blue	6UNIV5 Yellow	
Begin Kepler assembly, test, and launch operations (ATLO).	None	5ASO2 Green	6UNIV21 Yellow	**7UNIV8 Green**

Efficiency Measures

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete all development projects within 110% of the cost and schedule baseline.	4ASO1 White	5ASO13 Green	6UNIV22 White	**7UNIV9 Red**
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	None	5ASO14 Yellow	6UNIV23 Green	**7UNIV10 Green**
Peer-review and competitively award at least 80%, by budget, of research projects.	4SEU2 4ASO2 Green	5ASO15 Green	6UNIV24 Green	**7UNIV11 Green**

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	6UNIV25 Yellow	**7UNIV12 Green**

Why NASA did not achieve APG 7UNIV9: The GLAST mission exceeded 110 percent of the cost and schedule baselines. NASA delayed the GLAST launch due to continued slips in completing the Command and Data Handling subsystem, spacecraft testing schedule conflicts with Department of Defense projects, and spacecraft contractor performance issues.

Plans for achieving 7UNIV9: The GLAST Operational Readiness Review and launch are currently scheduled for mid-FY 2008. SMD continues to monitor all its development projects to maintain cost and schedule baselines.

Sub-goal 3E

Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.

	Green	Yellow	Red	White
4 Outcomes	4 (100%)	0	0	0
9 APGs	6 (67%)	1 (11%)	0	2 (22%)

Cost of Performance (in millions)
$594

Responsible Mission Directorate

Aeronautics Research (ARMD)

Contributing Theme

Aeronautics Technology (AT)

Theme Description

Aeronautics Technology conducts high-quality, innovative research that will lead to revolutionary concepts, technologies, and capabilities that enable radical change to both the airspace system and the aircraft that fly within it. At the same time, AT ensures that its research continues to play a vital role in support of the Agency's space exploration missions.

PART Assessment Rating						
Theme	**Last Year Assessed**	**Overall Rating**	**Program Purpose and Design**	**Strategic Planning**	**Program Management**	**Program Results/ Accountability**
Aeronautics Technology	2007	Effective	100%	100%	91%	78%

NASA is the Nation's leading government organization for aeronautical research. This world-class capability is built on a tradition of expertise in core disciplines like aerodynamics, acoustics, combustion, materials and structures, and dynamics and control. ARMD is comprised of four programs:

- The Fundamental Aeronautics Program conducts research to enable the design of vehicles that fly through any atmosphere at any speed. Future aircraft must address multiple design challenges, and therefore a key focus will be the development of physics-based, multidisciplinary design, analysis, and optimization (MDAO) tools.
- The Aviation Safety Program develops innovative tools, concepts, methods, and technologies that will improve the intrinsic safety attributes of current and future aircraft, and that will help overcome aviation safety challenges that would otherwise constrain the full realization of the Next Generation Air Transportation System (NextGen).
- The Airspace Systems Program conducts research to enable NextGen capabilities such as foundational research in multi-aircraft flow and airspace optimization, trajectory design and conformance, separation methods, and adaptive systems. The Airspace Systems Program research for the airspace and airportal domains is integrated into gate-to-gate solutions.
- The Aeronautics Test Program (ATP) ensures the strategic availability and accessibility of a critical suite of 1) major wind tunnels at Ames, Glenn, and Langley Research Centers, and 2) flight operations assets at the Western Aeronautical Test Range, support/test bed aircraft, and simulation and loads labs at Dryden Flight Research Center.

Benefits

NASA's aeronautics program ensures long-term focus in fundamental research in both traditional aeronautical disciplines and relevant emerging fields for integration into multidisciplinary system-level capabilities for broad application. This approach will enable revolutionary change to both the airspace system and the aircraft that fly within it, leading to a safer, more environmentally friendly, and more efficient national air transportation system. Furthermore, ARMD will disseminate all of its research results to the widest practical and appropriate extent (consistent with foreign policy and national security).

ARMD uses the NASA Research Announcement (NRA) process to foster collaborative research partnerships with the academic and private sector communities. The NRA process encourages awardees to spend time at NASA centers in order to enhance the exchange of ideas and expand the learning experience for everyone involved. Furthermore, ARMD has focused its educational activities to better attract the Nation's best and brightest students to aeronautics. These activities include design competitions and the establishment of graduate and undergraduate scholarships and internships.

Risks to Achieving Sub-goal 3E

NASA identifies highly challenging, cutting-edge aeronautics research goals that, by their nature, are inherently high risk. Even if each milestone is not met, the lessons that NASA learns advance the state of knowledge for aeronautics and helps the Agency make informed decisions to realign research to the appropriate areas. Redirection of resources to meet other national priorities is another major risk to NASA's programs and schedules. Should this occur, the Aeronautics Research Mission Directorate will re-align program milestones and schedules as needed to respond to such changes.

The Fundamental Aeronautics, Aviation Safety, Airspace Systems, and Aeronautics Test Programs partner with other government agencies, industry, and universities to meet program objectives. These partnerships provide many benefits, but also introduce external dependencies that could influence schedules and research output. The programs will mitigate this risk through close coordination with these partners.

FY 2008 Performance Forecast

Fundamental Aeronautics Program

- Develop and test component technology concepts used in conventional aircraft configurations to establish the feasibility of achieving significant noise reduction. For unconventional aircraft configurations, develop and test component technology that establishes the feasibility of achieving short take-off and landings on runways less than 3,000 feet;
- Validate model engine stall-control concepts using component test data to improve the operability range of rotorcraft engines and further improve their range and efficiency;
- Use laboratory tests to validate a composite containment system for supersonic engine fan blades that is 20 percent lighter than the metallic containment system developed by the High Speed Research Program in the late 1990s, demonstrating advancement in new concepts for high-efficiency propulsion and airframes for supersonic aircraft; and
- Establish technology baselines through the evaluation of hypersonic flight simulation tools, Guidance, Navigation and Control (GNC) technologies, and ablator systems using data from the Sub-Orbital Aerodynamic Re-entry Experiments (SOAREX).

Aviation Safety Program

- Develop and validate sensor fusion, fault detection, and isolation methods at the component level
- Develop a framework that integrates current and future detection, prediction, and mitigation methods to prevent aircraft aging-related hazards;
- Develop automation technologies to improve workload responsibilities and crew awareness of critical decision points during the approach and landing phase of flight; and
- Complete a flight evaluation of improved neural networks for a direct adaptive control law with more challenging failures than those performed in FY 2006 to stress the adaptive system.

Airspace Systems Program

- Develop capabilities in traffic flow management, dynamic airspace configuration, separation assurance, and airspace super-density operations which are supported by cross cutting technical areas of trajectory prediction, synthesis, prediction, and uncertainty, performance based services, and system-level design, analysis and simulation tools ; and
- Develop airportal and terminal capabilities in safe and efficient surface operations, coordinated arrival/departure operations, and airportal transition and integration.

Aeronautics Test Program

- Provide partial funding of the fixed costs for most of the ATP facilities, and funds to mothball others; perform significant maintenance activities to improve productivity and reduce operational cost; and invest in test technology and facility upgrades to yield new capabilities
- Implement a centralized force balance capability for aeropropulsion test facilities
- Perform a comprehensive facility assessment to document the physical condition and test capability of ATP facilities, including the status and competency of each facility's technical workforce.

Outcome 3E.1: By 2016, identify and develop tools, methods, and technologies for improving overall aircraft safety of new and legacy vehicles operating in the Next Generation Air Transportation System (projected for the year 2025).

FY04	FY05	FY06	FY 2007
None	None	3E.1 Green	**Green**

Researchers in the Aircraft Aging and Durability project assessed capabilities at NASA, other agencies, and the aerospace industry to establish a baseline for aircraft aging and durability state-of-the-art technologies, refine the approach for subsequent research tasks, and initiate partnerships for collaborative research. In addition, specific technologies were developed to detect, predict, and mitigate aging-related degradation. Some examples include: a tool for assessing wiring connection integrity, a theory and model for measuring metal fatigue, a method for coupling multi-scale models of damage processes in metals, methods for progressive damage analysis in composites, and heat treatments to optimize the durability of third-generation superalloys for engine disk applications. In addition, aging studies were initiated for advanced composites for aircraft airframe and engine fan case structures, and experiments to demonstrate the feasibility of detecting damage in electrical wiring prior to failure were conducted.

The Integrated Vehicle Health Management project, in collaboration with Moog Inc., conducted hardware-in-the-loop nominal and fault injection testing of selected fault modes for electro-mechanical actuators. In addition, a silicon-carbide differential amplifier integrated circuit chip, fabricated for the project's propulsion systems activity, demonstrated more than 2,000 hours of continuous electrical operation at 500° C. Prior to this work, such integrated circuit chips operated at such high temperatures for less than a few hours before degrading or failing. These extremely durable technologies will enable highly functional, but physically small, integrated circuitry to be used for sensing and control electronics within harsh environments, such as hot-sections of jet engines and spacecraft designed for long-duration missions.

The Integrated Intelligent Flight Deck project conducted initial experiments to measure the influence of vision-aiding technology on pilot performance while flying a critical phase of flight such as the final approach segment. The purpose was to begin the definition for quantitative, experimentally derived, performance-based criteria for all-weather Equivalent Visual Operations, systems that help pilots navigate without visual references and maintain safe distances from other aircraft during non-visual conditions. Twenty-three pilots conducted approaches and landings in visibilities ranging from 2,400 feet down to 1,200 feet, with various simulated airport approach lighting systems. Subjective results indicate that vision-based displays offer improvements in situation awareness, workload, and approach and landing performance. Subsequent work will characterize the pilot's awareness and reaction to the non-normal events that were introduced into the experiment.

The Integrated Resilient Aircraft Control project successfully tested a dynamic software tool—a parameter identification algorithm developed to learn and predict changes in aircraft dynamics and aerodynamic coefficients—on the Airborne Subscale Transport Aircraft Research (AirSTAR) flight research testbed. The AirSTAR is intended to allow testing that is too high risk for manned aircraft, especially in off-nominal conditions that are critical for assessing safety concepts and technologies. Such dynamic software tools will enable advanced flight control systems to automatically detect and adapt to off-nominal situations such as a malfunctioning flight actuator or damaged control surface.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Establish a baseline for state-of-the-art aircraft safety concepts and flight deck information management systems.	None	None	None	**7AT1 Green**

Outcome 3E.2: By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the Next Generation Air Transportation System.

FY04	FY05	FY06	FY 2007
None	None	3E.2 Green	**Green**

The NextGen Airspace project developed an operational concept and procedural document, safety analysis, and simulation of oceanic in-trail procedures. The project also conducted human-in-the-loop simulation on very closely spaced parallel approaches addressing techniques for safely getting more and varied aircraft types into the terminal domain, In addition, the Airspace project developed an initial concept for Airspace Super Density Operations that meets the multiple objectives of NextGen terminal airspace operations: significantly increased capacity, robustness to varied and chaotic weather conditions, reduced environmental impact, and coordination of arrival and departure operations to/from multiple proximate airports in a metroplex—a group of two or more airports whose arrival and departure operations are highly interdependent. The project conducted initial assessments of core elements, including: closely-spaced approach procedures, continuous descent arrival operations, four-dimensional trajectory navigation, delegated spacing function, and dynamic routing to avoid adverse weather. In addition, an aircraft-level flow control model was developed and used by the project to examine en route capacity constraints in the congested New York airspace. Results from more than 120 simulation scenarios showed that it is possible to prioritize New York flows through congested sectors without increasing system delays. Before the development of this model, there was no way to systematically look at such flows.

In order to ensure wide dissemination of research results to the broad aeronautics community, the NextGen Airspace project held its first Technical Interchange Meeting focusing on foundational research in March 2007. This event included discussions on the project's research thrust areas and technical presentations by principal investigators for each of the 15 NRAs selected in FY 2006. Over 150 participants from NASA, the Federal Aviation Administration (FAA), industry and academia shared ideas across the research community. Additionally, in February 2007, the project sponsored an international workshop on Dynamic Airspace Configuration, with over 65 participants from the United States and Europe, including academia, industry and government. This workshop addressed the challenges of migrating from the current structured, static homogenous airspace to a dynamic, heterogeneous airspace that adapts to user demand and meets changing constraints (e.g., weather, traffic congestion, diverse fleets).

The NextGen Airportal project moved into implementation in May 2007 after completing reformulation. The project identified key airport capacity constraint factors and ranked them according to airport demand forecasts as a basis for future research and study to accomplish this long-term goal. The project also developed the initial Airportal operational concepts, including Airportal functions, requirements, and procedures to supplement the definition of the initial concept NextGen super-density operations by the Airspace project. Additionally, the Airspace and Airportal projects jointly selected three NRA proposals to conduct research on the characteristics and roles of a metroplex.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete flight test evaluation of oceanic in-trail climb and descent using an Airborne Separation Assistance System (ASAS) and an Automatic Dependent Surveillance Broadcast – (ADS-B).	None	None	None	**7AT2 White**
Complete development of an incremental, sustainable transition roadmap from today's air transportation system to the Next Generation Air Transportation System (NGATS) 2025 concept of operations.	None	None	None	**7AT3 Green**

Why NASA rated APG 7AT2 White: NASA completed key elements of this service provider/airline sponsored flight test of oceanic in-trail climb descent using an Airborne Separation Assistance System. However, scheduling and execution of this flight test rests solely with the FAA and Airservices Australia. The flight test was not funded and will not occur and, therefore, NASA canceled the APG. The Airspace Systems Program completed the research support work under NASA's control:

- Documented concept on in-trail procedures (ITP);
- Completed safety methodology and initial analysis that has been reviewed by the International Civil Aviation Organization (ICAO) and scheduled for ICAO acceptance in November 2007;
- Validated ITP simulation; and
- Developed algorithms and engineering models used for procedure development in the NASA simulation tools.

Outcome 3E.3: By 2016, develop multidisciplinary design, analysis, and optimization capabilities for use in trade studies of new technologies, enabling better quantification of vehicle performance in all flight regimes and within a variety of transportation system architectures.

FY04	FY05	FY06	FY 2007
None	None	3E.3 Green	**Green**

The Subsonic Fixed Wing project, in partnership with Boeing and the U.S. Air Force, completed flight experiments of the X-48B Blended Wing Body (BWB) advanced aircraft at NASA's Dryden Flight Research Center. The BWB is a hybrid configuration combining the best attributes of a conventional tube-and-wing aircraft with a flying wing. It has the potential to meet expected future NextGen requirements for low noise, low emissions, and high efficiency, with the added potential capability to land and take-off on shorter runways than current aircraft. The flight experiments conducted with the X-48B explored the low-speed aerodynamic performance and stability and control characteristics of this promising aircraft configuration. It is the first time an accurately scaled BWB was flown. The experiments demonstrated the basic flying qualities of the X-48B and the effectiveness of the on-board flight control system.

The Subsonic Rotary Wing project, in partnership with Bell Helicopter Textron and the University of Maryland, conducted a series of helicopter noise tests near Hollister, California, to acquire ground-based acoustic data for maneuvering flight. This test measured the noise from a Bell Model 206 helicopter in both steady and maneuvering flight. Researchers used the NASA Portable Programmable Guidance Display tool to monitor aircraft flight conditions and guide maneuvers to enable precise, repeatable flight trajectories that resulted in data of high accuracy. This is a critical step toward enabling commercial rotorcraft to operate quietly over populated areas.

The Supersonics project completed a flight validation experiment at NASA's Dryden Flight Research Center in which researchers generated and propagated a series of reduced-strength, non-coalescing shocklets (mini sonic booms) produced by the Gulfstream QuietSpike™ device. This allowed the researchers to assess the QuietSpike's effectiveness as a sonic boom mitigation strategy. Increasing aircraft length and slenderness is known to be effective at reducing sonic boom. However, this results in a very heavy aircraft with little usable interior volume and poor low-speed performance. The QuietSpike is an innovative approach, developed by Gulfstream Aerospace, that extends a specially tailored "spike" from the nose of the aircraft, during cruise, to simulate a much longer yet lighter and more slender aircraft.

The Hypersonics project completed 10 successful engine tests of the X-1 scramjet engine in the NASA Langley Research Center's 8 Foot High Temperature Tunnel at simulated Mach numbers of 4.6 and 5.0, with two partially successful tests at Mach 6.5. The tests allowed researchers to quantify engine performance and operability, develop an engine start approach similar to that planned for flight, and demonstrate fuel staging between fuel injection sites. Fuel staging is one of the most critical issues in developing a viable hypersonic propulsion system. It is the ability to accommodate the transition from partly subsonic flow in the engine combustor (dual-mode) to fully supersonic flow (scram mode) operation as the vehicle accelerates through the hypersonic regime. Failure to properly manage this transition can cause an engine flameout or unstart, both of which would likely result in a loss of mission. The tests conducted at the Langley Research Center provided the necessary data and confidence to allow the U.S. Air Force to proceed toward a series of flight tests in FY 2009.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Baseline state-of-the-art analysis methods and tools to address aeronautics challenges within the hypersonic, subsonic (for rotary and fixed wing vehicles), and supersonic flight regimes.	None	None	None	**7AT4 Green**
Develop preliminary engine performance models for flight-weight propulsion systems to support hypersonic reference vehicles.	None	None	None	**7AT5 Green**
Determine fundamental propulsion system integration design issues for existing and advanced rotorcraft configurations.	None	None	None	**7AT6 Green**

Outcome 3E.4: Ensure the continuous availability of a portfolio of NASA-owned wind tunnels/ground test facilities, which are strategically important to meeting national aerospace program goals and requirements.

FY04	FY05	FY06	FY 2007
None	None	None	**Green**

The Aeronautics Test Program (ATP) invested approximately $25 million in two years on targeted facility maintenance projects to improve the reliability and ensure the continuous availability of a portfolio of NASA-owned wind tunnels and ground test facilities. This investment reduced the NASA deferred maintenance liability for these national assets by an estimated 10 percent.

ATP collaborated with the NASA Centers to establish a clear and consistent pricing structure and charging policy for wind tunnel testing across its facility portfolio. This approach assists test customers in their cost estimating activities and long-range test planning.

As part of its continuous efforts to improve facility operational efficiencies, ATP sponsored a National Strain Gage Balance Team, which completed a technical review and concluded that NASA's capability to utilize strain gage balances in wind tunnel testing has severely eroded. ARMD is reviewing several recommendations for FY 2008 implementation.

ATP collaborated with several national organizations and sponsored or co-sponsored several working group meetings (at several sites) to promulgate the National Aeronautics Research and Development Policy and to foster effective partnerships and working relationships. National partners include the Department of Defense (DoD) Test Resource Management Center and the American Institute of Aeronautics and Astronautics U.S. Industry Test Facilities Working Group.

On June 27, 2007, the first National Partnership for Aeronautical Testing (NPAT) Council meeting convened in Washington, DC. This initial meeting set the stage for future council meetings. During future technical interchanges, participants will set a national facility strategy. Participants included the associate administrator for ARMD, as well as the director for ATP, ARMD program directors, and the director for NASA's Shared Capabilities Asset Program; and DoD's director for the Defense Test Resource Management Center and representatives from the separate DoD services.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Develop a long-term, aeronautic test facility vision and funded plan working with all the appropriate stakeholders, to assure that the plan reflects the priorities of the long-term needs of the Nation.	None	None	None	**7AT7 Green**

Efficiency Measures

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	None	None	6AT12 Green	**7AT8 Yellow**

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Increase the annual percentage of research funding awarded to Aeronautics University Partnerships.	None	None	None	**7AT9 White**

Why NASA did not achieve APG 7AT8: A number of unexpected breakdowns and construction project delays occurred at several facilities resulting in the delivery of 73 percent of scheduled operating hours for all ATP facilities.

Plans for achieving 7AT8: ATP will continue to invest in test facility maintenance projects with the goal of improving facility reliability and availability. However, due to the age and current condition of the facilities, system failures and resulting unplanned downtime have exceeded ARMD's best estimates. To mitigate this in FY 2008, ATP will sponsor a comprehensive assessment of facilities and associated Center infrastructure and develop a long-range investment strategy.

Why NASA rated APG 7AT9 White: NASA canceled this APG because it was established prior to the restructuring of ARMD in FY 2006. While ARMD has established a steadily increasing source of external funding that is awarded through a full and open competitive process, such awards are not limited to universities. Industry and nonprofit organizations also are eligible to compete.

Sub-goal 3F

Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration.

	Green	Yellow	Red	White
3 Outcomes	3 (100%)	0	0	0
7 APGs	6 (86%)	1 (14%)	0	0

Cost of Performance (in millions)
$208

Responsible Mission Directorate

Exploration Systems (ESMD)

Contributing Theme

Human Systems Research & Technology (HSRT)

Theme Description

The Human Systems Research and Technology Theme advances knowledge and technologies critical to long-term human health and performance in low Earth orbit and beyond.

PART Assessment Rating						
Theme	**Last Year Assessed**	**Overall Rating**	**Program Purpose and Design**	**Strategic Planning**	**Program Management**	**Program Results/ Accountability**
Advanced Capabilities (replaced HSRT)	2007	Adequate	100%	90%	75%	45%

Note: ESMD reorganized its Themes and programs for the FY 2008 Budget Estimates. Programs associated with HSRT now are within the Advanced Capabilities Theme.

When astronauts return to the Moon and journey to further destinations, they will be subjected to the microgravity, radiation, and isolation of space for long periods of time. Keeping crews physically and mentally healthy during such long-duration missions will require new technologies and capabilities. Through a combination of ground- and space-based research, NASA is studying how the space environment, close quarters, heavy workloads, and long periods of time away from home contribute to physical and psychological stresses and is developing technologies that can prevent or mitigate the effects of these stresses. NASA also is developing innovative ways to meet the basic needs of astronauts—oxygen, water, food, and shelter—with systems that can operate dependably for weeks on the Moon and, eventually, for months on Mars.

Benefits

The medical knowledge and diagnostic and treatment technologies NASA uses to keep humans healthy and productive in space improve the medical treatment and health of humans on Earth. For example, NASA's research into human adaptation to microgravity has helped scientists better understand the changes that come with aging, such as bone loss, muscle atrophy, and loss of balance. NASA-developed telemedicine technologies, which help doctors on Earth monitor and treat astronauts in space through a combination of computer-assisted imaging and diagnostics, video, and telecommunications, also help doctors deliver quality medical care to people in isolated or underserved areas of the world. These technologies allow doctors located thousands of miles apart to collaborate in real time on medical treatment.

Over the years, companies have taken NASA life-support and medical technologies, produced by this and other NASA programs, and have developed them into commercial products that serve the public. Light-emitting diodes originally designed to grow plants in experiments aboard the Space Shuttle are now used to treat brain tumors. Devices built to measure the astronauts' equilibrium when they return from space are widely used by major medical centers to diagnose and treat patients with head injuries, stroke, chronic dizziness, and central nervous system disorders. A company turned a small, portable device originally designed to warn Shuttle and ISS crewmembers of depressurization into a hand-held device that warns pilots, mountain climbers, skydivers, and scuba divers of hazardous conditions before depressurization and hypoxia become a health threat. Miniaturized environmental monitoring and detection technologies for spacecraft cabin air monitoring have led to spin-offs that have applications for detection of nerve and blister agents, polychlorinated biphenyls and leaks in underground transmission lines. For more information on NASA technology-transfer successes, please visit the Spinoff home page at http://www.sti.nasa.gov/tto/.

Risks to Achieving Sub-goal 3F

A major challenge in completing all the planned experiments that require long-duration spaceflight is the availability of flight opportunities to conduct research on crew and associated systems.

FY 2008 Performance Forecast

- The Exploration Technology Development Program will test technologies for carbon dioxide and humidity removal, water disinfection, and solid waste volume compaction for potential use on Orion. It also will prepare the Electronic Nose and Vehicle Cabin Atmosphere Monitor flight hardware for launch and testing on the ISS.
- NASA will deliver the Combustion Integrated Rack (CIR) to the ISS. The CIR will accommodate a wide variety of combustion experiments.
- The Human Research Program will build, validate, and use the ISS to test technology prototypes used to deliver care to astronauts, including: rapidly deployed EVA sensors, a medical-grade water production system, a ventilation system that uses cabin oxygen instead of stored oxygen, and a capability to analyze blood- and saliva-borne biomarkers.
- The Human Research Program will use ground-based analogs to optimize human systems performance for human-rated vehicles being developed for Constellation Systems.
- The Human Research Program will continue ground- and ISS-based studies of health risks and countermeasures, focusing on: cardiac structure and function, stability of pharmaceuticals and nutrients in space, development of a food system that meets nutrition requirements for long-duration missions, and ways to monitor bone demineralization.
- Using mainly ground-based facilities, NASA will evaluate the increased risk of cancer as a function of age, age at exposure, radiation quality, latency, and gender. NASA also will initiate new studies into the effect of radiation dose rate on cancer risk. These studies will support more accurate prediction of risks and help NASA mitigate the effects of radiation during long-duration space missions.

Outcome 3F.1: By 2008, develop and test candidate countermeasures to ensure the health of humans traveling in space.

FY04	FY05	FY06	FY 2007
None	None	3F.1 Green	**Green**

The Human Research Program completed final on-orbit operations of the Renal Stone investigation. For the study, which began during Expedition 3 in 2001, investigators examined diet logs combined with urine samples from 20 astronaut subjects to test whether potassium citrate is an effective countermeasure against the formation of kidney stones while crewmembers are in orbit. The risk of kidney stones is elevated in space due to the mobilization of calcium from bone loss and the effects of microgravity on fluid distribution in the body.

The program initiated research using bedrest subjects for a low-intensity mechanical (oscillating plate) countermeasure to prohibit osteoporosis. The data from the research provide early evidence that vibration can correct damage of non-weight bearing to several aspects of the musculoskeletal system. The first ISS experiment will be initiated on Expedition 19 in spring 2009.

The program is conducting research to measure aerobic capacity (oxygen uptake). Two astronaut participants have completed the study, with a third subject in process. The study may require six or more subjects total. Measurement of aerobic capacity allows exercise physiologists and flight doctors to assess crew health and fitness and accurately prescribe exercise countermeasures for use onboard the ISS.

The program also initiated the Bisphosphonates as a Countermeasure to Space Flight Induced Bone Loss experiment. This experiment will determine whether bisphosphonates, in conjunction with the routine in-flight exercise program, will protect ISS crewmembers from the regional decreases in bone mineral density documented on previous ISS missions. This study will commence pending the availability of human subjects on the ISS.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete development of a renal stone countermeasure and validate it for use.	None	None	6HSRT9 Yellow	**7HSRT1 Green**
Begin validation of bone and cardiovascular countermeasures on the ISS.	None	None	6HSRT10 Green	**7HSRT2 Green**

Outcome 3F.2: By 2010, identify and test technologies to reduce total mission resource requirements for life support systems.

FY04	FY05	FY06	FY 2007
9.2.1 Green	8.7 Green	3F.2 Green	**Green**

The Exploration Technology Development Program is developing key space exploration technologies for enhanced life support systems, including: the Vapor Phase Catalytic Ammonia Removal system for recycling water from urine, humidity condensate, and sweat; solid waste compaction and odor control technologies; and advanced air revitalization technologies.

During FY 2007, the program conducted several tests of engineering concepts:
- Two engineering concepts for the Carbon Dioxide and Moisture Removal Amine Swing bed System (CAMRAS) to derive performance requirements for the Crew Exploration Vehicle (CEV). CAMRAS met or exceeded all derived performance requirements;
- Two approaches for CEV water disinfection (biocides and point-of-use filters); and
- A standard mechanical prototype trash compactor unit with simulated trash.

The program will provide test information for these candidate approaches to the Constellation Systems Program's CEV project.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete laboratory testing of Crew Exploration Vehicle candidate technologies for carbon dioxide (CO2) and humidity removal, water disinfection, and solid waste volume compaction, increasing the technology maturation in all areas.	None	None	None	**7HSRT3 Green**

Outcome 3F.3: By 2010, develop reliable spacecraft technologies for advanced environmental monitoring and control and fire safety.

FY04	FY05	FY06	FY 2007
3.3.2 Green	None	3F.3 Green	**Green**

NASA successfully completed the Critical Design Reviews for the Electronic Nose, or ENose, and the Vehicle Cabin Atmosphere Monitor (VCAM). Both the ENose and VCAM monitor the quality of the recycled air aboard the ISS, providing early alert of the presence of harmful gases.

NASA conducted the Dust Aerosol Measurement Feasibility Test (DAFT) and the Smoke and Aerosol Measurement Experiment (SAME) aboard the ISS. The DAFT experiment determined the effectiveness of a commercial hand-held air quality monitor to help in the design of future spacecraft fire detection systems. SAME, which was launched in August 2007 on STS-118, measured dust particles from smoldering materials in microgravity. The results from SAME will help researchers develop and validate smoke detection devices for spacecraft.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete critical design review for an ISS technology demonstration of the advanced environmental monitoring system.	None	None	None	**7HSRT4 Green**
Conduct at least two experiments on the ISS to advance next generation technologies for fire prevention, detection, and suppression on spacecraft.	None	None	None	**7HSRT5 Green**

Efficiency Measures

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Increase percentage of HSRT procurement funding, solely dedicated to Exploration Activities.	None	None	None	**7HSRT6 Green**

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	6HSRT247 Green	**7HSRT7 Yellow**

Why NASA did not achieve APG 7HSRT7: HSRT completed the Radiation NRA within 173 days. The implementation of this NRA involved two organizations, NASA and the National Space Biomedical Research Institute. Since this was the first time such a joint Radiation NRA was issued, the required coordination between these organizations resulted in approximately an extra month of time. The delay in the Radiation NRA completion did not impact distribution of research funds; this occurred in October 2007 as planned.

Plans for achieving 7HSRT7: Both organizations plan to eliminate some unanticipated schedule conflicts, streamlining the completion process for future Radiation NRAs.

Strategic Goal 4

Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.

	Green	Yellow	Red	White
2 Outcomes	1 (50%)	1 (50%)	0	0
8 APGs	4 (50%)	3 (38%)	0	1 (12%)

Cost of Performance (in millions)
$2,224

Responsible Mission Directorate

Exploration Systems (ESMD)

Contributing Theme

Constellation Systems

Theme Description

The Constellation Systems Theme develops new systems, initially outlined by the Exploration Systems Architecture Study, to support the International Space Station and enable sustainable and affordable human exploration of the Moon, Mars, and beyond.

PART Assessment Rating						
Theme	**Last Year Assessed**	**Overall Rating**	**Program Purpose and Design**	**Strategic Planning**	**Program Management**	**Program Results/ Accountability**
Constellation Systems	2006	Adequate	100%	78%	75%	40%

Strategic Goal 4 is essential to achieving NASA's Mission. The Nation's current space transportation systems—NASA's Space Shuttle and commercially available expendable launch vehicles—are unsuitable for human exploration beyond low Earth orbit. To achieve the long-term objective of returning explorers to the Moon and eventually sending them to Mars, NASA initiated the Constellation Systems Program to achieve Strategic Goal 4, developing new space transportation capabilities. So far, the program includes the Orion Crew Exploration Vehicle (CEV), the expendable crew launch vehicle Ares I, the heavy-lift cargo launch vehicle (CaLV) Ares V, spacesuits and tools required by the flight crews, and associated ground and mission operations infrastructure to support initial low Earth orbit missions.

Orion will be America's new spacecraft for human space exploration. It will carry four crewmembers to the Moon and serve as the primary exploration vehicle for future missions. It also will be capable of ferrying up to six astronauts (plus additional cargo) to and from the ISS if commercial transport services are unavailable. The Ares I will consist of a solid rocket booster and an upper stage that can carry Orion into low Earth orbit.

Benefits

Orion will support the expansion of human exploration missions and provide the means to take humans to the Moon where they can conduct scientific activities and make discoveries not possible solely with robotic explorers.

As with past and current human exploration programs, NASA's efforts to develop Orion and the Ares launchers will accelerate the development of technologies that are important for the economy and national security. The advanced systems and capabilities required for space travel include power generation and storage, communications and navigation, networking, robotics, and improved materials, all of which could be used on Earth to meet commercial and other national needs. As Shuttle activities wind down, Shuttle personnel will find new, challenging positions working on Constellation Systems development efforts, keeping this highly skilled segment of America's workforce productive and competitive. Constellation Systems also will provide a training ground for the next generation of scientists and engineers who will realize the Nation's space exploration dreams.

Furthermore, Orion will serve as a public symbol of the Nation's continued commitment to space exploration, much as the Shuttle has over the past 25 years. NASA anticipates that the exploration initiatives will spark the public's imagination and inspire the Nation's youth to pursue careers in science, technology, engineering, and mathematics as a result of their renewed interest in space.

Risks to Achieving Strategic Goal 4

The Constellation Systems Program is striving to meet challenges in the budgetary and technical areas. Maintaining the investment levels required in a budget-constrained environment is a major challenge facing the Constellation Systems Program. The Constellation Program must manage its development work such that it remains within budget while also meeting the externally committed milestones of Exploration. In the technical arena, the Constellation Systems Program also has some engineering challenges very similar to many NASA encountered during the Apollo Program and development of the Space Shuttle. Every time NASA faces an engineering challenge, Agency engineers examine all the options for addressing the issue. NASA has an excellent track record of resolving technical challenges and is expecting to resolve any technical issues and meet the Exploration Systems milestones.

FY 2008 Performance Forecast

- The Constellation Systems Program will reach a critical milestone in the latter part of FY 2008, when the Orion and Ares I Preliminary Design Reviews are scheduled to take place. Upon successful completion, these projects will transition from formulation to development.
- Also in the third quarter of FY 2008, Constellation Systems Program will conduct the Systems Definition Review for Mission Operations. Upon successful completion, this project will begin developing and updating processes and facilities needed to support Constellations Systems. The program also will conduct a Systems Definition Review for the Ground Operations project, which is tasked with reconfiguring Shuttle infrastructure capable of supporting Orion and Ares I. Upon successful completion, the project will enable operations and supportability factors to be incorporated into flight hardware designs.
- The Constellation Systems Program will conduct an Extravehicular Activity (EVA) System Configuration 1 Systems Definition Review early in FY 2008. Completion and approval will allow the project to proceed with source selections later in the fiscal year. The project will develop technologies for spacesuits and surface suits, air-lock outfitting equipment, Orion interface hardware, umbilicals, and space helmets. A successful configuration that integrates these elements will maximize capability, reusability, and commonality.

Outcome 4.1: No later than 2014, and as early as 2010, transport three crewmembers to the International Space Station and return them safely to Earth, demonstrating an operational capability to support human exploration missions.

FY04	FY05	FY06	FY 2007
None	7.1 Green	4.1 Green	**Yellow**

Although the Constellation Systems Program did not achieve Outcome 4.1 (due to the lack of program maturity at the time the performance measures were established), the program made significant progress towards demonstrating an operational capability to support human exploration missions. The program conducted key system-level and element-level trade studies and analyses to validate the design concepts against the requirements and/or determine whether changes to the baseline design concepts are warranted. The program completed the Systems Requirements Review (SRR) in November 2006, which initiated a “season of SRRs” for Orion, Ares I, Ground Operations, Mission Operations, and EVA Systems.

NASA and the prime contractor, Lockheed Martin, developed a Point of Departure (POD) architecture that combined the best features of the contractor and the NASA design concepts. This POD architecture supported the Orion SRR. The SRR, completed in March 2007, was held to ensure that: requirements had been identified; those requirements are consistent with Constellation Systems Program Requirements; the Constellation Systems Program Requirements have been properly translated into Orion systems and design requirements; and trade-offs between conflicting requirements have been performed and properly resolved.

The Ares I project successfully completed its SRR in December 2006, confirming that the Ares I architecture and design concept can fulfill the mission objectives and that the Ares project is ready to begin engineering design activities.

The Ground Operations Project successfully completed its SRR in May 2007 to ensure the system design interfaces and requirements are properly documented, characterized, and integrated with associated systems in the projects Systems Requirements Document.

The Mission Operations Project completed its SRR in March 2007 to document the requirements and capabilities for Constellation Systems mission control facilities, training facilities, and associated mission planning and management support.

Why NASA did not achieve Outcome 4.1: In order to meet an Orion Initial Operational Capability (IOC) of 2014, NASA would require additional funds in the out-years to meet that IOC schedule with a 65 percent cost confidence level in the Agency’s budgeting. For the sake of clarity, a cost confidence level is a calculation of the probability of performing a certain task over a given time at a specific cost. With a stable budget, NASA can achieve an IOC launch date of March 2015 at a 65 percent confidence level. Acceleration of this date may be possible given additional funding.

Plans for achieving 4.1: ESMD completed a critical assessment of the ESAS recommendations and incorporated changes intended to reduce overall life cycle costs and integrated risk for human lunar landings while meeting the NASA's Mission and Vision. NASA continues to perform trades in support of the requirements development process, which will culminate in a series of Systems Definitions Reviews for the CEV, CLV, and supporting ground elements. NASA's FY 2008 Budget Estimates notified Congress that the commitment date for achieving Outcome 4.1 now is no later than 2015.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Complete the Systems Design Review for the Constellation Program.	None	5TS1 Green	6CS1 Green	**7CS1 Yellow**
Complete the Preliminary Design for the Crew Exploration Vehicle (CEV).	None	None	6CS2 Green	**7CS2 Yellow**
Complete the Preliminary Design for the Crew Launch Vehicle (CLV) First Stage.	None	5TS3 Green	6CS3 Green	**7CS3 Yellow**
Begin construction and/or modifications to Kennedy Space Center ground processing and launch control facilities needed to support the CEV and CLV in accordance with the Systems Requirements Document.	None	None	6CS1 Green	**7CS4 Green**
Begin construction and/or modifications to Johnson Space Center flight control facilities needed to support the CEV and CLV in accordance with the Systems Requirements Document.	None	None	6CS1 Green	**7CS5 Green**

Why NASA did not achieve APGs 7CS1, 7CS2, and 7CS3: These metrics were established in 2005 at a time when the program was still in early formulation. Since then, ESMD has changed architecture and gained a better understanding of requirements, which resulted in a shift to the overall program schedule that also flowed down to the projects. The Orion Project refined its schedule to reflect the Constellation Systems Program architecture change and shifted the Preliminary Design Review (PDR) to align with the new program milestones.

Plans for achieving 7CS1: The Constellation Systems Program continues to perform key system- and element-level trade studies and analyses to validate the design concepts against the requirements and/or determine whether changes to the baseline design concepts are warranted. With successful completion of its SRR, the program is progressing steadily towards the Systems Definition Review (SDR) in 2008, with individual project reviews (Orion, Ares I, Ground Operations, Mission Operations, and EVA Systems) occurring prior to the program SDR.

Plans for achieving 7CS2: The Orion team concluded the SDR on August 31, 2007. Now the Orion team is assessing the design concept to ensure that the design configuration that came out of the SDR process provides a feasible design with respect to available resources including mass, power and cost. This configuration will be the starting point for the Design Analysis Cycle that leads to the PDR scheduled in 2008.

Plans for achieving 7CS3: The Ares I SRR, completed in December 2006, confirmed that the Ares I system requirements were complete, validated, and responsive to mission requirements. The Ares I project proceeded to SDR in September 2007. The SDR board convened on October 30, 2007, and provided approval for the project to proceed to PDR, at which point the project will initiate the element preliminary design reviews.

Outcome 4.2: By 2010, identify and test technologies to reduce total mission resource requirements for life support systems.

FY04	FY05	FY06	FY 2007
None	None	4.2 Green	**Green**

NASA is on schedule to deploy a new space suit with the CEV no later than 2015. In April 2007, the EVA Systems Project presented the acquisition strategy for the design and development of the initial space suit to the Agency management team at the Constellation Space Suit System Procurement Strategy Meeting. The project also successfully conducted the SRR. In July, the project released for industry comment a draft Request for Proposal (RFP) for the Constellation Space Suit System. The final RFP was released in October.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Define the acquisition strategy for the design and development of the initial space suit for exploration.	None	None	None	**7CS6 Green**
Initiate procurement/development of the initial space suit for exploration.	None	None	None	**7CS7 Green**

Efficiency Measures

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Complete all development projects within 110% of the cost and schedule baseline.	None	None	6CS5 Green	**7CS9 White**

Why NASA rated APG 7CS9 White: Constellation Systems did not complete any development projects during FY 2007, so NASA postponed this APG until a later fiscal year.

Strategic Goal 5

Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.

	Green	Yellow	Red	White
3 Outcomes	3 (100%)	0	0	0
3 APGs	2 (67%)	1 (33%)	0	0

Cost of Performance (in millions)
$105

Responsible Mission Directorate	Contributing Theme	Theme Description
Exploration Systems (ESMD)	Constellation Systems	The Constellation Systems Theme develops new systems, initially outlined by the Exploration Systems Architecture Study, to support the International Space Station and enable sustainable and affordable human exploration of the Moon, Mars, and beyond.
	Exploration Systems Research & Technology (ESRT)	The Exploration Systems Research and Technology Theme develops and demonstrates new technologies that will enable future human and robotic exploration missions, including robotic precursor missions for lunar exploration.
Space Operations (SOMD)	Space and Flight Support (SFS)	Space and Flight Support includes Space Communications and Navigation, Launch Services, Rocket Propulsion Testing, and Crew Health and Safety. These programs are essential for conducting human and robotic space exploration, aeronautical research, and biological and physical research. They provide services to a wide range of customers, including NASA scientists and engineers, other federal agencies, universities, foreign governments, and industry.

PART Assessment Rating

Theme	Last Year Assessed	Overall Rating	Program Purpose and Design	Strategic Planning	Program Management	Program Results/ Accountability
Constellation Systems	2006	Adequate	100%	78%	75%	40%
Advanced Capabilities (replaced ESRT)	2007	Adequate	100%	90%	75%	45%
Space and Flight Support	2007	Moderately Effective	100%	100%	88%	61%

Note: ESMD reorganized its Themes and programs as of NASA's FY 2008 Budget Estimates. Activities included under ESRT now are part of the Advanced Capabilities Theme.

The objective of Strategic Goal 5 is to acquire launch services and technologies that enable NASA's robotic and human missions. NASA's robotic missions are launched on commercial vehicles acquired by SFS. And as the Space Shuttle nears retirement, NASA is interested in ISS cargo delivery and return services provided by emerging launch service companies.

Benefits

Since NASA's creation in 1958, the commercial sector has been an important Agency partner in space exploration. NASA purchases launch vehicles for robotic missions from the commercial sector. NASA works with commercial partners to develop communication and navigation systems, build spacecraft, and design spacesuits. Along the way, the commercial space sector has grown into a multi-billion-dollar industry that delivers services, such as satellite television and global navigation, to the public and contributes to a strong U.S. economy.

Historically, several large corporations have driven the commercial space industry, but now start-up ventures are pushing the sector into new areas. To encourage this emerging sector of the space industry, ESMD has adopted a Commercial Development Policy that will be used as a basis for an Agency-level policy. Programs and projects, such as Commercial Orbital Transportation Services (COTS) and Centennial Challenges (both described in more detail below) are examples of this policy already being implemented within the Agency. By helping emerging companies expand their services and increase their experience, NASA hopes to encourage the growth of a competitive market that will help to reduce launch costs and provide NASA with access to new capabilities. NASA seeks to stimulate the emerging U.S. entrepreneurial launch sector and accelerate the growth of the commercial space industry by maximizing industry's ability to retain intellectual property rights and awarding prizes for achievements in creating space technologies and systems.

NASA also is encouraging the emerging U.S. commercial space sector through more creative, less traditional approaches. In FY 2006, NASA selected a portfolio of two emerging aerospace companies, Space Exploration Technologies (SpaceX) and Rocketplane–Kistler (RpK), to demonstrate orbital cargo transportation services through the COTS project. The Agency later added to its portfolio by signing unfunded Space Act Agreements with five other companies.

Since FY 2005, NASA has held prize competitions, called Centennial Challenges, for ground-based demonstrations of breakthroughs in various aerospace technologies. Although there is no guarantee that a breakthrough or winner will emerge from any particular prize competition, by encouraging participation, NASA hopes to encourage private sector breakthroughs across a broad range of technologies and designs.

Risks to Achieving Strategic Goal 5

Using Alternative Launch Providers presents potential increased risk to the Agency because the companies' launch systems are unproven. NASA needs to balance the need to encourage emerging companies against the need to carry out Agency missions with limited risk. In 2007, the Launch Services Program (LSP) completed an Agency strategic review of options for expendable launch vehicles in the medium performance class. A key recommendation accepted by the Agency is to give significant attention to enabling the Alternative Launch Provider community in becoming certified for NASA use. LSP also coordinated an Agency review of NPD 8610.7 "Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions" to evaluate the feasibility of changes to Agency policy to enable the use of emerging launch service providers. The policy element under review is the number of demonstrated successful launches required for qualification. The risk mitigation is the level of insight NASA is allowed into the launch providers' systems, determining the level of demonstration required. These changes recognize the current industry market and what steps are required for certification. There is no guarantee that new providers will be ready and certified when needed for NASA missions.

The successful implementation of commercial services involves detailed technical work needed to successfully integrate private sector vehicles and NASA systems. With one funded and five unfunded partners onboard, NASA and its partners are working closely to ensure that the communications, docking or berthing, operational, and navigational interfaces are well planned and the technical requirements well understood. In addition, the commercial partner services must prove, through the ISS safety panel process, that their system is sufficiently safe in order to be allowed to approach the station.

Another challenge was brought on by the failure of one of NASA's funded partners to perform in accordance with their Space Act Agreement, resulting in their subsequent termination. The loss of a partner narrows the field of options for success, thus NASA is conducting a competition in early FY 2008 to bring on an additional funded partner or partners as soon as possible.

FY 2008 Performance Forecast

- In FY 2008, NASA will launch four missions on expendable launch vehicles: the Gamma-ray Large Area Space Telescope (GLAST), the Ocean Surface Topography Mission (OSTM), and the Interstellar Boundary Explorer (IBEX), and the Geostationary Operational Environmental Satellites (GOES)-O. The other two launches are reimbursables for the Missile Defense Agency.
- In winter 2007/2008, NASA will complete a modification to NPD 8610.7, which will enable emerging launch service providers to certify their systems for NASA use.
- NASA will continue transitioning to new working arrangements associated with the formation of the United Launch Alliance.
- NASA will complete the certification of the Taurus XL launch vehicle in support of the Orbiting Carbon Observatory (OCO) and Glory missions scheduled to launch in FY 2009.
- NASA will continue its work toward preparing a contract mechanism for NASA Launch Services to purchase launch services from the emerging U.S. commercial space sector.
- After NASA terminated one of the funded Space Act Agreements, NASA issued a competitive announcement to solicit proposals for a new partner or partners using the remaining funding. In a manner similar to the original round of competition in 2006, NASA intends to enter into a second round of agreements with private industry to develop and demonstrate the vehicles, systems, and operations needed to resupply, return cargo from, and potentially transport crew to and from a human space facility, with the International Space Station providing the representative requirements for such a facility. The Agency is currently reviewing those proposals and hopes to make a decision about whether to fund one or more of the proposals early next year.
- NASA's existing portfolio of funded and unfunded partners is expected to make progress towards demonstrating capabilities associated with Strategic Goal 5 in FY 2008.

Outcome 5.1: Develop and demonstrate a means for NASA to purchase launch services from emerging launch providers.

FY04	FY05	FY06	FY 2007
8.1.1 Green	17.1 Green	5.1 Green	**Green**

LSP completed an Agency strategic review of medium-sized expendable launch vehicle options in which the program recommended that NASA give significant attention to enabling the emerging commercial launch service providers in becoming certified for NASA use. The program also coordinated an Agency review of NASA Policy Document 8610.7, "Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions," to evaluate the feasibility of changes to Agency policy that would enable the use of emerging launch service providers sooner.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Realize competitive rates from emerging U.S. launch providers and open the bidding process to a larger number of launch providers.	None	None	None	**7SFS4 Green**

Outcome 5.2: By 2010, demonstrate one or more commercial space services for ISS cargo and/or crew transport.

FY04	FY05	FY06	FY 2007
8.1.1 Green	17.1 Green	5.2 Green	**Green**

The COTS project is a high-risk investment by NASA to spur development of a cost-effective, U.S. commercial capability to carry cargo to the ISS, with future options for transporting crew. In August 2006, RpK and SpaceX entered funded Space Act Agreements with NASA to develop cargo transportation to and from low Earth orbit by 2010. Additionally, NASA signed unfunded Space Act Agreements with companies developing and demonstrating their orbital transportation capabilities: PlanetSpace, Inc.; SpaceHab, Inc., SpaceDev, Inc., Transformational Space Corporation (t/space), and Constellation Services International, Inc. (CSI). The performance commitment in FY 2007 was to complete all negotiated deliverables for both funded Space Act Agreements. NASA assesses and funds based on performance against these negotiated milestones. Per this assessment, both funded companies made progress against what was planned. One company completed all five planned deliverables outlined in their agreement, while the other encountered difficulty and worked with the Agency for a mutually acceptable resolution. The latter company was unable to make the full planned progress (completing two out of five planned deliverables) triggering termination of their Space Act Agreement. This is an expected potential outcome for investments in this risk area, and the reason for investing in more than one partner. The overall outcome should be met as one partner is still on track to meet the planned deliverables in the next two years leading up to the on-orbit demonstration in 2010.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Complete assessment of at least two contractor deliverables that will support the development of vehicles that can provide commercial cargo or crew transport services.	None	5ISS7 Yellow	6ISS2 Green	**7CS8 Yellow**

Why NASA did not achieve APG 7CS8: In NASA's assessment, while significant progress was made in FY 2007 toward achieving the long-term goals of the program, not all planned work content was provided. Hence NASA only partially achieved the APG. This is an expected potential outcome for investments in this risk area, and the reason for investing in more than one partner. NASA expects that the long-term goals of the program will be met.

Plans for achieving 7CS8: Since the program made significant progress toward the long-term goals—and the results of the FY 2007 specific work still support this—NASA has no plans to meet this specific APG in the future.

Outcome 5.3: By 2012, complete one or more prize competitions for independently designed, developed, launched, and operated missions related to space science or space exploration.

FY04	FY05	FY06	FY 2007
None	None	None	**Green**

Since the beginning of the Centennial Challenges Program through the end of FY 2007, NASA conducted 10 competition events in each of the six unique prize categories, five of which are related to space exploration: Astronaut Glove, Regolith Excavation, Tether, Beam Power, and Lunar Lander. Among these exploration-related competitions, the program awarded one purse of $200 thousand, won by Peter Homer, for the 2007 Astronaut Glove Challenge held on May 3–4 in Windsor Locks, Connecticut.

A prize challenge is considered "complete" when the program has successfully conducted the planned number of competition events, whether or not a team/individual competitor has won the prize money. NASA anticipates that at least six prize contests will be conducted in FY 2008.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Conduct at least two prize competitions that encourage the development and demonstration of advanced, critical technologies supporting NASA's missions and goals.	None	5HRT17 Blue	None	**7ESRT3 Green**

Strategic Goal 6

Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.

	Green	Yellow	Red	White
4 Outcomes	4 (100%)	0	0	0
8 APGs	6 (75%)	0	0	2 (25%)

Cost of Performance (in millions)
$791

Responsible Mission Directorate	Contributing Theme	Theme Description
Exploration Systems (ESMD)	Exploration Systems Research & Technology (ESRT)	The Exploration Systems Research and Technology Theme develops and demonstrates new technologies that will enable future human and robotic exploration missions, including robotic precursor missions for lunar exploration.
Space Operations (SOMD)	Space and Flight Support (SFS)	Space and Flight Support includes Space Communications and Navigation, Launch Services, Rocket Propulsion Testing, and Crew Health and Safety. These programs are essential for conducting human and robotic space exploration, aeronautical research, and biological and physical research. They provide services to a wide range of customers, including NASA scientists and engineers, other federal agencies, universities, foreign governments, and industry.

PART Assessment Rating

Theme	Last Year Assessed	Overall Rating	Program Purpose and Design	Strategic Planning	Program Management	Program Results/ Accountability
Advanced Capabilities (replaced ESRT)	2007	Adequate	100%	90%	75%	45%
Space and Flight Support	2007	Moderately Effective	100%	100%	88%	61%

Note: ESMD reorganized its Themes and programs as of NASA's FY 2008 Budget Estimates. Activities included under ESRT now are part of the Advanced Capabilities Theme.

Missions to the Moon in the 21st century will be vastly different from the Apollo missions. Future missions will carry more crewmembers, expand the range of lunar landing sites, and increase the length of time astronauts spend exploring the lunar surface. Future explorers also will experiment with using lunar resources (e.g., possible water ice located deep within lunar craters) to reduce the amount of supplies that must be brought from Earth and to support an extended human presence on the Moon.

To achieve Strategic Goal 6, NASA is leveraging partnerships with industry and the international space community to acquire next-generation technologies for life support, communications and navigation, radiation shielding, power generation and storage, propulsion, and resource extraction and processing.

NASA is laying the foundation for the lunar return program by focusing Agency research on robotic reconnaissance explorers, surface nuclear power systems, and advanced communications systems. These technologies will support the lunar return program and will evolve and be adapted to support future Mars missions.

Benefits

NASA and the Agency's partners transfer advanced space exploration systems and capabilities—power generation, communications, computing, robotics, and improved materials from space exploration research and execution—to the commercial sector to serve public, national, and global needs. In the past, technologies developed for space exploration have yielded ground-based applications such as non-polluting solar energy systems, advanced batteries for laptop computers and cell phones, and fuel cells for electric vehicles.

Historically, space exploration has inspired industry, academia, and individual researchers to redefine what is “possible.” NASA’s Vision to expand the limits of robotic and human exploration through a technically ambitious portfolio of programs should provide even greater challenges and opportunities for personal development and future economic growth to NASA’s extended family of visionary partners.

The activities under Strategic Goal 6 lay the groundwork for NASA’s future human space exploration goals. Through the successful completion of these activities, NASA will have the technologies and capabilities to support humans on the Moon by the time the Orion Crew Exploration Vehicle and the Ares launch vehicles are fully operational. Along the way, these activities will benefit other efforts across NASA: new power generation and nuclear technologies will help future space exploration missions; autonomous systems and integrated systems health management can make air travel safer and more efficient; and improved space communications enable better data delivery to and from the Space Shuttle, the ISS, and robotic spacecraft.

Risks to Achieving Strategic Goal 6

As the name suggests, the Advanced Capabilities Theme develops new, advanced technologies for NASA’s robotic and human exploration missions. Many of the projects conducted by the Theme’s Exploration Technology Development Program (ETDP, the successor to ESRT) are either in formulation or early stages of development. As such, they are subject to challenges that affect any project in its early stages:

- Reductions in planned budget may prevent technologies from being matured in time to support preliminary design of flight systems;
- The evolving lunar architecture may cause technology development priorities to change; and
- Technologies may be more difficult to develop to the required level of maturity than originally anticipated.

To mitigate these risks, NASA is conducting follow-on studies to the Exploration Systems Architecture Study. Through this process, NASA continues to: adjust the exploration architecture based on budget constraints, technology readiness levels, and probable capabilities; reassess technology needs and refocusing research and development based on study findings; and strategically plan for near- and long-term needs, creating a balanced portfolio of medium- to high-maturity technologies required by current missions and higher-risk technologies that may not have immediate mission applications but would enable future missions.

FY 2008 Performance Forecast

- Prepare the LRO/LCROSS missions for launch in the fourth quarter of 2008 (FY 2009);
- Deliver the prototype five meter-diameter ablative heat shield for Orion;
- Demonstrate an unpressurized rover for transporting crew and payloads across lunar surface in a desert field test;
- Deliver the Combustion Integrated Rack and its insert, the Flame Extinguishment Experiment, in preparation for launch to the ISS;
- After awarding the TDRS replenishment (TDRS K/L) project in the first quarter of FY 2008, complete the Preliminary Design Review;
- Complete upgrades to the NASA Integrated Services Network (NISN) mission network and migrate the services to the new infrastructure;
- Complete the Systems Requirement Review and Preliminary Design Review for the Space Communication and Navigation Network (SCaN) Constellation Integration Program (formerly known as the Exploration Communications and Navigations Systems);
- Review the Deep Space Network requirements for the post-2015 timeframe and assess subsequent alternatives; and
- Complete installation of the 18-meter Ka-band systems at White Sands for the Solar Dynamics Observatory and Lunar Reconnaissance Orbiter (LRO) missions.

Outcome 6.1: By 2008, launch a Lunar Reconnaissance Orbiter (LRO) that will provide information about potential human exploration sites.

FY04	FY05	FY06	FY 2007
5.13.1 Green	None	6.1 Green	**Green**

The LRO Program successfully met the critical milestones for the performance period. All instruments and the core spacecraft have completed the Critical Design Review and program partners are fabricating and assembling the hardware. Early integration testing with full instrument and vehicle integration began in fall 2007. NASA successfully completed all design milestones for the Lunar Crater Observation and Sensing Satellite (LCROSS), which will launch with LRO, and the project partners have begun subsystem fabrication and assembly. NASA began the integration and test phase for the LCROSS spacecraft in October 2007 and the mission is on-track for launch with LRO in 2008.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Complete the Non-Advocate Review (Authority to Proceed) for the Lunar Reconnaissance Orbiter.	None	None	6SSE1 Green	**7ESRT4 Green**

Outcome 6.2: By 2012, develop and test technologies for in-situ resource utilization, power generation, and autonomous systems that reduce consumables launched from Earth and moderate mission risk.

FY04	FY05	FY06	FY 2007
9.4.2 Green	11.3 Green	6.2 Green	**Green**
9.4.1 Green	11.4 Green		

ESMD is developing key technologies, including oxygen production from regolith, advanced rovers for surface mobility, concepts for zero boil-off cryogenic propellant storage, propulsion systems that use propellants generated from in-situ resources, and radiation hardened microelectronics to reduce mission risk. Due to budget reductions, NASA reduced technology efforts. However, with further analysis that led to task reprioritization, ESMD completed a demonstration of oxygen production from simulated lunar regolith using a technology called RESOLVE. Also, ESMD demonstrated remotely supervised deployment of lunar infrastructure at the Desert Rats field test.

Note: NASA reduced several research and technology efforts to meet budgetary needs. As a result, NASA believed that two APGs under Outcome 6.2 would not be achievable, and therefore canceled them, as communicated to Congress in the initial FY 2007 operating plan.

Outcome 6.3: By 2010, identify and conduct long-term research necessary to develop nuclear technologies essential to support human-robotic lunar missions and that are extensible to exploration of Mars.

FY04	FY05	FY06	FY 2007
9.4.3 Green	11.5 White	6.3 Green	**Green**

The Fission Surface Power System (FSP) project transitioned to a focused development and test effort for nuclear power systems that could provide abundant, constant surface power for a lunar outpost at any surface location to enable long-duration stays on the Moon while being extensible for Mars missions. The project team completed the Affordable Fission Surface Power System Study with participation by nuclear power experts from both NASA and the U.S. Department of Energy. The team also continued FSP concept definition activities: initiating a formal reference concept selection; continuing risk-reduction technology research, including development and operation of FSP component and system test facilities; and preparing a draft project plan.

The FSP project is transitioning into ETDP.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Complete a focused plan and initiate research for nuclear systems technology development for lunar surface fission power generation in support of protracted missions.	None	None	None	**7ESRT5 Green**

Outcome 6.4: Implement the space communications and navigation architecture responsive to Science and Exploration mission requirements.

FY04	FY05	FY06	FY 2007
8.5.1 Green	6.2 Green	6.4 Green	**Green**

In 2006, the Space Communications Program developed a plan for updating NASA's space communications and navigation architecture, as directed in the NASA Authorization Act of 2005. NASA delivered the management-approved report to the House Committee on Science and Technology on July 25, 2007.

The Space Communications Program is working with SOMD, ESMD, and SMD to ensure that communication and navigation needs are met. As part of this effort, the program partners with the commercial sector to obtain and maintain reliable technologies at competitive prices: the Communication Navigation and Networking Reconfigurable Testbed (CoNNeCT), which is investigating reprogrammable (software-defined) radio technology for use during space exploration missions, is a joint government and commercial development project; NASA is working with industry partners on the Tracking and Data Relay Satellite (TDRS) Continuation Project; and the Near Earth Network acquires over 60 percent of tracking services on a commercial fee-for-service basis.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Develop and submit in February 2007 a space communications plan based on an architecture that supports NASA's exploration and science programs for the 2010–2015 timeframe and beyond.	None	None	None	**7SFS1 Green**
Implement technology initiatives consistent with approved baseline space communications and navigations architecture.	4SFS8 Green	5SFS8 Green	6SFS1 Green	**7SFS2 Green**
Pursue commercial opportunities for the space communication and navigation architecture.	None	None	None	**7SFS3 Green**

Efficiency Measures

FY 2007 Efficiency Measure Annual Performance Goals	FY04	FY05	FY06	FY 2007
Complete all development projects within 110% of the cost and schedule baseline.	None	None	6ESRT13 White	**7ESRT6 White**
Complete all development projects within 110% of the cost and schedule baseline.	4SFS14 Green	5SFS21 Green	6SFS7 White	**7SFS5 White**
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	4RPFS11 Green	5SFS22 Green	6SFS8 Green	**7SFS6 Green**

Why NASA rated APG 7ESRT6 White: The Advanced Capabilities Theme was not scheduled to complete any development projects in FY 2007, so NASA postponed this APG until a later fiscal year.

Why NASA rated APG 7SFS5 White: The Space Communication Program was not scheduled to complete any development projects in FY 2007, so NASA postponed this APG until a later fiscal year.

Cross-Agency Support Programs

Cross-Agency Support Programs: Education

	Green	Yellow	Red	White
3 Outcomes	3 (100%)	0	0	0
10 APGs	10 (100%)	0	0	0

Responsible Mission Directorate

Cross-Agency Support Programs (CASP)

Contributing Theme

Education

Theme Description

The Education Theme partners with academia, professional associations, industry, and other agencies to provide teachers and faculty with experiences that capitalize on the excitement of NASA's missions. It also offers involvement in NASA's research efforts to encourage students to pursue higher education in science, technology, engineering, and mathematics, ensuring a future supply of highly trained people.

PART Assessment Rating						
Theme	**Last Year Assessed**	**Overall Rating**	**Program Purpose and Design**	**Strategic Planning**	**Program Management**	**Program Results/ Accountability**
Education	2007	Results Not Demonstrated	100%	88%	60%	33%

NASA's Office of Education works through strategic partnerships and linkages between formal and informal education providers to strengthen the Nation's future workforce. Using the excitement of NASA's missions to inspire and capture the imagination of students, NASA programs and learning materials encourage students to pursue studies and careers in science, technology, engineering, and mathematics (STEM). NASA offers a progression of educational opportunities for students, teachers, and faculty that promote STEM literacy, help to attract and retain students in STEM disciplines, and improve awareness of NASA's Mission. Education's collaboration with the NASA Mission Directorates and Centers, other federal agencies engaged in educational activities, and various public and private partners helps to leverage the effectiveness and reach of its programs.

Benefits

NASA's landmark achievements in air and space, made possible by scientific excellence and technical innovation, have deepened humankind's understanding of the universe while yielding down-to-Earth advances in air travel, health care, electronics, computing, and more. These achievements ultimately share a single source—education. NASA's Office of Education uses NASA's unique missions and vast scientific and technical experience to inspire and motivate America's future leaders.

To achieve NASA's Strategic Goals, the Agency must ensure a pipeline of highly skilled, diverse individuals. In the near-term, NASA will meet workforce needs by additional training for current employees and recruiting employees with skills and capabilities in recent research and technology fields into the Agency. To meet long-term workforce needs, NASA's Education programs help inspire students at all levels to pursue STEM-related careers, providing professional development opportunities to STEM teachers, and developing interesting STEM content for the classroom, the Web, and informal learning environments like museums and community-based organizations.

Risks to Achieving Education's Outcomes

Budget stability is the greatest challenge facing the Education Program. To implement its plans with strategic partners, NASA must ensure that it can deliver on its commitments. Continuing and developing new partnerships with formal and informal education providers, as well as attracting and retaining STEM students in success-oriented programs requires consistent and sustained support.

FY 2008 Performance Forecast

- NASA will re-align and restructure projects within Education to focus and accelerate products and services to meet NASA's needs.

Outcome ED.1: Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals through a portfolio of programs.

FY04	FY05	FY06	FY 2007
None	13.2 Green	ED-1 Green	**Green**
None	13.3 Green		

The Office of Education provides opportunities to help students and educators gain hands-on experience in a range of STEM-related areas through NASA internships, fellowships, and research experiences. The goal is to give students the motivation, inspiration, and experience they need to serve the Nation's current and future workforce needs. In FY 2007, Education significantly exceeded several of its award targets: more than 1,000 competitive study opportunities to higher education students; more than 800 study opportunities, including 538 Space Grant consortia, to underserved students, teachers, and faculties; and 139 grants to 50 underrepresented and underserved institutions.

Education initiated a study of previous student participants in NASA education opportunities and its effects on the NASA workforce. Education continues to work with NASA's Office of Human Capital Management's data system to collect, analyze, and report on student participants who have entered the NASA workforce. Additionally, NASA is redesigning its data system to include a student participant tracking system and process. There is no federal data collection system that supports this process.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Award 1,000 competitive internships, fellowships, and research opportunities for higher education students and faculty in STEM disciplines.	None	None	6ED3 Green	**7ED1 Green**
Award 270 competitive scholarships, internships, fellowships, and research opportunities for underrepresented and underserved students, teachers and faculty in STEM disciplines.	None	None	6ED6 Green	**7ED2 Green**
Provide 95 grants to enhance the capability of 50 underrepresented and underserved colleges and universities to compete for and conduct basic or applied NASA-related research.	None	None	6ED7 Yellow	**7ED3 Green**
Collect, analyze, and report longitudinal data on student participants to determine the degree to which participants enter the NASA workforce or other NASA-related career fields.	None	None	6ED5 Green	**7ED5 Green**

Outcome ED-2: Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty.

FY04	FY05	FY06	FY 2007
None	None	None	**Green**

A challenging budget year required the Office of Education to set programmatic priorities which resulted in the funding of projects with the highest contribution potential toward its goals. The Office of Education successfully conducted 10 Educator Astronaut workshops, involving more than 130 educators, and selected and supported 25 additional schools to participate in the NASA Explorer Schools program. Although the Explorer School target to select 50 new schools was not feasible, the objective to maintain a steady-state total of 100 participating schools was met.

Through ISS EarthKAM students were able to perform simple (partial) experiments by taking photographs of Earth using the Web to direct a digital camera during select spaceflights and from the ISS. ISS EarthKAM is a NASA-sponsored research program that provides stunning, high-quality photographs of the planet. These simple student experiments (more than 100 in FY 2007) involved approximately 3,600 middle school students and 54 undergraduate students in authentic, first-hand NASA mission activities.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Conduct 10 Educator Astronaut workshops, involving approximately 200 educators.	None	None	None	**7ED6 Green**
Select and support 50 additional schools to participate in the NASA Explorer Schools program, maintaining the total number at 100.	None	5ED14 Green	None	**7ED7 Green**
Select 100 student experiments, involving 1,000 students, to participate in the Flight Projects program.	None	None	None	**7ED8 Green**

Outcome ED-3: Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission.

FY04	FY05	FY06	FY 2007
None	13.5 Green	None	**Green**

The Office of Education collaborated with NASA's Office of Public Affairs, Office of Communications Planning, Mission Directorates and Field centers to develop partnership strategies and activities to enhance the capabilities of the informal education community. Activities and programs were structured to provide access to NASA staff, research, technology, information and facilities as the means for inspiring the next generation of explorers. 350 museums and science centers were actively engaged in major NASA events in FY 2007. The NASA Space Grant consortium supported 214,106 individuals in informal education projects and activities this year. Additionally, 1,750 informal education providers in organizations as diverse as community and youth groups, astronomy clubs, libraries, and the Boy and Girl Scouts used NASA resources in their programming.

The Office of Education also positioned its E-Education Program to serve as an important linchpin across its portfolio. E-Education was able to advance and support education product reviews, assist approved products in meeting 508-compliancy prior to electronic posting in the NASA Portal, and assist products in meeting standards of the Agency's Communication Materials Review. With a limited budget and the momentum gained from E-Education, three of the four E-Education projects contributed toward digitizing and providing meta-tags to over 10 percent of NASA's approved learning materials using technology-enabled learning systems. Each project had a unique niche in this effort to deliver materials to the end user.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Digitize and meta-tag 10 percent of NASA's approved learning materials to be delivered using technology-enabled learning systems.	None	None	None	**7ED9 Green**

Efficiency Measures

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Collect, analyze, and report that 100% of grantees annually report on their accomplishments.	None	None	6ED11 Green	**7ED11 Green**
Peer review and competitively award at least 85%, by budget, of research projects.	4ED24 Green	5ED19 Green	6ED12 Red	**7ED12 Green**

Cross-Agency Support Programs: Advanced Business Systems (IEMP)

	Green	Yellow	Red	White
2 Outcomes	1 (100%)	0	0	0
3 APGs	3 (100%)	0	0	0

Responsible Mission Directorate Equivalent

Cross-Agency Support Programs (CASP)

Contributing Theme

Advanced Business Systems (IEMP)

Theme Description

The Advanced Business Systems Theme implements Agency-wide initiatives to improve financial, procurement, asset management, and human capital performance. The initiatives integrate business decision-making with scientific and technical leadership by providing managers with timely, accurate, and useful information.

PART Assessment Rating						
Theme	**Last Year Assessed**	**Overall Rating**	**Program Purpose and Design**	**Strategic Planning**	**Program Management**	**Program Results/ Accountability**
ABS	2006	Moderately Effective	80%	100%	88%	67%

NASA established the Advanced Business Systems Theme in FY 2006 to reflect the implementation of Agency-wide business systems as a direct program. This Theme is commonly referred to by its program title, Integrated Enterprise Management Program (IEMP).

NASA established IEMP in 2000 with an objective to modernize and integrate NASA's business systems and processes. Since 2000, IEMP has implemented eleven Agency-wide business systems in support of the Agency's Strategic Plan. IEMP will continue to implement four additional Agency systems to provide quality information to decision makers prior to completing the program in FY09.

Benefits

Within NASA's Strategic Plan, this Theme supports multiple Goals and Sub-goals, and aligns with NASA's Cross Cutting Management Strategies.

NASA's IEMP is transforming the Agency's business systems, processes, and procedures to improve financial management and accountability and to increase efficiency and cost savings across the Agency. The program is currently implementing new systems and processes that: (1) improve the management of Agency and contractor held personal property that will result in cost savings, greater reuse of existing assets and better accountability for assets; (2) provide employees and management with new, secure tools for accessing personnel data, and planning and budgeting NASA's workforce; (3) allow better management of flight operations and logistics for the Agency's aircraft fleet; and (4) standardize travel planning, travel expense reimbursement, payment processing, credit card reconciliation, and travel management reporting for NASA.

Risks to Achieving IEMP's Outcomes and Other Support Activities

One of NASA's challenges is to develop and maintain a concept of operations for Agency-wide business systems. This challenge was highlighted in a recent report produced by the General Accountability Office. The report indicated that NASA had not documented an integrated future vision for the agency's business systems. A concept of operations describes the systems current state, desired future state and associated operational scenarios in layman's terms. This is important since a concept of operations document can be used to support both strategic and design decisions as well as provide context to the user community. A concept of operations allows the reader to understand inter-related functions, high level processes, and tools from an integrated systems point of view. This challenge is complex given the number of business systems throughout the Agency and the need to engage representatives across the user base. NASA recognizes the value in developing an Agency-wide business system concept of operations to support both strategic and tactical decision making.

IEMP also is working to mediate additional challenges:

- Evolving Agency business requirements may require more funding and staff than is available;

- If the Agency continues to identify new high-priority business requirements that must be implemented, Centers and Mission Support Offices may be severely impacted; and
- If customers/stakeholders do not feel that the information tools and reports provided by the Human Capital Information Environment (HCIE) are easily accessible and useable then users may reject HCIE or the project may need significant rework resulting in schedule slips and cost overruns.

FY 2008 Performance Forecast

- In FY 2008, complete the Integrated Asset Management (IAM) Property, Plant, and Equipment (PP&E) Module implementation at all Centers. The IAM PP&E implementation will integrate processes between PP&E logistics and PP&E financial management, improve PP&E logistics management and improve PP&E financial management.
- By the end of FY 2008, complete HCIE full operational capability at the Centers. HCIE will eliminate redundant systems, consolidate current applications, and integrate the remaining human capital processes and systems And allow NASA managers access to a centralized reporting environment for decision making.
- Continue the Aircraft Management Module Phase 2 implementation. Phase 2 of the AMM project includes the logistics management component, the aircraft and asset maintenance management components and the aircraft configuration management capabilities. The AMM will enhance safety of ground and flight operations, improve visibility into aircraft operations processes and improve financial and business management.

Outcome IEM-1: By 2008, implement Agency business systems that provide timely, consistent and reliable business information for management decisions.

FY 04	FY 05	FY 06	FY 2007
None	None	None	**Green**

IEMP was established in 2000 with an objective to modernize and integrate NASA's business systems and processes. Since 2000, IEMP has implemented eleven Agency-wide business systems in support of the Agency's Strategic Plan. IEMP will continue to implement four additional Agency systems to improve efficiency and provide quality information to decision makers prior to the completion of the program in FY09.

In November 2006, NASA implemented an updated version of the SAP Core Financial software. The update included several critical enhancements that have improved the Agency's compliance with federal financial and accounting systems standards and improved the quality of financial and management information for decision makers. The upgrade improved the data integrity by eliminating duplicate entry in two systems, reducing human error and eliminating manual processes. The FY 2007 financial statements were generated from the updated Core Financial software.

FY 2007 Annual Performance Goal	FY04	FY05	FY06	FY 2007
Upgrade NASA's existing Core Financial system, through the SAP Version Update Project, resulting in improved data integrity.	None	None	None	**7IEM1 Green**

Outcome IEM-2: Increase efficiency by implementing new business systems and reengineering Agency business processes.

FY 04	FY 05	FY 06	FY 2007
None	None	IEM-2 Green	**Green**

Prior to IEMP, NASA's financial, physical, and business management environment was comprised of decentralized, non-integrated systems characterized by function specific, Center-unique policies, procedures, and practices. IEMP engaged a modular and incremental reengineering of business processes and implementation of business systems influenced by federal requirements, contribution to Agency goals, Center needs, design and implementation complexity, data dependencies, and available budget thus bringing increased efficiency to NASA's financial, procurement, human resources and asset management communities. IEMP will continue to reengineer Agency processes and implement new business systems until the program is completed in FY 2009.

In November 2006, NASA implemented the Contract Management Module to support the Agency's needs in contract/grant writing and administration, procurement workload management and data reporting/management. The Contract Management Module provides added efficiency to procurement processes by providing an end-to-end tool that is automated and standard across the Agency. Other efficiencies have been gained by reducing the amount of manual entry required; allowing procurement professionals more time to focus on strategic procurement activities.

In April 2007, the Aircraft Management Module completed their phase I implementation at all aircraft Centers. The phase I implementation provides the Agency with a tool to help NASA manage the Agency's fleet of mission-support, research, and mission-management aircraft by tracking aircraft inspections, mission configurations and aircrew qualifications. Prior to the phase I implementation, many processes were manual and labor intensive. The Aircraft Management Module will implement phase II at all aircraft centers by September 2009; resulting in improved management and tracking of aircraft repair parts and asset tracking as well as improve the integration with the Agency's financial system.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Implement the Contract Management Module to increase efficiency in procurement processes.	None	None	None	**7IEM2 Green**
Implement the Aircraft Management Module to reduce the risk of flight operations through improved tracking of crew and aircraft currency qualifications.	None	None	None	**7IEM3 Green**

Cross-Agency Support Programs: Innovative Partnerships Program (IPP)

	Green	Yellow	Red	White
1 Outcome	1 (100%)	0	0	0
4 APGs	4 (100%)	0	0	0

Responsible Mission Directorate Equivalent

Cross-Agency Support Programs (CASP)

Contributing Theme

Innovative Partnerships Program (IPP)

Theme Description

The IPP Theme provides leveraged technology for NASA's programs through partnerships with industry, academia, other government industries, and national laboratories. The resulting technologies benefit NASA's Mission while also having strong potential transfer to commercial application and public benefit.

PART Assessment Rating

Theme	Last Year Assessed	Overall Rating	Program Purpose and Design	Strategic Planning	Program Management	Program Results/ Accountability
Innovative Partnerships Program	IPP will be reviewed in 2008	N/A	N/A	N/A	N/A	N/A

To achieve the NASA's mission in an affordable and sustainable manner, the Agency partners with industry and academia to leverage outside investments and expertise while providing an economic incentive to invest in NASA programs.

IPP supports multiple Strategic Goals and Sub-goals in the 2006 NASA Strategic Plan, and serves all four Mission Directorates with offices across NASA's 10 Centers. Mission Directorates outline their technology needs, and IPP helps satisfy those needs through research and development with efficient strategic partnerships

Benefits

IPP provides the technology solutions for NASA programs and projects through dual-use technology development and joint-partnerships. By broadening NASA's connection to emerging technologies, IPP provides an increased range of technological solutions for programs while reducing costs.

IPP provides technology transfer out of NASA (called spinoffs) for commercial or socio-economic benefit to the Nation. In addition, IPP facilitates protection of the government's rights in NASA's inventions, as mandated by legislation. Technology Transfer, Small Business Innovative Research, and Centennial Challenges tap into sources of innovation outside NASA and leverage NASA's resources with private or other external resources to develop new technologies for NASA mission use. IPP also transfers technologies having strong potential for commercial applications yielding public benefits. All of IPP's functions primarily serve NASA's mission interests, both in the near and long terms, and with respect to a broad range of technologies and technology readiness. IPP targets and provides a broad spectrum of U.S. industrial and non-profit entities the opportunity for grass-roots direct involvement in NASA's exploration and other missions.

Risks to Achieving IPP's Outcome and Other Support Activities

FY 2008 budget reductions and the FY 2007 budget rescission will have significant negative consequences for the IPP program. The impacts cannot be mitigated without restoring funding cuts. Technology Transfer Partnerships will be reduced by more than one-third across all Centers, resulting in an opportunity cost of more than three times the value in terms of lost leveraged resources from external sources. There also will be significant, proportionate reductions in Center support-contractor workforce. All of these reductions will result in fewer opportunities to develop new and innovative technologies to meet mission needs and reduces resources to secure and commercially apply NASA's intellectual property for the public good. Significantly less funding will be available for SBIR and Small Business Technology Transfer (STTR) awards, where the subject technology development is directly tied to specific Mission Directorate needs. In addition, no new funding for Centennial Challenges eliminates the potential to pursue new challenges that would drive innovation in technology areas critical to the Agency.

FY 2008 Performance Forecast

- Develop at least 12 technology-related significant partnerships, and complete at least 30 technology transfer agreements with the commercial and academic community through licensing, software use agreements, facility use agreements, and Space Act Agreements;
- Complete and institutionalize an enhanced Intellectual Property management process; and
- Develop and demonstrate a means for NASA to purchase services from emerging parabolic aircraft flight and suborbital launch providers for microgravity research and training, to the extent limited resources permit.

Outcome IPP-1: Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and projects.

In FY 2007, IPP helped NASA enter into over 200 Space Act Agreements with private and other external entities for development of dual-use technology targeted to Mission Directorate technology needs. IPP provided $9.2 million in funding for 38 Seed Fund partnerships for development of a broad spectrum of technologies addressing specific Mission Directorate technology gaps. Partner and Center contributions of cash and in-kind resources leveraged these funds by nearly a factor of four. IPP facilitated the signing of 35 license agreements and 682 Software Use Agreements.

In addition, IPP facilitated the reporting of 1,268 new invention disclosures. As a result, 105 NASA patent applications were filed and 93 patents awarded. Revenues realized from licenses of NASA-sponsored technologies exceeded $4 million. NASA patent protection strategic decision processes include consideration of both the likelihood of commercial application of the technology, as well as likelihood of the licensed NASA technology triggering a future partnering opportunity directed at NASA mission needs.

IPP completed the transition of NASA's SBIR/STTR program to a consolidated model better tailored to produce technologies of direct Mission Directorate relevance at less operational cost. IPP also completed six Centennial Challenge events and awarded a combined $450 thousand in prize money to two competition categories (see the Strategic Goal 5 for more information). IPP completed significant groundwork to put in place its FAST program to use commercially provided services to conduct technology demonstrations in a zero- or reduced-gravity environment, maturing technologies needed by NASA. Similarly, IPP made significant progress in establishing its Innovation Transfusion program whereby NASA technical personnel will enhance their capabilities through exposure to innovative technologies, processes, and practices outside of the Agency. IPP has significantly strengthened the relevance of its publications so that the public and other NASA stakeholders may more clearly recognize NASA's contributions to the Nation and humankind. *Spinoff 2007* highlights 39 new examples of how NASA innovation can be transferred to the commercial market place and applied to areas such as health and medicine, transportation, public safety, consumer goods, homes and recreation, environmental and agricultural resources, computer technology and industrial production. Finally, IPP has strengthened the involvement of the Mission Directorates and Mission Support Offices in all of its program elements to better serve Agency-wide and public needs.

FY 04	FY 05	FY 06	FY 2007
10.3.1 Blue	11.7 Green	IPP-1 Green	**Green**

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Develop 20 technology-related significant partnerships that create leveraged value for NASA's programs and projects. Track both quantitative dollar value and qualitative benefits to NASA (e.g. reduced volume or mass, improved safety).	None	None	None	**7IPP1 Green**
Complete 50 technology transfer agreements with the commercial and academic community through such mechanisms as: licenses, software use agreements, facility use agreements, and space act agreements.	None	None	None	**7IPP2 Green**
Fully implement an annual portfolio licensing approach that targets licensing goals of greatest value/benefit to NASA. Examples of such value are: licensing royalties, and new technology products available to NASA. Royalties should be $4M per year or greater.	None	None	None	**7IPP3 Green**
Complete and institutionalize an enhanced Intellectual Property (IP) management process that enables stronger use of NASA's IP to support NASA's strategies. Implement such IP management together with at least two significant NASA programs or projects.	None	None	None	**7IPP4 Green**

Cross-Agency Support Programs: Strategic Capabilities Assets Program (SCAP)

	Green	Yellow	Red	White
1 Outcome	1 (100%)	0	0	0
2 APGs	2 (100%)	0	0	0

Responsible Mission Directorate Equivalent

Cross-Agency Support Programs (CASP)

Contributing Theme

Strategic Capabilities Assets Program (SCAP)

Theme Description

The SCAP Theme ensures that key capabilities and assets are available for future missions. It also helps NASA prioritize critical capabilities and make strategic investment decisions to replace, modify, or disposition assets.

PART Assessment Rating

Theme	Last Year Assessed	Overall Rating	Program Purpose and Design	Strategic Planning	Program Management	Program Results/ Accountability
Strategic Capabilities Assets Program	OMB has not assessed SCAP	N/A	N/A	N/A	N/A	N/A

NASA established SCAP to ensure key capabilities and assets, such as wind tunnels and test facilities at Centers, are available for future missions and to help NASA prioritize and make strategic investment decisions to replace, modify, or disposition these capabilities/assets. It is managed at the Agency level, with funding and day-to-day management responsibilities generally resident in Centers and in the Office of Infrastructure and Administration. Mission Directorates share management responsibilities with SCAP on the Aeronautics Test Program and High-End Computing Columbia Program.

Benefits

SCAP serves each NASA Mission Directorate by providing the facilities and capabilities to investigate, test, and establish new scientific and engineering theories, principles, and methods. SCAP establishes alliances between the NASA Centers with like assets; makes decisions on disposition of capabilities no longer required; identifies re-investments and re-capitalization opportunities within and among classes of assets; executes changes; and reviews these capabilities each year to ensure the requirements are still valid. SCAP ensures that NASA has the assets and capabilities needed to achieve the Agency's Mission, by strategically managing capabilities, setting uniform use policies, and reducing budget constraints by eliminating redundant and unneeded assets,.

Other government agencies, industry, and academia routinely use the SCAP facilities to enhance their resources in meeting project requirements. The resulting advanced technologies often have dual-use capabilities that improve the Nation's position in the global market place as well as its defense capabilities.

Risks to Achieving SCAP's Outcome and Other Support Activities

Given that only selected, limited, investments are available for the recapitalization of test facilities managed by SCAP, there is a possibility that test facilities will not meet mission requirements at the desired test date.

FY 2008 Performance Forecast

- SCAP will concentrate on sustaining the infrastructure (base support or underlying structure, i.e., the basic facilities, equipment, services, and components required to sustain or enhance the facility itself) within asset classes and between Centers. SCAP also will institute consistency in reimbursable pricing policies, conduct quarterly program reviews for better management insight into the capabilities and provide a forum for cooperation among all the Centers within asset classes.
- SCAP will continue the management of capabilities added in FY 2007 and will begin to broaden its alliances outside of the Agency for such capabilities as thermal vacuum chambers. Organizations such as the Space Environments Simulation Facilities Alliance will help to strengthen these alliances. SCAP will examine and scrutinize new proposals for additional capabilities submitted as part of the FY 2009 budget process.
- SCAP has identified capabilities no longer required by the Agency and has developed a disposition plan for these assets. During FY 2007, SCAP completed disposition of assets such as the 757 aircraft at Langley Research Center.

SCAP also abandoned the Cryogenic Propellant Tank Facility (K site) and initiated mothballing the Hypersonic Test Facility at Glenn Research Center/Plum Brook Station. Other assets are undergoing the disposition approval process. SCAP will take action on them when final decisions are made.

Outcome SC-1: Establish and maintain selected Agency level shared capabilities, across multiple classes of assets (e.g., wind tunnels, vacuum chambers, etc.), to ensure that they will continue to be available to support the missions that require them.

FY04	FY05	FY06	FY 2007
None	None	None	**Green**

During the FY 2008 budget process SCAP selected, and the Agency started funding in FY 2007, three major strategic categories of assets for incorporation into the SCAP portfolio, including simulators, thermal vacuum chambers, and the arc jet at Ames Research Center. These programs have attracted new users and will be available for future Agency programs. Two new programs were added in Spring 2007: upgrades to the Space Power Facility at Glenn Research Center/Plum Brook Station, and the Microgravity Flight Services Program.

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Prioritize funding requirements and select classes of assets for inclusion in the Strategic Capabilities Assets Program*.	None	None	None	**7SC1 Green**
Identify re-investment/re-capitalization opportunities within and among classes of assets and execute the approved changes (e.g., reallocate funds, upgrade facilities, etc.).	None	None	None	**7SC2 Green**

***** Formerly known as the Shared Capability Assets Program.

Efficiency Measures by Mission Directorate and Theme

NASA uses Efficiency Measure APGs to track performance in a number of program and project management areas, including life cycle schedule and cost and competitive award processes. NASA organizes the Efficiency Measure APGs by Theme to emphasize and encourage individual program accountability.

	Green	Yellow	Red	White
28 APGs	14 (50%)	3 (11%)	4 (14%)	7 (25%)

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Science Mission Directorate				
Earth–Sun System				
Complete all development projects within 110% of the cost and schedule baseline. (This APG is repeated under Sub-goal 3B.)	4ESS1 Green	5SEC14 Red	6ESS24 Red	**7ESS21 Yellow**
Deliver at least 90% of scheduled operating hours for all operations and research facilities. (This APG is repeated under Sub-goal 3B.)	None	5SEC14 Yellow	6ESS25 Green	**7ESS22 Green**
Peer-review and competitively award at least 80%, by budget, of research projects. (This APG is repeated under Sub-goal 3B.)	4ESA8 Green	5SEC16 Green	6ESS26 Green	**7ESS23 Green**
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	6ESS27 Green	**7ESS24 Red**
Solar System Exploration				
Complete all development projects within 110% of the cost and schedule baseline.	4SSE1 Yellow	5SSE15 Yellow	6SSE29 Red	**7SSE10 Red**
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	None	5SSE16 Green	6SSE30 Green	**7SSE11 Green**
Peer-review and competitively award at least 80%, by budget, of research projects.	4SSE2 Green	5SSE17 Green	6SSE31 Green	**7SSE12 Green**
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	6SSE32 Green	**7SSE13 Red**
The Universe				
Complete all development projects within 110% of the cost and schedule baseline.	4ASO1 White	5ASO13 Green	6UNIV22 White	**7UNIV9 Red**
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	None	5ASO14 Yellow	6UNIV23 Green	**7UNIV10 Green**
Peer-review and competitively award at least 80%, by budget, of research projects.	4SEU2 4ASO2 Green	5ASO15 Green	6UNIV24 Green	**7UNIV11 Green**
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	6UNIV25 Yellow	**7UNIV12 Green**
Aeronautics Research Mission Directorate				
Aeronautics Technology				
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	None	None	6AT12 Green	**7AT8 Yellow**
Increase the annual percentage of research funding awarded to Aeronautics University Partnerships.	None	None	None	**7AT9 White**
Exploration Systems Mission Directorate				
Constellation Systems				
Complete all development projects within 110% of the cost and schedule baseline. (This APG is repeated under Strategic Goal 5.)	None	None	6CS5 Green	**7CS9 White**

FY 2007 Annual Performance Goals	FY04	FY05	FY06	FY 2007
Exploration Systems Research and Technology				
Complete all development projects within 110% of the cost and schedule baseline.	None	None	6ESRT13 White	**7ESRT6 White**
Increase the number of technology products transferred to Constellation Systems developers for mission application.	None	None	None	**7ESRT7 White**
Human Systems Research and Technology				
Increase percentage of HSRT procurement funding, solely dedicated to Exploration Activities.	None	None	None	**7HSRT6 Green**
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	6HSRT247 Green	**7HSRT7 Yellow**
Space Operations Mission Directorate				
International Space Station				
Complete all development projects within 110% of the cost and schedule baseline.	4ISS7 Green	5ISS8 Green	6ISS5 Green	**7ISS6 White**
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	None	5ISS9 Green	7ISS6 Green	**7ISS7 Green**
Space and Flight Support				
Complete all development projects within 110% of the cost and schedule baseline.	4SFS14 Green	5SFS21 Green	6SFS7 White	**7SFS5 White**
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	4RPFS11 Green	5SFS22 Green	6SFS8 Green	**7SFS6 Green**
Space Shuttle				
Complete all development projects within 110% of the cost and schedule baseline.	4SSP4 Yellow	5SSP4 Yellow	6SSP2 White	**7SSP4 White**
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	None	5SSP5 Green	6SSP3 Green	**7SSP5 Green**
While ensuring the safety of ongoing flight operations and by working with exploration development programs, reduce Space Shuttle sustaining engineering hours, annual value of Space Shuttle production contracts, and the number of dedicated Space Shuttle facilities, where possible.	None	None	None	**7SSP6 Green**
Cross-Agency Support Programs				
Education				
Collect, analyze, and report that 100% of grantees annually report on their accomplishments.	None	None	6ED11 Green	**7ED11 Green**
Peer review and competitively award at least 85%, by budget, of research projects.	4ED24 Green	5ED19 Green	6ED12 Red	**7ED12 Green**

FY 2007 Performance Improvement Plan

The following table reports all the APGs that NASA was unable to achieve fully in FY 2007 and multi-year Outcomes that NASA may not or will not achieve by the Outcome's targeted completion date. The table is organized by Mission Directorate or equivalent and Theme. The Performance Improvement Plans also are available as part of the Strategic Goal narratives.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Science				
Earth Science Theme				
7ESS4 (Outcome 3A.3)	Complete Landsat Data Continuity Mission (LDCM) Confirmation Review.	White	NASA canceled this APG due to a mandated change in the procurement approach.	N/A
7ESS6 (Outcome 3A.3)	Complete Orbiting Carbon Observatory (OCO) Assembly, Test and Launch Operations (ATLO) Readiness Review.	Yellow	Technical and schedule performance issues with the OCO instrument subcontractor resulted in a four-month launch delay. Consequently, SMD adjusted all major milestones, including the ATLO Readiness Review, to accommodate the new launch date.	As part of the rebaselined schedule, SMD plans to conduct the OCO ATLO Readiness Review in January 2008. SMD continues to monitor all its development projects to maintain cost and schedule baselines.
Outcome 3A.5	Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.	Yellow	Performance toward this Outcome continues to be a concern due to uncertainties in climate data continuity and delays and technical issues related to the NPOESS Preparatory Project (NPP) mission. Although the NASA-developed NPP spacecraft and the NASA-supplied Advanced Technology Microwave Sounder (ATMS) instrument have been successfully delivered and tested and the ATMS is integrated onto the NPP spacecraft, significant technical and schedule problems have caused delays with the development and delivery of the NPOESS-developed Visible/Infrared Imager/Radiometer Suite (VIIRS) instrument. The performance of the instrument will not meet all of NASA's NPP Level 1 requirements and, therefore, will impact key climate research measurements of ocean color and atmospheric aerosols. Contractor performance also poses risks to both the NPP and Glory missions. Performance issues have been causing cost and schedule overruns, which impact not only the timely implementation of the systematic Earth Observation missions, but the overall success of the flight program.	In order to improve contractor performance and limit further cost and schedule overruns, NASA implemented management changes on the Glory mission. Management changes also were approved by the Tri-Agency (NASA, NOAA, and Department of Defense) Executive Committee and implemented by the Integrated Program Office (IPO) on NPOESS. Program funding ensures NASA support to the IPO technical management personnel, funding for the competitively selected NPP science team, and the continued NPP project requirements. NASA continues to work with partner agencies to utilize the assessment information developed by the NPP project and science team in developing a joint mitigation strategy and implementation plan.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
7ESS8 (Outcome 3A.5)	Complete Glory mission Pre-Ship Review.	Yellow	SMD did not complete the Glory mission Pre-Ship Review. The contractor, Raytheon Space and Airborne Systems, experienced delays in developing the Aerosol Polarimetry Sensor (APS) instrument, resulting in a decision to move the instrument work to a different development facility. This caused an estimated six-month delay to the APS delivery. There are no significant technical issues with the development of this instrument.	SMD is revising project plans and scope to optimize the schedule and manpower for the late delivery of the APS. The Pre-Ship Review is scheduled for January 2009. SMD continues to monitor all its development projects to maintain cost and schedule baselines.
7ESS24 (Efficiency Measure)	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	Red	Earth–Sun System research grant selection notifications were significantly delayed in FY 2007 as a result of several factors that resulted in an increase rather than a decrease to processing times. The 15-percent reduction in the Research and Analysis budget in FY 2006, maintained in FY 2007 under the year-long continuing resolution, delayed selection decisions. Additionally, due to several large triennial programs being competed in FY 2007 and the increasing pressure for funding, the number of selection notifications (599) for the Earth–Sun System Theme was 61-percent greater than in FY 2006 (373).	SMD is implementing a number of measures to reduce processing times and expects to make significant progress. These measures include finding greater efficiencies in the manner in which panel reviews are constructed, reassessing the steps taken to conduct the proposal review process, and instituting job sharing to afford greater support and back-up contingencies for program officers. Furthermore, it is SMD's goal to adjust the timing of review panels to achieve greater efficiency. However, it should be noted that processing times for Earth Science will likely show an increase every third or fourth year, when the program conducts several large reviews at the start of a cycle. Although staggering the scheduling of these reviews would speed processing times, doing so would have programmatic impacts and will have to be carefully considered.
Heliophysics Theme				
7ESS14 (Outcomes 3B.1, 3B.2, and 3B.3)	Deliver Solar Dynamics Observatory (SDO) instruments to spacecraft for integration.	Yellow	The delivery of two of the three SDO instruments was delayed due to unanticipated technical difficulties in the data interfaces between the Helioseismic and Magnetic Imager (HMI) and the Atmospheric Imaging Assembly (AIA) and the spacecraft's command and data handling system. Both instruments use the new technology of 4000 x 4000 charge-coupled detectors to take high-resolution video for HMI and images for AIA of the Sun. The difficulties are attributed to both the charge coupled detectors and new, untested electronics technology and software that would allow SDO to transfer data at 130 Megabits per second with very high accuracy.	The HMI instrument was delivered in November 2007. The AIA instruments were delivered in December 2007. SMD continues to monitor all its development projects to maintain cost and schedule baselines.
7ESS15 (Outcomes 3B.1 and 3B.2)	Complete Magnetospheric MultiScale (MMS) instrument suite Preliminary Design Review (PDR).	Red	NASA replanned the MMS mission to resolve the discrepancy between mission requirements and the available budget. Progress on mission milestones was delayed during the replanned schedule, but this replanning allowed the mission to go forward intact, without major performance degradation.	NASA approved MMS for transition to Phase B in November 2007. The MMS instrument suite PDR is scheduled for completion in FY 2009.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
7ESS21 (Efficiency Measure)	Complete all development projects within 110% of the cost and schedule baseline.	Yellow	The THEMIS mission exceeded its schedule baseline by 13 percent. The launch vehicle provider requested a four-month launch delay to resolve a second-stage oxidizer tank anomaly on the Delta launch vehicle.	The THEMIS mission launched in February 2007. SMD continues to monitor all its development projects to maintain cost and schedule baselines. Cost control is now a significant central tenet of SMD's management and future missions are being held to stricter standards than in the recent past.
Planetary Science Theme				
7SSE3 (Outcome 3C.1)	Complete Juno Preliminary Design Review (PDR).	White	In 2006, NASA postponed the Juno PDR after altering the New Frontiers Program budget and shifting the Juno launch date to a 2010–2011 timeframe. Because NASA did not issue a revised FY 2007 Performance Plan with the FY 2008 Budget Estimate and, therefore, was unable to revise this APG before the beginning of the FY 2007 performance year, management chose to cancel the measure. The Juno PDR is scheduled for May 2008.	N/A
7SSE10 (Efficiency Measures)	Complete all development projects within 110% of the cost and schedule baseline.	Red	NASA successfully launched the Phoenix and Dawn missions during FY 2007. The Phoenix mission was completed on schedule and exceeded its cost baseline by only three percent. However, the Dawn mission exceeded its schedule baseline by 54 percent and its cost baseline by 27 percent. Unresolved technical and schedule issues driven by delayed hardware deliveries compromised the 2006 launch opportunity for the Dawn mission, leading NASA to cancel the mission in December 2005. After extensive reviews and replanning, NASA restarted the mission in March 2006, with a new launch date of June 2007. Launch vehicle and telemetry support issues caused NASA to delay the launch from June to September 2007.	The Dawn mission was successfully launched on September 26, 2007, completing the work affecting this measure in FY 2007. SMD continues to monitor all its development projects to maintain cost and schedule baselines. Cost control is now a central tenet of SMD's management, and future missions are being held to stricter standards than in the recent past. When SMD reviews projects at key decision points, descope options are given primary consideration in addressing any cost growth. SMD took such action recently on the Kepler project, for which a cost increase was mitigated by shortening the mission duration by six months and by holding the contractor's fee as reserve on the project.
7SSE13 (Efficiency Measure)	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	Red	Due to increasing pressure for funding, the number of selection notifications (445) was 35-percent greater than in FY 2006 (330). Rather than showing progress toward the FY 2007 goal of selecting proposals within 259 days of the proposal due date, the Planetary Science Theme's processing times increased to 314 days.	SMD is implementing a number of measures to reduce processing times and expects to make significant progress. These measures include finding greater efficiencies in the manner in which panel reviews are constructed, reassessing the steps taken to conduct the proposal review process, and instituting job-sharing to afford greater support and back-up contingencies for program officers. Furthermore, it is SMD's goal to adjust the timing of review panels to achieve greater efficiency.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Astrophysics Theme				
Outcome 3D.4	Progress in creating a census of extra-solar planets and measuring their properties.	Yellow	The Astrophysics Theme's performance towards this Outcome continues to be "Yellow" due primarily to the inability to ramp up flight developments in previously planned planet-finding and characterizing missions. Science progress is good, but the scale of investments needed to start new missions, coupled with the Theme's decreasing overall budget and other significant commitments, resulted in previously envisioned missions slipping beyond the budget horizon.	The Astrophysics Theme solicited mission concept studies for planet-finding and characterizing missions that would be more affordable. The proposals, which were due in November 2007, will be evaluated in FY 2008.
7UNIV2 (Outcome 3D.1)	Complete Gamma-ray Large Area Space Telescope (GLAST) Operations Readiness Review (ORR).	Yellow	NASA delayed the GLAST launch due to continued slips in completing the Command and Data Handling subsystem, spacecraft testing schedule conflicts with Department of Defense projects, and spacecraft contractor performance issues.	The GLAST Operational Readiness Review and launch are scheduled for mid-2008. SMD continues to monitor all its development projects to maintain cost and schedule baselines.
7UNIV9 (Efficiency Measure)	Complete all development projects within 110% of the cost and schedule baseline.	Red	The GLAST mission exceeded 110 percent of the cost and schedule baselines. NASA delayed the GLAST launch due to continued slips in completing the Command and Data Handling subsystem, spacecraft testing schedule conflicts with Department of Defense projects, and spacecraft contractor performance issues.	The GLAST Operational Readiness Review and launch are currently scheduled for mid-FY 2008. SMD continues to monitor all its development projects to maintain cost and schedule baselines.
Aeronautics Research				
Aeronautics Technology Theme				
7AT2 (Outcome 3E.2)	Complete flight test evaluation of oceanic in-trail climb and descent using an Airborne Separation Assistance System (ASAS) and an Automatic Dependent Surveillance Broadcast – (ADS-B).	White	NASA completed key elements of this service provider/airline sponsored flight test of oceanic in-trail climb descent using an Airborne Separation Assistance System. However, scheduling and execution of this flight test rests solely with the FAA and Airservices Australia. The flight test was not funded and will not occur and, therefore, NASA canceled the APG. The Airspace Systems Program completed the research support work under NASA's control: • Documented concept on in-trail procedures (ITP); • Completed safety methodology and initial analysis that has been reviewed by the International Civil Aviation Organization (ICAO) and scheduled for ICAO acceptance in November 2007; • Validated ITP simulation; and • Developed algorithms and engineering models used for procedure development in the NASA simulation tools.	N/A

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
7AT8 (Efficiency Measure)	Deliver at least 90% of scheduled operating hours for all operations and research facilities.	Yellow	A number of unexpected breakdowns and construction project delays occurred at several facilities resulting in the delivery of 73 percent of scheduled operating hours for all Aeronautics Test Program (ATP) facilities.	ATP will continue to invest in test facility maintenance projects with the goal of improving facility reliability and availability. However, due to the age and current condition of the facilities, system failures and resulting unplanned downtime have exceeded ARMD's best estimates. To mitigate this in FY 2008, ATP will sponsor a comprehensive assessment of facilities and associated Center infrastructure and develop a long-range investment strategy.
7AT9 (Efficiency Measure)	Increase the annual percentage of research funding awarded to Aeronautics University Partnerships.	White	NASA canceled this APG because it was established prior to the restructuring of ARMD in FY 2006. While ARMD has established a steadily increasing source of external funding that is awarded through a full and open competitive process, such awards are not limited to universities. Industry and nonprofit organizations also are eligible to compete.	N/A
Exploration Systems				
Constellation Systems Theme				
Outcome 4.1	No later than 2014, and as early as 2010, transport three crewmembers to the International Space Station and return them safely to Earth, demonstrating an operational capability to support human exploration missions.	Yellow	Using recommendations from the Exploration Systems Architecture Study (ESAS), the Constellation Systems Program initially pursued the CEV, CLV, CaLV, and Earth Departure Stage points of departure to enable crew transportation to the ISS and future missions to the Moon and Mars. Following the tenets of rigorous systems engineering, NASA conducted trade studies, in tandem with independent cost estimating and acquisition planning, during the early formulation phases of the CEV, CLV, and CaLV to validate ESAS findings against assumptions and known risks, and to revalidate resource and acquisition strategies in relation to NASA's priorities. The primary objective of these studies was to recalibrate decision-making assumptions to address the priority placed on Moon return missions, rather than on minimizing the human spaceflight gap and on the more distant Mars exploration milestone. In January 2006, the Agency streamlined its approach to launch vehicles hardware development based on the results of systems engineering trade studies.	ESMD completed a critical assessment of the ESAS recommendations and incorporated changes intended to reduce overall life cycle costs and integrated risk for human lunar landings while meeting the NASA's Mission and Vision. NASA continues to perform trades in support of the requirements development process, which will culminate in a series of Systems Requirements Reviews for the CEV, CLV, and supporting ground elements. NASA's FY 2008 Budget Estimates notified Congress that the commitment date for achieving Outcome 4.1 now is no later than 2015.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
7CS1 (Outcome 4.1)	Complete the Systems Design Review for the Constellation Program.	Yellow	This metric was established in 2005 at a time when the program was still in early formulation. Since then, ESMD has changed architecture and gained a better understanding of requirements, which resulted in a shift to the overall program schedule that also flowed down to the projects. The Orion Project refined its schedule to reflect the Constellation Systems Program architecture change and shifted the Preliminary Design Review (PDR) to align with the new program milestones.	The Constellation Systems Program continues to perform key system- and element-level trade studies and analyses to validate the design concepts against the requirements and/or determine whether changes to the baseline design concepts are warranted. With successful completion of its Systems Requirements Review (SRR), the program is progressing steadily towards the Systems Definition Review (SDR) in 2008, with individual project reviews (Orion, Ares I, Ground Operations, Mission Operations, and EVA Systems) occurring prior to the program SDR.
7CS2 (Outcome 4.1)	Complete the Preliminary Design for the Crew Exploration Vehicle (CEV).	Yellow	This metric was established in 2005 at a time when the program was still in early formulation. Since then, ESMD has changed architecture and gained a better understanding of requirements, which resulted in a shift to the overall program schedule that also flowed down to the projects. The Orion Project refined its schedule to reflect the Constellation Systems Program architecture change and shifted the PDR to align with the new program milestones.	NASA and the prime contractor, Lockheed Martin, developed a Point of Departure (POD) architecture that combined the best features of the contractor and the NASA design concepts. This POD architecture supported the Orion SRR. The SRR, completed in March 2007, was held to ensure that: requirements had been identified; those requirements are consistent with Constellation Systems Program Requirements; the Constellation Systems Program Requirements have been properly translated into Orion systems and design requirements; and trade-offs between conflicting requirements have been performed and properly resolved. The Orion team concluded the SDR on August 31, 2007. Now the Orion team is assessing the design concept to ensure that the design configuration that came out of the SDR process provides a feasible design with respect to available resources including mass, power and cost. This configuration will be the starting point for the Design Analysis Cycle that leads to the PDR scheduled in 2008.
7CS3 (Outcome 4.1)	Complete the Preliminary Design for the Crew Launch Vehicle (CLV) First Stage.	Yellow	This metric was established in 2005 at a time when the program was still in early formulation. Since then, ESMD has changed architecture and gained a better understanding of requirements, which resulted in a shift to the overall program schedule that also flowed down to the projects. The Orion Project refined its schedule to reflect the Constellation Systems Program architecture change and shifted the PDR to align with the new program milestones.	The Ares I SRR, completed in December 2006, confirmed that the Ares I system requirements were complete, validated, and responsive to mission requirements. The Ares I project proceeded to SDR in September 2007. The SDR board convened on October 30, 2007, and provided approval for the project to proceed to PDR, at which point the project will initiate the element preliminary design reviews.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
7CS8 (Outcome 5.2)	Complete assessment of at least two contractor deliverables that will support the development of vehicles that can provide commercial cargo or crew transport services.	Yellow	In NASA's assessment, while significant progress was made in FY 2007 toward achieving the long-term goals of the program, not all planned work content was provided. Hence NASA only partially achieved the APG. This is an expected potential outcome for investments in this risk area, and the reason for funding more than one contractor. NASA expects that the long-term goals of the program will be met.	Since the program made significant progress toward the long-term goals—and the results of the FY 2007 specific work still support this—NASA has no plans to meet this specific APG met in the future.
7CS9 (Efficiency Measure)	Complete all development projects within 110% of the cost and schedule baseline.	White	Constellation Systems did not complete any development projects during FY 2007, so NASA postponed this APG until a later fiscal year.	N/A
Advanced Capabilities Theme (Engineering Systems Research & Technology and Human Systems Research & Technology)				
7ESRT6 (Efficiency Measure)	Complete all development projects within 110% of the cost and schedule baseline.	White	The Advanced Capabilities Theme was not scheduled to complete any development projects in FY 2007, so NASA postponed this APG until a later fiscal year.	N/A
7HSRT7 (Efficiency Measure)	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	Yellow	HSRT completed the Radiation NRA within 173 days. The implementation of this NRA involved two organizations, NASA and the National Space Biomedical Research Institute. Since this was the first time such a joint Radiation NRA was issued, the required coordination between these organizations resulted in approximately an extra month of time. The delay in the Radiation NRA completion did not impact distribution of research funds; this occurred in October 2007 as planned.	Both organizations plan to eliminate some unanticipated schedule conflicts, streamlining the completion process for future Radiation NRAs.
Space Operations				
Space Shuttle Theme				
7SSP4 (Efficiency Measure)	Complete all development projects within 110% of the cost and schedule baseline.	White	SOMD was not scheduled to complete any development projects in the Space Shuttle Theme during FY 2007, so NASA has postponed this Efficiency Measure until a later fiscal year.	N/A
International Space Station Theme				
7ISS6 (Efficiency Measure)	Complete all development projects within 110% of the cost and schedule baseline.	White	SOMD was not scheduled to complete any development projects in the ISS Theme during FY 2007, so NASA has postponed this Efficiency Measure until a later fiscal year.	N/A
Space and Flight Support Theme				
7SFS5 (Efficiency Measure)	Complete all development projects within 110% of the cost and schedule baseline.	White	The Space Communication Program was not scheduled to complete any development projects in FY 2007, so NASA postponed this APG until a later fiscal year.	N/A

NASA's FY 2006 Performance Improvement Plan Update

NASA reviews program and project deficiencies as reported in the annual Performance and Accountability Report and tracks the progress of remedial actions taken to correct shortcomings. The following table presents the FY 2006 multi-year Outcomes and APGs that were rated Yellow or Red, the plans and schedules to correct them presented in the FY 2006 Performance Improvement Plan, and the results of FY 2007 follow-up actions.

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2007
Science			
6ESS6 (This APG is repeated for Outcomes 3A.1, 3A.2, 3A.3, 3A.4, 3A.5, and 3A.6)			
Improve level of customer satisfaction as measured by a baselined index obtained through the use of annual surveys.	Yellow	The FY 2006 EOSDIS customer satisfaction survey, performed by the Claes-Fornell Institute (CFI), produced a score of 74, a decrease from a high score of 78 in 2005, but above the federal government average of 71.	Consistent with past practice, CFI provided detailed survey data, which will enable NASA to focus its ongoing efforts to improve Earth science data, information, and services provision. Specific attention will be given to ways of maintaining and improving customer satisfaction while also focusing on the potentially conflicting, but very important, goals of increasing the number and types of users and new data types.
FY 2007 Follow-up: Throughout FY 2007, NASA worked with CFI to improve customer satisfaction as described in the FY 2006 Performance Improvement Plan. The EOSDIS customer satisfaction score increased to 75 in FY 2007, again exceeding the federal government average of 72.			
Outcome 3A.4			
Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability.	Yellow	Research results in 2006 enabled significant progress in understanding and modeling the water cycle. However, delays in the development and launch of the Global Precipitation Measurement (GPM) mission and the NPOESS Preparatory Project (NPP) will impact NASA's progress in this science focus area.	NASA will develop an Earth science roadmap based on the mission priorities established in the decadal survey, available in November 2006. The Agency will use the roadmap to re-baseline the support available to GPM by the end of 2006 and provide finalized support by the spring of 2007. Program funding supports the NPP 2009 launch date.
FY 2007 Follow-up: NASA worked towards achieving this as described in the FY 2006 Performance Improvement Plan, and rated the Outcome "Green" for FY 2007.			
Outcome 3A.5			
Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.	Yellow	Cost overruns and technical difficulties delayed the NPOESS Preparatory Project (NPP) mission, which will impact NASA's progress in this science focus area.	Program funding supports the NPP 2009 launch date.
FY 2007 Follow-up: The program funding in question was put in place before the close of FY 2006. However, the 2009 NPP launch date is currently at risk, and this Outcome remains "Yellow" for FY 2007.			
6ESS23 (Outcome 3A.5)			
Complete Operational Readiness Review for the NPOESS Preparatory Project (NPP).	Red	Due to late delivery of the key Visible/Infrared Imager/Radiometer Suite (VIIRS) instrument from a program partner, NASA moved the Operational Readiness Review for NPP to September 2009.	NASA management postponed this review until FY 2008.
FY 2007 Follow-up: The Operational Readiness Review is scheduled for September 2009, as stated under "Why the Measure Was Not Met." The timeframe of FY 2008 reported under "Plans for Achieving the Measure" was incorrect.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2007
6ESS21 (Outcome 3A.7)			
Benchmark the assimilation of observations and products in decision support systems serving applications of national priority. Progress will be evaluated by the Committee on Environmental and National Resources.	Yellow	NASA completed this benchmarking in support of such areas as agricultural efficiency, air quality, aviation, disaster management, and public health. However, the external evaluation was postponed, primarily due to delays related to committee members' schedules.	The National Research Council will finalize its evaluation by spring 2007. Results will be available through *http://aiwg.gsfc.nasa.gov*, and will be addressed in the FY 2007 Performance and Accountability Report.
FY 2007 Follow-up: In 2007, the National Research Council published *Assessment of the NASA Applied Sciences Program*, available at www.nap.edu/catalog.php?record_id=11987.			
6ESS24 (Efficiency Measure)			
Complete all development projects within 110% of the cost and schedule baseline.	Red	The STEREO and AIM missions, scheduled for completion in FY 2006, exceeded 110% of the cost and schedule baselines. After launch vehicle delays, STEREO was launched on October 25, 2006, exceeding the baseline schedule by 25%. The final cost exceeded the baseline by 26%. AIM is currently scheduled for launch in spring 2007 and is expected to exceed both the cost and schedule baselines by approximately 20% due to delays associated with the launch vehicle and the failure of the SOFIE instrument during observatory vibration testing.	NASA will continue to conduct appropriate reviews as the AIM mission progresses toward launch.
FY 2007 Follow-up: NASA launched AIM on April 25, 2007.			
6SSE27 (Outcome 3C.1)			
Successfully launch Dawn spacecraft.	Yellow	NASA delayed the launch of Dawn due to technical difficulties.	Dawn underwent reviews to address technical and cost issues and the launch is currently scheduled for June 2007.
FY 2007 Follow-up: Due to consistently bad weather and technical problems with launch vehicle tracking systems off the coast of Africa, NASA rescheduled the Dawn launch to a September–October timeframe. NASA launched the Dawn mission on September 27, 2007.			
6SSE9 (Outcome 3C.2)			
Successfully demonstrate progress in understanding why the terrestrial planets are so different from one another. Progress toward achieving outcomes will be validated by external expert review.	Yellow	External reviewers deemed all of the evidence presented for this APG as positive. However, since the evidence was based on preliminary results, the external reviewers rated the progress on this goal as less robust than the progress seen in other areas of planetary science.	NASA-funded investigators are participating in the European Space Agency's Venus Express mission. Venus Express, launched in November 2005, arrived at Venus in April and is orbiting the planet, studying its atmosphere in detail. In addition, under the Discovery Program 2006 Announcement of Opportunity, NASA selected for concept study a return to Venus mission. Vesper, the Venus Chemistry and Dynamics Orbiter, proposes to significantly advance understanding of the atmospheric composition and dynamics of Venus, especially its photochemistry. Successful completion of the concept study would allow continuation into a full design effort.
FY 2007 Follow-up: NASA followed the FY 2006 improvement plan as stated. In December 2007, NASA announced the selection of the Gravity Recovery and Interior Laboratory (GRAIL) as the next Discovery mission.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2007
6SSE19 (Outcome 3C.2)			
Successfully demonstrate progress in understanding the character and extent of prebiotic chemistry on Mars. Progress toward achieving outcomes will be validated by external expert review.	Yellow	The lack of direct measurements has limited NASA's progress in this area. While laboratory and field research enabled some progress, direct measurements have not been made since the Viking missions in the 1970s.	The next two Mars missions, Phoenix, to be launched in 2007, and the Mars Science Laboratory, to be launched in 2009, have technology to directly measure organic compounds and potentially elucidate the character and extent of prebiotic chemistry.
FY 2007 Follow-up: NASA followed the FY 2006 improvement plan as stated. The Phoenix Mars Lander launched on August 4, 2007, and will land on Mars in May 2008. The Mars Science Laboratory is on schedule for launch in 2009.			
6SSE20 (Outcome 3C.3)			
Successfully demonstrate progress in searching for chemical and biological signatures of past and present life on Mars. Progress toward achieving outcomes will be validated by external expert review.	Yellow	Although the current missions at Mars are extremely capable and have exceeded expectations, NASA did not design the instrumentation to address this objective.	The next two Mars missions, Phoenix, to be launched in 2007, and the Mars Science Laboratory, to be launched in 2009, have the capability to measure organic compounds and mineralogy to search for chemical and biological signatures of life.
FY 2007 Follow-up: NASA followed the FY 2006 improvement plan as stated. The Phoenix Mars Lander launched on August 4, 2007, and will land on Mars in May 2008. The Mars Science Laboratory is on schedule for launch in 2009.			
6SSE29 (Efficiency Measure)			
Complete all development projects within 110% of the cost and schedule baseline.	Red	The New Horizon and Dawn missions, scheduled for completion in FY 2006, exceeded 110% of the cost baseline. New Horizons, which was launched on time—January 19, 2006—exceeded the cost baseline by 15%. The Dawn mission, which underwent reviews to address technical and cost issues, is expected to exceed the cost baseline by 32% and the schedule baseline by 43% with the launch being delayed to 2007.	NASA will continue to conduct appropriate reviews as the Dawn mission progresses toward launch.
FY 2007 Follow-up: NASA followed the FY 2006 improvement plan as stated. Due to consistently bad weather and technical problems with launch vehicle tracking systems off the coast of Africa, NASA rescheduled the Dawn launch from June 2007 to a September–October 2007 timeframe. NASA launched the Dawn mission on September 27, 2007.			
6UNIV19 (Outcome 3D.1)			
Complete Gamma-ray Large Area Space Telescope (GLAST) Spacecraft Integration and Test (I&T).	Yellow	NASA postponed the GLAST I&T due to electronic parts problems and the need to change release mechanisms on the spacecraft.	Spacecraft I&T is scheduled currently for early FY 2007.
FY 2007 Follow-up: NASA completed the GLAST I&T in March 2007. GLAST remains behind the planned schedule, and NASA rated APG 7UNIV2 (Complete Gamma-ray Large Area Space Telescope (GLAST) Operations Readiness Review (ORR)) "Yellow." GLAST is scheduled for launch in mid-2008.			
6UNIV20 (Outcomes 3D.1, 3D.2, and 3D.3)			
Complete James Webb Space Telescope (JWST) Mission Preliminary Design Review (PDR).	Red	NASA revised the JWST schedule in response to growth in the cost estimate that NASA had identified in FY 2005.	NASA moved the launch date to 2013. As a result, NASA will hold the PDR in March 2008.
FY 2007 Follow-up: The PDR is scheduled for March 2008.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2007
Outcome 3D.2			
Progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects recognized in the present universe.	Yellow	NASA made scientific progress toward this Outcome, but delays in the development and launch of JWST will impact future results.	The James Webb Space Telescope has undergone a comprehensive project replan. The mission is scheduled to launch in 2013.
FY 2007 Follow-up: NASA followed the FY 2006 Improvement Plan as stated. During FY 2007, the Universe Theme completed the PDR for JWST's Integrated Science Instrument Module as planned, and NASA rated the JWST APG (7UNIV4) "Green." The solid progress achieved on JWST during FY 2007, combined with ongoing science results in this Outcome, put NASA on track to achieve 3D.2.			
6UNIV16 (Outcome 3D.2)			
Successfully demonstrate progress in discovering how the interplay of baryons, dark matter, and gravity shapes galaxies and systems of galaxies. Progress toward achieving outcomes will be validated by external expert review.	Yellow	The external review found that NASA made limited progress toward this performance goal. Comments included the opinion that this goal, as written, was too challenging or ambitious, and suggested that it be dropped. Reviewers noted that APGs 6UNIV14 and 6UNIV17 also will yield information about the interplay of baryons, dark matter, and gravity in the evolution of galaxies.	NASA will change this APG in FY 2007.
FY 2007 Follow-up: NASA changed this APG as stated.			
Outcome 3D.3			
Progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems.	Yellow	NASA made scientific progress on this Outcome, but future results will be impacted by delays in the SOFIA and JWST programs. These two new facilities are expected to make significant progress in star formation studies because of their mid- and far-infrared observation capabilities.	See SOFIA (6UNIV18) and JWST (6UNIV20) performance measures.
FY 2007 Follow-up: Progress on SOFIA has improved during FY 2007 and progress on JWST has been very good, resulting in a "Green" rating for this Outcome.			
6UNIV18 (Outcome 3D.3)			
Complete Stratospheric Observatory for Infrared Astronomy (SOFIA) Airworthiness Flight Testing.	Red	NASA chartered a review in March 2006 to document the status of the SOFIA Program and to identify and analyze options. NASA determined the most appropriate course of action is to continue the SOFIA Program with significant program restructuring, including transferring the direct management of SOFIA's airborne system (aircraft and telescope) development and extensive flight testing to Dryden Flight Research Center.	NASA will transfer the SOFIA airborne system to DFRC in early 2007 to initiate the flight test program. An operational readiness review will follow completion of this extensive flight test program in 2010.
FY 2007 Follow-up: The program team transferred SOFIA to Dryden Flight Research Center and the program is making anticipated progress. The equivalent of "airworthiness flight testing" is scheduled for 2010, as reported in the FY 2006 Performance Improvement Plan.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2007
Outcome 3D.4			
Progress in creating a census of extra-solar planets and measuring their properties.	Yellow	NASA made scientific progress on the Outcome, but delays in the development and deployment of next generation missions will impact further results.	Kepler I&T is scheduled to begin in June 2007, with a launch readiness date of November 2008. NASA deferred the Space Interferometry Mission (SIM) beyond the budget planning period.
FY 2007 Follow-up: Kepler I&T began in September 2007. The launch readiness date is now February 2009. This Outcome is rated "Yellow" again in FY 2007, with the following explanation of the shortfall: Performance in this Outcome continues to be a concern due primarily to the division's inability to ramp-up flight developments in previously planned planet-finding and characterizing missions. Science progress is good, but the scale of investments needed to start new missions, coupled with the division's decreasing top line and other significant commitments, have meant that earlier envisioned missions have slipped outside the budget horizon. The Astrophysics Theme solicited mission concept studies for planet-finding and characterizing missions that would be more affordable. The proposals, which were due in November 2007, will be evaluated in FY 2008.			
6UNIV5 (Outcome 3D.4)			
Progress in creating a census of extra-solar planets and measuring their properties.	Yellow	NASA made scientific progress on the Outcome, but delays in the development and deployment of next generation missions will impact further results.	Kepler I&T is scheduled to begin in June 2007, with a launch readiness date of November 2008. NASA deferred the Space Interferometry Mission (SIM) beyond the budget planning period.
FY 2007 Follow-up: Kepler I&T began in September 2007. The launch readiness date is now February 2009. The external expert review gave this area a "Green" rating for FY 2007 due to significant science progress in current census activities.			
6UNIV21 (Outcome 3D.4)			
Begin Kepler Spacecraft Integration and Test (I&T).	Yellow	Inefficiencies, particularly with regard to work on the spacecraft's photometer, caused delays and cost impacts for the Kepler project and an inability to maintain the previous launch schedule of June 2008.	Kepler I&T is currently scheduled to begin in June 2007, with a launch readiness date of November 2008.
FY 2007 Follow-up: Kepler I&T began in September 2007.			
6UNIV25 (Efficiency Measure)			
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	Yellow	NASA reduced the time necessary to award 80% of NRA grants by 2.5% from FY 2005 to FY 2006, missing the 5% target.	The Science Mission Directorate will continue to make efforts to reduce processing times and expects to meet this APG assuming no changes in procurement requirements or funding calendar.
FY 2007 Follow-up: The Universe Theme achieved its FY 2007 goal of completing 80% of grant selections within 219 days of the proposal due date. By achieving a timeframe of 196 days, the Universe Theme improved the time from proposal to selection by 15 percent over FY 2006, exceeding the 5 percent required by the APG.			
Aeronautics Research			
6AT14 (Outcome 3E.1)			
Complete Aviation Safety Program restructuring activities in order to focus research efforts more precisely on the Nation's aviation safety challenges for the Next Generation Air Transportation System (2025) and beyond.	Yellow	The Aviation Safety Program delayed approval of one of its four projects: The Integrated Resilient Aircraft Controls, which develops capabilities to reduce (or eliminate) aircraft loss-of-control accidents and ensure safe flight under off-nominal conditions.	Program management expects final approval of this project during the first quarter of FY 2007.
FY 2007 Follow-up: The Aviation Safety Program moved the Integrated Resilient Aircraft Controls Project into implementation in May 2007, and the project conducted research in FY 2007 as anticipated.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2007
6AT15 (Outcome 3E.1)			
Utilizing a competitive peer-reviewed selection process, determine the research portfolio and partnerships to enable advances in the Aviation Safety thrust areas (Integrated Intelligent Flight Deck Technologies, Integrated Vehicle Health Management, Integrated Resilient Aircraft Controls, and Aircraft Aging and Durability).	Yellow	The Aviation Safety Program delayed approval of one of its four projects: The Integrated Resilient Aircraft Controls, which develops capabilities to reduce (or eliminate) aircraft loss-of-control accidents and ensure safe flight under off-nominal conditions.	Program management expects final approval of this project during the first quarter of FY 2007.
FY 2007 Follow-up: The Aviation Safety Program moved the Integrated Resilient Aircraft Controls Project into implementation in May 2007, and the project conducted research in FY 2007 as anticipated.			
6AT16 (Outcome 3E.2)			
Complete Airspace Systems Program restructuring activities in order to align research efforts to address the Joint Planning and Development Office's Next Generation Air Transportation System (NGATS) capability requirements for 2025.	Yellow	The Airspace Systems Program delayed approval of a portion of its project portfolio (the NGATS Air Traffic Management Airportal project) that will develop capabilities to increase throughput in terminal and airport domains enabling NGATS.	The approval of the NGATS Air Traffic Management Airportal Project is expected in the first quarter of FY 2007.
FY 2007 Follow-up: The Airspace Systems Program moved the NGATS Air Traffic Management Airportal Project into implementation in May 2007, allowing the program to achieve its APGs in FY 2007.			
6AT17 (Outcome 3E.2)			
Utilizing a competitive peer-reviewed selection process, determine the research portfolio and partnerships to enable advances in the Airspace Systems thrust areas (Next Generation Air Transportation Systems and Super Density Surface Management.)	Yellow	The Airspace Systems Program delayed approval of a portion of its project portfolio (the NGATS Air Traffic Management Airportal project) that will develop capabilities to increase throughput in terminal and airport domains enabling NGATS.	The approval of the NGATS Air Traffic Management Airportal Project is expected in the first quarter of FY 2007.
FY 2007 Follow-up: The Airspace Systems Program moved the NGATS Air Traffic Management Airportal Project into implementation in May 2007. During FY 2007, the project selected three NASA Research Announcement proposals, completing this APG and allowing the program to meet its performance targets for FY 2007.			
Exploration Systems			
6HSRT9 (Outcome 3F.1)			
Complete renal stone countermeasure development.	Yellow	NASA researchers did not complete the renal stone countermeasure study.	Data collection from the final subject is scheduled for March 2007.
FY 2007 Follow-up: By spring 2007, 20 test subjects had participated in the renal stone countermeasure study, giving NASA enough data to conduct the final analysis. See the Outcome narrative for 7HSRT1 under Sub-goal 3F for more information.			

<table>
<tr><th>Description</th><th>Rating</th><th>Why the Measure Was Not Met</th><th>Plans for Achieving the Measure in FY 2007</th></tr>
<tr><td colspan="4">Space Operations</td></tr>
<tr><td colspan="4">Outcome 1.1</td></tr>
<tr><td>Assure the safety and integrity of the Space Shuttle workforce, systems and processes, while flying the manifest.</td><td>Yellow</td><td>The Space Shuttle Program reported and investigated three major incidents in FY 2006. Two Type-B mishaps include damage to Discovery's robotic manipulator arm caused while crews were servicing the Shuttle in the Orbiter Processing Facility hangar, and damage to Atlantis' coolant loop accumulator due to over-pressurization. NASA also reported a personnel injury at Kennedy Space Center's Launch Complex 39A.</td><td>NASA convened a mishap investigation board for each incident. The boards are on schedule to complete their investigations and deliver their final reports in FY 2007.</td></tr>
<tr><td colspan="4">FY 2007 Follow-up: The mishap investigation boards have completed their investigations and released their final reports to the Program Office on April 18, 2007, and corrective actions are in work.</td></tr>
<tr><td colspan="4">6SSP1 (Outcome 1.1)</td></tr>
<tr><td>Assure the safety and integrity of the Space Shuttle workforce, systems and processes, while flying the manifest.</td><td>Red</td><td>The Space Shuttle Program reported and investigated three major incidents in FY 2006. Two Type-B mishaps include damage to Discovery's robotic manipulator arm caused while crews were servicing the Shuttle in the Orbiter Processing Facility hangar, and damage to Atlantis' coolant loop accumulator due to over-pressurization. NASA also reported a personnel injury at Kennedy Space Center's Launch Complex 39A.</td><td>NASA convened a mishap investigation board for each incident. The boards are on schedule to complete their investigations and deliver their final reports in FY 2007.</td></tr>
<tr><td colspan="4">FY 2007 Follow-up: The mishap investigation boards have completed their investigations and released their final reports to the Program Office on April 18, 2007, and NASA is conducting corrective actions.</td></tr>
<tr><td colspan="4">6ISS3 (Outcome 2.1)</td></tr>
<tr><td>Provide 80 percent of FY 2006 planned on-orbit resources and accommodations to support research, including power, data, crew time, logistics and accommodations.</td><td>Yellow</td><td>NASA was unable to meet the original goal of regularly scheduled Shuttle flights throughout FY 2006 due to foam issues on the external tank. While these issues were resolved, NASA did not launch the Shuttle until July 2006—10 months after the start of FY 2006. Shuttle flight delays reduced actual upmass and volume capabilities.</td><td>Shuttle schedules have been adjusted for FY 2007, but these schedules always are subject to change as circumstances warrant.</td></tr>
<tr><td colspan="4">FY 2007 Follow-up: Using Russian Soyuz and Progress flights to the ISS, NASA met this performance measure within FY 2006. The Space Operations Mission Directorate upgraded this measure to "Green" in September 2006, but NASA did not capture the change in the FY 2006 PAR. Performance measure 6ISS3 will be rated "Green" in trending information beginning with this report.</td></tr>
<tr><td colspan="4">Cross-Agency Support Programs</td></tr>
<tr><td colspan="4">6ED4 (Outcome ED-1)</td></tr>
<tr><td>Complete a retrospective longitudinal study of student participants to determine the degree to which participants entered the NASA workforce or other NASA-related career fields.</td><td>Yellow</td><td>NASA did not complete the retrospective study of student participants' entry into the NASA workforce due to technical issues directly related to the large population of potential survey respondents.</td><td>NASA is adjusting the survey instrument and protocol and the survey will be completed in FY 2007.</td></tr>
<tr><td colspan="4">FY 2007 Follow-up: As a result of funding reductions and programmatic reprioritization, NASA canceled this APG.</td></tr>
</table>

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2007
6ED7 (Outcome ED-1)			
Provide approximately 50 grants to enhance the capability of approximately 25 underrepresented and underserved colleges and universities to compete for and conduct basic or applied NASA-related research. (APG revised: grants reduced from 350 to 50 based on FY 2006 Appropriation.)	Yellow	NASA exceeded the number of institutions during FY 2006, but did not achieve the targeted number of grant awards.	NASA's FY 2007 budget includes funds necessary to achieve future goals.
FY 2007 Follow-up: For FY 2007, NASA increased the targeted number of grants from 50 to 95 (see APG 7ED3). This target was exceeded by 44 grants (see Outcome ED-1 narrative) due to reprioritization of funding and an increased number of minority institutions that successfully competed for other NASA education awards.			
6ED12 (Efficiency Measure)			
Peer review and competitively award at least 80%, by budget, of research projects.	Red	NASA could not complete this performance measure due to Congressionally directed, site-specific projects which accounted for approximately 50% of the Education Program's appropriation.	NASA has briefed relevant Congressional committee staff regarding the impact of Congressional interest items. NASA's FY 2007 program plan will achieve the target of 80% competitive awards unless Congressionally directed appropriations exceed 20% of the budget.
FY 2007 Follow-up: The intent of this APG had been for NASA to use the Higher Education budget for research projects, but it was not explicitly stated in the APG. Education met the FY 2007 performance target of 85% (see Efficiency Measure, 7ED12).			

PART Status and Improvement Plans

PART is an evaluation tool developed by OMB to assess the effectiveness of federal programs. It provides a rigorous and interactive method to assess program planning, management, and performance toward quantitative, outcome-driven goals. NASA submits one-third of the Agency's program portfolios, or Themes, to OMB each year, resulting in a complete Agency assessment approximately every three years.

The PART assessments ask approximately 25 questions about a Theme's performance and management. Based on answers provided by the Theme, OMB applies a percentile score that yields the following ratings:

- **Effective (85–100%):** This is the highest rating a program can achieve. Programs rated Effective set ambitious goals, achieve results, are well-managed and improve efficiency.
- **Moderately Effective (70–84%):** In general, a program rated Moderately Effective has set ambitious goals and is well-managed. Moderately Effective programs likely need to improve their efficiency or address other problems in the programs' design or management in order to achieve better results.
- **Adequate (50–69%):** This rating describes a program that needs to set more ambitious goals, achieve better results, improve accountability or strengthen its management practices.
- **Ineffective (0–49%):** Programs receiving this rating are not using tax dollars effectively. Ineffective programs have been unable to achieve results due to a lack of clarity regarding the program's purpose or goals, poor management, or some other significant weakness.
- **Results Not Demonstrated:** This rating indicates that a program has not been able to develop acceptable performance goals or collect data to determine whether it is performing.

The table below summarizes the FY 2007 PART status and improvement plans for each Theme organized by Mission Directorate. Additional discussion of PART plans is included under "Program Assessment Rating Tool (PART)" within the Theme sections of NASA's FY 2009 Budget Estimates. For detailed listings of NASA's program measures and assessments or for more on PART, please visit OMB's PART Web site at ExpectMore.gov.

Science Mission Directorate			
Theme: Earth–Sun System			
Last Year Assessed: 2005		**Rating:** Moderately Effective	
Program Purpose and Design: 100%	**Strategic Planning:** 100%	**Program Management:** 84%	**Program Results/ Accountability:** 74%
Rating Rationale: The Earth–Sun System Theme, which included both Earth Science and Heliophysics, was subject to a PART review in 2005 and received a "Moderately Effective" rating (score of 84%). The assessment found that this program is well-defined, with a clear purpose, and has an effective strategic planning process, aligning it well to NASA's mission. A key opportunity to increase effectiveness lies in continuing to improve efficiencies in mission operations, in reducing science data validation periods and in making NASA research available to a broader community. In FY 2008, the Earth-Sun System is separated into two distinct themes: Earth Science, which will undergo its next PART review during the year; and Heliophysics, which will be reviewed at a later date.			
Previous Year Assessed: None		*Rating: N/A*	
Program Purpose and Design: N/A	*Strategic Planning: N/A*	*Program Management: N/A*	*Program Results/ Accountability: N/A*
Program Improvement Plan:		**Actions as of Fall 2007:**	
• Report for major missions on: estimated mission lifecycle cost upon entering development; key schedule milestones associated with each mission phase for those missions formally approved for formulation; mission cost and schedule progress achieved in each phase before entering the next; and any plans to re-baseline lifecycle cost and schedule.		• Action taken; expected completion date 12/31/2009: NASA provided its initial baseline cost/schedule report to OMB on its spaceflight projects with an estimated lifecycle of $250M or above, in August 2007. This was per NSPD 49 implementation. Since then NASA has provided quarterly updates against this baseline. Several new requirements have been added to the Agency from the Congress. Further, there have been lessons learned as a result of the reporting process. NASA will update its process in light of these two things by March 2008.	
• Assess the obstacles to improving the hand-off of NASA's research and development to other federal agencies and implement to the extent possible organizational and system fixes to ensure results.		• Completed: NASA and its partners have approaches in place to transition mature NASA research and development to other federal agencies. For example, NASA and NOAA have recently signed a Research and Operations Agreement and have identified a broad range of Earth science activities that are good candidates for infusion into future NOAA operational activities. As another example, NASA and USGS are working together with the OSTP to complete a strategy to assure continuity of Landsat-type data beyond LDCM.	

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<tr><td colspan="2">• Assure that the priorities developed in the National Research Council’s forthcoming Earth science decadal survey are reflected to the extent feasible in the program’s portfolio.</td><td colspan="2">• <u>Completed:</u> The NRC’s Earth Science decadal survey expressed support for NASA’s Earth Science missions currently in development and recommended priorities for new missions. These priorities are reflected in the FY 2009 President’s Budget, which includes increased funding in the current budget horizon for NASA to begin formulation of the first four missions defined, and, depending on the outcome of the formulation activities, to begin development of the most mature of the missions.</td></tr>
<tr><td colspan="4">Theme: Solar System Exploration</td></tr>
<tr><td colspan="2">Last Year Assessed: 2006</td><td colspan="2">Rating: Effective</td></tr>
<tr><td>Program Purpose and Design: 100%</td><td>Strategic Planning: 100%</td><td>Program Management: 91%</td><td>Program Results/ Accountability: 74%</td></tr>
<tr><td colspan="4">Rating Rationale: The Planetary Science Theme was subject to a PARTs review in both 2003 and 2006 and received an "Effective" rating both times. The assessment found that this program is well-defined and well-managed, with a clear purpose and direct ties to NASA's mission. The program has relevant research priorities, that reflect the priorities of the planetary science community. Further, that the program applies lessons learned from past mission failures.</td></tr>
<tr><td colspan="2">Previous Year Assessed: 2003</td><td colspan="2">Rating: Effective</td></tr>
<tr><td>Program Purpose and Design: 100%</td><td>Strategic Planning: 100%</td><td>Program Management: 100%</td><td>Program Results/ Accountability: 74%</td></tr>
<tr><td colspan="2">Program Improvement Plan:
• Report for major missions on: estimated mission lifecycle cost upon entering development; key schedule milestones associated with each mission phase for those missions formally approved for formulation; mission cost and schedule progress achieved in each phase before entering the next; and any plans to re-baseline lifecycle cost and schedule.
• NASA will explore options for modifying the current approach to its competed planetary science programs to allow for a healthy mix of missions of various size and scope, potentially including missions to the outer planets.
• NASA will define its requirements, approach, projected schedule, and budget profile (with proposed offsets) for Deep Space Network upgrades, in time for the FY 2009 budget submit to OMB.</td><td colspan="2">Actions as of Fall 2007:
• <u>Action taken; expected completion date 12/31/2009:</u> NASA provided its initial baseline cost/schedule report to OMB on its spaceflight projects with an estimated lifecycle of $250M or above, in August 2007. This was per NSPD 49 implementation. Since then NASA has provided quarterly updates against this baseline. Several new requirements have been added to the Agency from the Congress. Further, there have been lessons learned as a result of the reporting process. NASA will update its process in light of these two things by March 2008.
• <u>Completed:</u> The planetary science program now includes an outer planets flagship mission. After evaluating science, technical risk, and cost considerations, NASA selected Europa, Ganymede, and Titan mission concepts for further definition study. The final selection of mission target will be made in FY08. An accelerated pre-Phase A effort which leverages the past two years of study will then be initiated, culminating in a Mission Concept Review in 2008 and start of formulation activities in early 2009.
• Action taken; expected 12/31/2009: This action is expected to move to the Space and Flight Support Theme and will not be completed until the FY 2010 budget submission.</td></tr>
<tr><td colspan="4">Theme: Astronomy and Astrophysics Research</td></tr>
<tr><td colspan="2">Last Year Assessed: 2007</td><td colspan="2">Rating: Adequate</td></tr>
<tr><td>Program Purpose and Design: 100%</td><td>Strategic Planning: 100%</td><td>Program Management: 75%</td><td>Program Results/ Accountability: 47%</td></tr>
<tr><td colspan="4">Rating Rationale: The Astrophysics Theme received a PART rating of "Adequate" in 2007. The assessment found that the program continues to return outstanding, groundbreaking scientific results in support of the community's scientific research priorities. However, significant concern regarding flight program cost and schedule performance was noted.</td></tr>
<tr><td colspan="2">Previous Year Assessed—Structure and Evolution of the Universe: 2004</td><td colspan="2">Rating: Effective</td></tr>
<tr><td>Program Purpose and Design: 100%</td><td>Strategic Planning: 100%</td><td>Program Management: 91%</td><td>Program Results/ Accountability: 84%</td></tr>
<tr><td colspan="2">Program Improvement Plan:
• Report for major missions on: estimated mission lifecycle cost upon entering development; key schedule milestones associated with each mission phase for those missions formally approved for formulation; mission cost and schedule progress achieved in each phase before entering the next; and any plans to re-baseline lifecycle cost and schedule.</td><td colspan="2">Actions as of Fall 2007:
• <u>Action taken; expected completion date 12/31/2009:</u> NASA provided its initial baseline cost/schedule report to OMB on its spaceflight projects with an estimated lifecycle of $250M or above, in August 2007. This was per NSPD 49 implementation. Since then NASA has provided quarterly updates against this baseline. Several new requirements have been added to the Agency from the Congress. Further, there have been lessons learned as a result of the reporting process. NASA will update its process in light of these two things by March 2008.</td></tr>
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• Improving flight project cost and schedule performance by changing mission plans, scope, partners, and management where appropriate.	• Action taken; expected completion date 12/31/2009: SMD has adopted a new management approach featuring control of cost through scope changes and other methods that allow missions to be managed within cost caps while maintaining risk at acceptable levels. A key focus is on ensuring that project budget and scope are aligned early in the formulation phase, as was recently addressed for the MMS mission. Other efforts include the pursuit of new partnerships and expanded cost-sharing with existing partners for SOFIA and other programs.
• Improving performance of partners (including grantees, contractors, cost-sharing partners, and other government partners) towards achieving cost and schedule goals.	• Action taken; expected completion date 12/31/2009: In order to improve contract management, the Astrophysics Division has instituted Earned Value Management (EVM) reporting for all contractors on major missions. Other methods have also been employed; these include the reallocation of a portion of the Kepler prime contractor's fee to be awarded contingent on the achievement of specific performance measures.
• Establishing means to maximize return on available resources for flight and research projects as well as metrics to measure efficiencies gained.	• Action taken; expected completion date 12/31/2009: In the FY09 budget, SMD has placed an emphasis on maximizing near-term opportunities in the Explorer, Sounding Rockets, and Balloon programs to strengthen the science community. SMD's new cost control ethic is also a part of this effort. Flagship missions have been added to the senior review process normally reserved for smaller missions to assess the value of continuation after completion of prime missions. SMD is also evaluating efficiency metrics in preparation for the 2008 PART process.
• Making grantee annual performance data available on the NASA web site.	• Action taken; expected completion date 6/30/2009: The NASA website currently indicates when grantees' annual progress reports have been reviewed and approved, a requirement for release of the next year's funding increment. The Agency is investigating systems for posting grant results; further action will be taken consistent with the pending OSTP requirements regarding standardization of progress reports.

Aeronautics Research Mission Directorate

Theme: Aeronautics Technology

Last Year Assessed: 2007		**Rating:** Effective	
Program Purpose and Design: 100%	**Strategic Planning:** 100%	**Program Management:** 91%	**Program Results/ Accountability:** 78%

Rating Rationale: In FY 2007, the Aeronautics Technology Theme received a PART rating of "Effective" (the highest rating possible). The assessment found that this program has a clear purpose, is well designed, and focuses on research that is appropriate for government, consistent with the National Aeronautics R&D Policy, and has a comprehensive set of ambitious but realistic performance measures.

Previous Year Assessed: 2004		*Rating: Moderately Effective*	
Program Purpose and Design: 100%	*Strategic Planning: 100%*	*Program Management: 73%*	*Program Results/ Accountability: 67%*

Program Improvement Plan:	**Actions as of Fall 2007:**
• Conduct an annual review by experts from outside the program, FFRDC, and/or from other government agencies to assess the restructured Aeronautics Research Mission Directorate program's quality of research and alignment with national priorities. The review will determine how well the program is aligned with the stated objectives of the NASA Strategic Plan and the National Aeronautics Research and Development Policy, identify any gaps, and assess the quality of the research. ARMD will setup the charter and validation of the annual review to meet the standards of Independent Evaluation (to be completed in January 2008).	• Completed: Independent annual reviews of ARMD Aviation Safety, Fundamental Aeronautics, Airspace Systems, and Aeronautics Test programs were completed by December 2007. Other government agencies represented on the independent review panels were the Federal Aviation Administration, National Transportation Safety Board, National Oceanic and Atmospheric Administration, Department of Defense, U.S. Army, U.S. Air Force, U.S. Navy, and the National Science Foundation.
• Complete the independent assessment of NASA's fundamental aeronautics research, contracted to the National Research Council of the National Academies—study, titled "Evaluation of NASA's Fundamental Aeronautics Research Program." (To be released publicly June 2008; preliminary report due in March 2008.)	• Action taken; expected completion date 4/01/08: All meetings conducted by the NRC regarding the independent assessment of NASA's fundamental aeronautics research were completed in 2007. Preliminary report is estimated for release in March 2008.
• Ensure that NASA's aeronautics research is in alignment with the research needs of the Next Generation Air Transportation System (NextGen) as defined in the NextGen Research and Development Plan and Integrated Work Plan.	• Completed: ARMD supports 84 of the 163 R&D needs in the NextGen R&D Plan. NASA contributed to all JPDO planning products, including the Concept of Operations, the Enterprise Architecture, the R&D Plan, & the Integrated Work Plan. NASA/JPDO senior management held the first two of ongoing quarterly review meetings. NASA worked with the FAA and JPDO to elevate and coordinate environmental and safety R&D. NASA wrote a white paper describing its support to NextGen (at http://www.aeronautics.nasa.gov).

• Under the leadership of PA&E, benchmark R&T practices in performance and budget integration and performance measurement (i.e. efficiencies and evaluations) with other government agencies.	• Action taken; expected completion date 12/31/09: This will be an on-going set of activities with participation of multiple NASA organizations. PA&E has conducted an initial survey of other federal agencies' budget and performance documentation to identify parties of interest for benchmarking. Planned benchmarking activities in the first quarter of FY08 are with the Nat'l Cancer Institute's Off. of Science Planning and Assessment, the Off. of Director of Nat'l Intelligence and Off. of Strategic Planning & Performance Mgmt at Treasury.

Exploration Systems Mission Directorate

Theme: Constellation Systems

Last Year Assessed: 2006		**Rating:** Adequate	
Program Purpose and Design: 100%	**Strategic Planning:** 78%	**Program Management:** 75%	**Program Results/ Accountability:** 40%
Rating Rationale: The Constellation Systems Theme received a FY 2006 PART rating of "Adequate." The rating reflected a strong ability to convey the program's purpose and design, combined with a low rating in program accountability due to a lack of independent review planning at that time, as well as an inability to demonstrate performance and efficiencies due to the immaturity of the program, which was still in formulation at that time.			
Previous Year Assessed: None		*Rating: N/A*	
Program Purpose and Design: N/A	*Strategic Planning: N/A*	*Program Management: N/A*	*Program Results/ Accountability: N/A*

Program Improvement Plan:	**Actions as of Fall 2007:**
• Conduct planned internal reviews.	• Action taken; expected completion date 9/30/2008: In Q2 of FY07, Constellation progressed through all of the Constellation projects SRR's (CLV, CEV, Mission Operations, Ground Operations, and EVA). The next internal reviews are SDR (Systems Definition Review) scheduled to begin Q4 of FY07 and finish by Q3 of FY08 will all projects. PDR (Preliminary Design Review) for the Constellation Program is scheduled for completion by Q4 of FY08.
• Plan and conduct comprehensive external program review.	• Action taken; expected completion date 9/30/2008: NASA has implemented a plan for external evaluation of the Constellation Systems of sufficient independence, scope, and quality with the Standing Review Boards evaluating NASA's performance throughout the design life cycle or the Program and projects. In addition, the National Academy of Science is being considered as a potential external review body however nothing has been implemented to date.
• Develop and baseline metrics for transition of activities and assets from Space Operations to Constellations Systems.	• Action taken; expected completion date 9/30/2008: Baseline metrics (i.e., cost, schedule, throughput, effectiveness) for transition of activities & assets from Space Operations to Constellations Systems are under development. The Program is working closely w/ SOMD to ensure metrics are captured.

Theme: Advanced Capabilities

Last Year Assessed: 2007		**Rating:** Adequate	
Program Purpose and Design: 100%	**Strategic Planning:** 90%	**Program Management:** 75%	**Program Results/ Accountability:** 45%
Rating Rationale: The 2007 PART review of the Advanced Capabilities Theme's constituent programs, Exploration Technology Development and Human Research, resulted in an rating of "Adequate." The evaluation validated that the programs were focused on providing knowledge and technology to enable future human exploration missions beyond low Earth orbit. The Advanced Capabilities Theme did not receive a higher rating largely due to the following reasons: the Theme had not received independent evaluations of sufficient scope and quality; and the Theme had not demonstrated sufficient efficiencies. Note: Prior to the FY 2008 Budget Estimates, the work associated with Advanced Capabilities was budgeted under two Themes, Human Systems Research and Technology (HSRT) and Exploration Systems Research and Technology (ESRT). HSRT underwent PART assessment in 2005 (see below); ESRT was not assessed.			
Previous Year Assessed (HSRT): 2005		*Rating (HSRT): Adequate*	
Program Purpose and Design (HSRT): 100%	*Strategic Planning (HSRT): 100%*	*Program Management (HSRT): 91%*	*Program Results/ Accountability (HSRT): 48%*

Program Improvement Plan:	**Actions as of Fall 2007:**
• Enter into an arrangement with the National Research Council for an independent assessment of NASA's restructured Exploration Technology Develop Program (ETDP) to determine how well the program is aligned with the stated objectives of the Vision for Space Exploration and assess the quality of the research. ETDP will report, and incorporate NRC recommendations into the Exploration Technology Development Program.	• Action taken; expected completion date 9/30/2008: The Aeronautics and Space Engineering Board of the National Research Council (NRC) has formed a committee to perform an independent assessment of NASA's restructured Exploration Technology Development Program (ETDP). Details of the committee charter and scope of work can be found at: http://www8.nationalacademies.org/cp/ projectview.aspx?key=48849. The NRC plans to issue an interim report of its findings in March 2008.

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- Establish an ongoing process to perform independent retrospective evaluations of the quality of Human Research Program (HRP). Conduct an independent evaluation for HRP to demonstrate the new process.
- Establish means to maximize return on available resources, metrics to measure efficiencies gained, and demonstrate improved efficiencies for Space Radiation Research Facility.
- Under the leadership of PA&E, benchmark R&T practices in performance and budget integration and performance measurement (i.e., efficiencies and evaluations) with other government agencies.

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- Action taken; expected completion date 9/30/2008: The Human Research Program has reviewed or is in the process of reviewing all the directed research projects using Non-Advocate Review Panels. The Institute of Medicine of the National Academies will review the "NASA Research on Human Health Risks" starting January 2008 (anticipated completion date June 2008). Independent Program Implementation Review will be completed August 2008.
- Action taken; expected completion date 12/31/2010: NASA established an efficiency baseline for measurement on the research throughput of the Space Radiation Research Facility in 2006. There were efficiencies seen in 2007 as recorded by the PART metric. NASA will continue to strive for efficiencies in this area and will maintain this as a performance improvement action for several years as the Agency assures this is tracked and achieved.
- Action taken; expected completion date 12/31/2009: This will be an on-going set of activities with participation of multiple NASA organizations. PA&E has conducted an initial survey of other federal agencies' budget and performance documentation to identify parties of interest for benchmarking. Planned benchmarking activities in the first quarter of FY08 are with the National Cancer Institute's Office of Science Planning and Assessment, the Office of Director of National Intelligence and Office of Strategic Planning and Performance Management at Treasury.

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<tr><td colspan="4">Space Operations Mission Directorate</td></tr>
<tr><td colspan="4">Theme: Space Shuttle</td></tr>
<tr><td colspan="2">Last Year Assessed: 2005</td><td colspan="2">Rating: Adequate</td></tr>
<tr><td>Program Purpose and Design: 100%</td><td>Strategic Planning: 89%</td><td>Program Management: 50%</td><td>Program Results/ Accountability: 33%</td></tr>
<tr><td colspan="4">Rating Rationale: The Space Shuttle Theme received FY 2005 PART rating of "Adequate", as an update to its original FY 2003 rating of "Results Not Demonstrated." The original rating was received while the Space Shuttle was still on its path to a return to flight in the aftermath of the Columbia accident. The reasons for the updated rating include a well-defined purpose and system design, benefiting from strong strategic planning. To perform beyond an "Adequate" rating, improvements are required in the areas of program management and program results. The Space Shuttle Program is taking steps to improve programmatic and financial management, and identify the program benefits from several successful missions, including return to ISS assembly in September 2006.</td></tr>
<tr><td colspan="2">Previous Year Assessed: 2003</td><td colspan="2">Rating: Results Not Demonstrated</td></tr>
<tr><td>Program Purpose and Design: 80%</td><td>Strategic Planning: 44%</td><td>Program Management: 88%</td><td>Program Results/ Accountability: 7%</td></tr>
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Program Improvement Plan:

- Return the Shuttle safely to flight and continue using it to support the Space Station.
- Develop outcome-oriented short and long-term measures for the Space Shuttle Program.
- Plan to retire the Shuttle by the end of the decade, when its role in assembling the International Space Station is complete.

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Actions as of Fall 2007:

- Action taken; expected completion date 9/30/2010: Between July 2005 and December 2007, the Space Shuttle Program has returned to flight and successfully completed seven flights to the International Space Station. The program recovered from significant hail damage while STS-117 was on the launch pad and succeeded in flying three missions in 2007. Program performance since return to flight continues to support the completion of the International Space Station by no later than September 30, 2010.
- Completed: The Space Shuttle Program has developed outcome-oriented long- and short-term measures. These may be found in the metric section of this PART review and in the NASA fiscal years 2006 and 2007 annual performance plans.
- Completed: Plans are in place. Revised ISS assembly sequence approved by international partners. Results from Return to Flight missions STS-114 and STS-121 support the manifest for completing ISS assembly and, potentially, a fifth servicing mission to Hubble by 2010. Human Spaceflight Transition Plan complete. Transition and integration control boards established within the Shuttle program and at the Mission and Agency level to coordinate transition activities between Shuttle and the Constellation Program.

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• Develop outcome-oriented measures to assess the effectiveness of the transition between the Space Shuttle and exploration programs.		• Action taken; expected completion date 3/31/2008: NASA continues to track (through metrics) the sharing and disposition of facilities, property, and capabilities no longer needed for the safe completion of the SSP manifest, and to coordinate those activities across the Space Shuttle, ISS, and Constellation programs through program and HQ-level control boards to ensure best value for the Agency. An update to the Agency-level Transition Plan will be released in the second quarter of FY 2008 and will include updates to transition measures.	
• Improve NASA's financial management system to eliminate the agency's four ongoing material weaknesses and to comply with the Federal Financial Management Improvement Act.		• Inactive: OMB to transfer this plan out of the Space Shuttle reporting section. The intent of this performance improvement plan was recaptured by the Agency and OMB in the 2006 review of the Integrated Enterprise Management Program. It will no longer be tracked under the Space Shuttle Program.	
Theme: International Space Station			
Last Year Assessed: 2004		**Rating:** Moderately Effective	
Program Purpose and Design: 100%	**Strategic Planning:** 100%	**Program Management:** 88%	**Program Results/ Accountability:** 47%
Rating Rationale: The International Space Station Program received an FY 2004 PART rating of "Moderately Effective." The assessment found that the program had greatly improved its management, particularly in the area of cost control and had effectively managed its budget reserves. Further concern was expressed that the ISS was extremely dependent on the Space Shuttle. The original rating was due to delays in meeting the goals of the ISS Program in the aftermath of the Columbia accident. The ISS program continues to address the concern of dependency on the Space Shuttle. The program will receive a full PART review in calendar year 2008.			
Previous Year Assessed: 2003		*Rating: Results Not Demonstrated*	
Program Purpose and Design: 100%	*Strategic Planning: 78%*	*Program Management: 100%*	*Program Results/ Accountability: 26%*
Program Improvement Plan:		**Actions as of Fall 2007:**	
• Develop alternatives to the Space Shuttle for resupplying the International Space Station.		• Action taken; expected completion date 7/01/2010: The ISS Program has negotiated balance of contribution agreements with ESA and JAXA to provide cargo delivery services to the ISS. NASA has also purchased cargo delivery services from the Russians through 2011. NASA's primary cargo acquisition strategy, which is still in development, is to purchase domestic commercial cargo capabilities in the post-Shuttle timeframe. NASA is also developing a backup strategy to purchase Partner capabilities in the event domestic providers are not available.	
• Hold program managers accountable for cost, schedule, and performance results and demonstrate that the program is achieving its annual performance goals.		• Completed: SOMD specific program management practices have been in place for several years that incorporate leading industry and government practices. Program management practices are reviewed quarterly. The ISS Program monitors contractor and International Partners progress, technical performance, actions, risk, cost, and schedule through regularly scheduled unilateral and multi-lateral reviews, audits, technical interchange meetings, boards, and panels.	
Theme: Space and Flight Support			
Last Year Assessed: 2007		**Rating:** Moderately Effective	
Program Purpose and Design: 100%	**Strategic Planning:** 100%	**Program Management:** 88%	**Program Results/ Accountability:** 61%
Rating Rationale: The Space and Flight Support (SFS) Theme's 2007 PART rating of "Moderately Effective" is an improvement over its original FY 2004 PART rating of "Adequate." The SFS Theme continues to meet existing NASA needs such as reliable communication and navigation services for space missions, safe and cost-effective access to space on commercial launch vehicles, and rocket testing for current and future programs. Steps that were taken to improve included the increased use of independent assessments and the development of relevant performance measures that will provide the indication if program outcomes are being met.			
Previous Year Assessed: 2004		*Rating: Adequate*	
Program Purpose and Design: 100%	*Strategic Planning: 67%*	*Program Management: 88%*	*Program Results/ Accountability: 45%*
Program Improvement Plan:		**Actions as of Fall 2007:**	
• Continue to fund the program at an essentially flat level, but strive to improve the program's results by increasing efficiency.		• Action taken; expected completion date 9/30/2009: SFS funding remains flat with exception of the development of the TDRS K/L project in SC. LSP has partnered with existing program to streamline and share center infrastructure capabilities such as network cables. The RPT program through the shared Test Operations Contract has gained efficiencies by consolidating certain management and administrative functions while achieving existing test milestones. SFS has a new efficiency measure developed last year, NASA will track for a year or two.	
• Develop better measures that will help to drive program improvement.		• Completed: We revisited the Crew Health and Safety metrics to get better aligned. Space and Flight Support was PARTed last year and developed new measures and metrics.	

• Collect efficiency data consistently and annually for all program activities, report performance against the program's established metrics and targets, and compare/ benchmark these results to similar services available from private industry or other emerging commercial providers to ensure the best value to the government.	• Action taken; expected completion date 9/30/2009: Efficiency metric created in 2006. 2007 data reported under the Program Performance Measures section. NASA will continue to track this measure for another year or two.
• Based on a detailed review of which Space and Flight Support assets will be needed post-Shuttle retirement, develop a plan that assesses the most cost-effective way to sustain necessary capabilities and tracks their performance and efficiency, during a this period of possible reduced demand.	• Action taken; expected completion date 9/30/2011: LSP has no assets used by Shuttle that will impact them post-Shuttle retirement. However, there are some KSC/Shuttle assets such as the com infrastructure and propellant servicing equipment that could impose cost impacts to LSP. Potential impacts remain unclear until CX requirements are known. The RPT Program completed a Facility Alignment Utilization Study in June 2007. RPT is using output from the study to develop a planning model for test stand requirements. We do not expect reduced demand for SFS programs.
• During the period of post-Shuttle retirement through human lunar operations, identify budget impacts for the Space Communications program to meet changing requirements for human and robotic space communications. Develop plan for the most cost-effective way to sustain necessary capabilities, track performance and efficiency, and meet the changing lunar operations requirements.	• Action taken; expected completion date 3/30/2009: Requirements are being iterated with the Mission Directorates in order to assess alternative architectures. Based on requirements, a Systems Engineering Team comprised of experts from performing SCaN Centers and HQ Mission Directorates will develop an Integrated Space Communications Architecture roadmap.

Cross-Agency Support Programs

Theme: Education

Last Year Assessed: 2007		**Rating:** Results Not Demonstrated	
Program Purpose and Design: 100%	**Strategic Planning:** 88%	**Program Management:** 60%	**Program Results/ Accountability:** 33%
Rating Rationale: NASA's Education Theme received a 2007 PART rating of "Results Not Demonstrated." Many positive attributes were cited and it was concluded that the Theme attracts students to science and technology careers at NASA. On the other hand, it was cited that NASA lacked complete data on the effectiveness of its Education programs. The Theme did not have sufficient data to document the extent to which participants had taken jobs with NASA or related fields. It did not report on a complete set of performance measures that reflected the desired program Outcomes.			
Previous Year Assessed: 2004		*Rating: Adequate*	
Program Purpose and Design: 100%	*Strategic Planning: 75%*	*Program Management: 40%*	*Program Results/ Accountability: 40%*

Program Improvement Plan:	**Actions as of Fall 2007:**
• Collecting performance data consistently and annually for all program activities, reporting performance against the program's established metrics and targets, and using results to improve performance.	• Action taken; expected completion date 9/30/2010: NASA created an evaluation function and budget to improve data collection processes. The CIO is contracted to develop an education data system to replace 3 existing databases. Concomitant with the data system design, a business process analysis is being conducted to document data collection requirements and ensure reliable data are routinely collected and reported for all projects. Quarterly reviews of data collection and progress of projects are conducted by Education senior leadership.
• Conducting independent evaluations to assess the program's effectiveness and efficiency against the program's established metrics and performance goals and applying resources based on the results.	• Action taken; expected completion date 9/30/2010: Pursuant to the OMB-approved evaluation plan, solicitation is underway for independent contractor with broad, deep expertise in STEM education evaluation. Under task orders, contractor will conduct objective, reliable, and valid evaluations of project effectiveness. Office is reviewing recommendations from National Academies study and will begin adjusting programming beginning in FY08 based on recommendations. FY08 projects for evaluation include Tribal, HIS, HBCU collaborations, EPSCoR, MUREP.
• Offering opportunities not addressed by other agencies and that are unique in their use of NASA's resources and benefits to NASA's mission and collaborating with other agencies where appropriate.	• Action taken; expected completion date 9/30/2010: All FY07 higher education solicitations (Space Grant, EPSCoR, GSRP, etc.) specifically map to, and require research on, current mission directorate science and engineering priorities. Contracted OPM TMAT to assist in analysis for mission appropriate expansion and collaboration. Ongoing coordination through National Science and Technology Council Education Subcommittee and Interagency Aerospace Revitalization Task Force.

• Avoiding duplication with other NASA education programs.		• <u>Action taken; expected completion date 9/30/2010:</u> Office of Education chairs ECC to ensure consistency of program formulation, strategy, and implementation. The Office coordinates and integrates NASA's education strategic framework, implementation approach, and policies. AA for Education leads development of an implementation plan (goals, objectives, and metrics) to guide Agency external education programs and for monitoring and reporting progress against goals and objectives. AA establishes the Agency APGs. Codified in NPD 1000.3c Section 4.13.2.2.	
• Filling NASA's workforce needs using a stronger effort to consider eligible program participants and facilitate their entry into positions at NASA.		• <u>Action taken; expected completion date 9/30/2010:</u> MOU between Offices of Human Capital Management, Diversity and Equal Opportunity, and Education created to facilitate student movement into workforce. Activities include development of student opportunity brochure completed; draft policy revisions for internship and co-op conversion, development of database linking NASA Competency needs and degrees offered at universities, consolidated website for Internship/Fellowship application process, employment, and hiring opportunities.	
• Establishing baselines for all performance metrics.		• <u>Completed:</u> FY07 baselines for all measures established and documented in PART Web (11/07).	
• Fully execute the new education investment framework per the framework's implementation plan, to complete the strategic alignment of the Education portfolio that best supports the Agency strategic direction and the Exploration Vision. This action is a continuation of a former follow-on action to develop the investment framework and implementation plan.		• <u>Action taken; expected completion date 9/30/2010:</u> Framework adopted and codified it in NPD 1000.3c. Hired portfolio manager, and ECC analyzed portfolio, to be complete by 03/08. Review of portfolio, recommendations from NRC study, and external evaluations will inform future budget allocations. Per framework, and adopted by ECC, phased implementation is in 4th phase. Portfolio analysis indicated need for HS pipeline program. Internal review of Academy projects and independent benchmark study conducted. ECC approved Inspire implementation plan.	
Theme: Integrated Enterprise Management Program			
Last Year Assessed: 2006		**Rating:** Moderately Effective	
Program Purpose and Design: 80%	**Strategic Planning:** 100%	**Program Management:** 88%	**Program Results/ Accountability:** 67%
Rating Rationale: The Integrated Enterprise Management Program received a FY 2006 PART rating of "Moderately Effective." The rating reflects that the program addresses clear and existing needs of the Agency. The implementation of business systems across NASA allows timely access to standardized, agencywide data. The program had achieved progress towards long-term goals but has remaining work. For example, at the time of the review, the program had implemented several software modules to improve financial management but the software did not provide adequate functionality, specifically in regards to compliance with the Federal Financial Management Improvement Act. Also, in 2006, NASA had yet to formulate a complete, concrete, and realistic plan for a clean audit.			
Previous Year Assessed: None		*Rating: N/A*	
Program Purpose and Design: N/A	*Strategic Planning: N/A*	*Program Management: N/A*	*Program Results/ Accountability: N/A*
Program Improvement Plan:		**Actions as of Fall 2007:**	
• Upgrading the Agency's Financial Software System (SAP) to improve NASA's compliance with the Federal Financial Management Improvement Act.		• <u>Action taken; expected completion date 12/31/2009:</u> 1) SAP upgraded software was put into production at FYE. Users began using the system on November 13, 2006. 2) IEMP will work with the OCFO to assess and ensure NASA's compliance with the Federal Financial Management Improvement Act.	
• Clarifying and prioritizing requirements for future business systems.		• <u>Action taken; expected completion date 12/31/2008:</u> 1) IEMP has formed the Management/Business Systems Integration Group to gather and prioritize Agency requirements for IEMP. 2) Established the NASA Management/Business Systems Integration Group (M/BSIG) Charter to define functions and membership. 3) M/BSIG to clarify and prioritize requirements for future business systems.	
• Supporting the Office of the Chief Financial Officer in obtaining a clean audit.		• <u>Action taken; expected completion date 12/31/2009:</u> IEMP will meet with the OCFO after the external auditors publish the Agency's audit results to identify areas where IEMP can make system improvements to assist with trouble areas as identified by the auditors.	
Theme: Innovative Partnerships Program			
Last Year Assessed: None		**Rating:** N/A	
Theme: Strategic Capabilities Assets Program			
Last Year Assessed: None		**Rating:** N/A	

NASA's Participation in the Performance and Accountability Report Pilot Program

SCIENCE

For necessary expenses, not otherwise provided for, in the conduct and support of science research and development activities, including research, development, operations, support, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; environmental compliance and restoration; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $4,441,519,000 to remain available until September 30, 2010: Provided, That when any activity has been initiated by the incurrence of obligations for construction of facilities or environmental compliance and restoration activities as authorized by law, such amount available for such activity shall remain available until expended.

AERONAUTICS

For necessary expenses, not otherwise provided for, in the conduct and support of aeronautics research and development activities, including research, development, operations, support, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; environmental compliance and restoration; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $446,500,000 to remain available until September 30, 2010: Provided, That when any activity has been initiated by the incurrence of obligations for construction of facilities or environmental compliance and restoration activities as authorized by law, such amount available for such activity shall remain available until expended.

EXPLORATION

For necessary expenses, not otherwise provided for, in the conduct and support of exploration research and development activities, including research, development, operations, support, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; environmental compliance and restoration; space flight, spacecraft control, and communications activities; program management, personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $3,500,469,000 to remain available until September 30, 2010: Provided, That when any activity has been initiated by the incurrence of obligations for construction of facilities or environmental compliance and restoration activities as authorized by law, such amount available for such activity shall remain available until expended.

EDUCATION

For necessary expenses, not otherwise provided for, in carrying out aerospace and aeronautical education research and development activities, including research, development, operations, support, and services; program management; personnel and related costs, uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $115,600,000, to remain available until September 30, 2010.

CROSS AGENCY SUPPORT

For necessary expenses, not otherwise provided for, in the conduct and support of science, aeronautics, exploration, space operations and education research and development activities, including research, development, operations, support, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; environmental compliance and restoration; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; not to exceed $70,000 for official reception and representation expenses; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $3,299,902,000, to remain available until September 30, 2010: Provided, That when any activity has been initiated by the incurrence of obligations for construction of facilities or environmental compliance and restoration activities as authorized by law, such amount available for such activity shall remain available until expended: Provided further, That the previous proviso does not apply to the amounts appropriated for institutional minor revitalization and minor construction of facilities, and institutional facility planning and design, for which funding shall be available until September 30, 2011.

SPACE OPERATIONS

For necessary expenses, not otherwise provided for, in the conduct and support of space operations research and development activities, including research, development, operations, support and services; space flight, spacecraft control and communications activities including operations, production, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; environmental compliance and restoration; program management; personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles and purchase, lease, charter, maintenance and operation of mission and administrative aircraft, $5,774,710,000, to remain available until September 30, 2010: Provided, That when any activity has been initiated by the incurrence of obligations for construction of facilities or environmental compliance and restoration activities as authorized by law, such amount available for such activity shall remain available until expended.

OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General in carrying out the Inspector General Act of 1978, $35,500,000, to remain available until September 30, 2010.

ADMINISTRATIVE PROVISIONS
(INCLUDING TRANSFER OF FUNDS)

Funds for announced prizes otherwise authorized shall remain available, without fiscal year limitation, until the prize is claimed or the offer is withdrawn.

Not to exceed 5 percent of any appropriation made available for the current fiscal year for the National Aeronautics and Space Administration in this Act may be transferred between such appropriations, but no such appropriation, except as otherwise specifically provided, shall be increased by more than 10 percent by any such transfers. Any transfer pursuant to this provision shall be treated as a reprogramming of funds under section 505 of this Act and shall not be available for obligation except in compliance with the procedures set forth in that section.

FY 2009 Proposed Appropriation Language

The unexpired balances of the Science, Aeronautics, and Exploration account, for activities for which funds are provided under this Act, may be transferred to the new accounts established in this Act that provide such activity. Balances so transferred shall be merged with the funds in the newly established accounts, but shall be available under the same terms, conditions and period of time as previously appropriated.

For closeout of all Space Shuttle contracts and associated programs, sums in Human Space Flight, Space Flight Capabilities, and Exploration Capabilities appropriation accounts expiring in 2003 or later are to remain available through 2015 for the disbursement of termination costs.

Reference: Acronyms

AA	Associate Administrator
AAAC	Astronomy and Astrophysics Advisory Committee
AAD	Aircraft Aging and Durability
AATT	Advanced Air Transportation Technologies
ABS	Advanced Business System
AC	Advanced Capabilities
ACCESS	Advanced Collaborative Connections for Earth System Science
ACE	Advanced Composition Explorer
ACES	Airspace Concepts Evaluation System
ACIS	Advanced CCD Imaging Spectrometer
ACRIMSat	Active Cavity Radiometer Irradiance Monitor Satellite
ACS	Advanced Camera for Surveys (Hubble Space Telescope instrument)
ADA	Associate Deputy Administrator
ADCAR	Astrophysics Data Curation and Archival Research
ADFT	Ascent Development Flight Test
ADP	Astrophysics Data Program
ADS	Astrophysics Data System
AEDC	Arnold Engineering Development Center
AEH	Advanced Environmental Health
AEMC	Advanced Environmental Monitoring and Control
AESP	Aerospace Education Services Program
AFB	Air Force Base
AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
AIA	Atmospheric Imaging Assembly (Solar Dynamic Observatory instrument)
AIM	Aeronomy of Ice in the Mesosphere
AirSAR	Airborne Synthetic Aperture Radar
AISR	Applied Information Systems Research
AITS	Agency Information Technology Services
ALI	Advanced Land Imager
ALS	Aircraft Logistics System
ALV	Air Launch Vehicle
AMM	Aircraft Management Module
AMMOS	Advanced Multi-Mission Operations System
AMO	Agency Management and Operations
AMR	Advanced Microwave Radiometer (Ocean Surface Topography Mission instrument)
AMS	Alpha Magnetic Spectrometer
AMSR-E	Advanced Microwave Scanning Radiometer for the Earth Observing System
ANSP	Air Navigation Service Provider
AO	Announcement of Opportunity
APG	Annual Performance Goal
APL	Applied Physics Laboratory (Johns Hopkins University)
APS	Advanced Polarimeter Sensor (Glory instrument)
ARC	Ames Research Center
ARMD	Aeronautics Research Mission Directorate
AS&T	Aeronautics Science and Technology
ASAP	Aerospace Safety Advisory Panel
ASE	Aero- Servo- Elastic
ASI	Agenzia Spaziale Italiana (Italian Space Agency)
ASP	Airspace Systems Program
ASPERA-3	Analyzer of Space Plasma and Energetic Atoms-3
ASR	Aviation Safety Report
ASRC	Arctic Slope Regional Corporation
ASRG	Advanced Stirling Radioisotope Generator
ASSP	Architecture for Survivable System Processing
AST	Advanced Subsonic Technology
ASTER	Advanced Spaceborne Thermal Emission Reflection Radiometer
ASVM	Aircraft and Systems Vulnerability Mitigation
ATG	Airspace Traffic Generator
ATLO	Assembly, Test, Launch Operations
ATM	Air Traffic Management
ATMS	Advanced Technology Microwave Sounder (NPOESS Preparatory Project instrument)
ATP	Aeronautics Test Program
ATV	Automated Transfer Vehicle
AuRA	Autono Robust Avionics
AVIRIS	Airborne Visible/Infrared Imaging Spectrometer
AvSP	Aviation Safety Program
AvSa	Aviation Safety
BARREL	Balloon Array for Radiation-belt Relativistic Electron Losses
BATC	Ball Aerospace and Technology Corporation
BCAT-4	Binary Critical Aggregation Test- 4
BCP	Ball Commercial Platform
BE	Beyond Einstein
BEPAC	Beyond Einstein Program Assessment Committee
BHP	Behavioral Health and Performance
BPI	Budget Performance and Integration
BSIG	Business Systems Integration Group
BWB	Blended Wing Body
BWG	Beam Wave Guide
C&DH	Command and Data Handling
C3I	Command, Control, Communication Information
C3P	Commercial Cargo Crew Project
C3PO	Commercial Cargo Crew Program Office
C3S	Command, Control, and Communication Segment
C4P	Commercial Cargo Crew Capability Project
CAEP	Committee on Aviation Environmental Protection
CALIOP	Cloud-Aerosol LIdar with Orthogonal Polarization
CALIPSO	Cloud–Aerosol Lidar and Infrared Pathfinder Satellite Observations
CaLV	Cargo Launch Vehicle
CAN	Cooperative Agreement Notice
CAPTEM	Curation and Analysis Planning Team for Extraterrestrial Materials
CARA	California Association for Research in Astronomy
CARD	Constellation Architectural Requirements Document
CASP	Cross Agency Support Programs
CAST	Commercial Aviation Safety Team
CCD	Charge Coupled Device
CCMC	Community Coordinated Modeling Center

CCRI	Climate Change Research Initiative
CCSP	Climate Change Science Program
CDAP	Cassini Data Analysis Program
CDC	Centers for Disease Control
CDI	Congressionally Directed Items
CDL	Center for Distance Learning
CDR	Critical Design Review
CEU	Combined Electronics
CEV	Crew Exploration Vehicle
CFD	Computational Fluid Dynamics
CFE	Capillary Flow Experiment
CFM	Cryogenic Fluid Management
CGA	Corporate G&A
CGRO-EGRET	Compton Gamma-Ray Observatory–Energetic Gamma-Ray Experiment Telescope
ChemCam	Chemistry Camera
CHIPS	Cosmic Hot Interstellar Plasma Spectrometer
CHS	Crew Health and Safety
CI	Counter-intelligence
CICT	Computing, Information and Communications Technology
CINDI	Coupled Ion Neutral Dynamics Investigation
CIO	Chief Information Officer
CIPAIR	Curriculum Improvement Partnership Award for the Integration of Research
CIR	Combustion Integrated Rack
CIRA	Cooperative Institute for Research in the Atmosphere
CLV	Crew Launch Vehicle
CM&O	Center Management and Operations
CMAO	Contract Management Assistance Officer
CMB	Cosmic Microwave Background
CME	Coronal Mass Ejection
CMM	Contract Management Module
CMO	Center Management Operations
CNES	Centre Nationale D'Etudes Spatiale (French Space Agency)
CO	Carbon Monoxide
CO2	Carbon Dioxide
COBE	Cosmic Background Explorer
CoF	Construction of Facilities
CONAE	Argentina's National Committee of Space Activities
CONTOUR	Comet Nucleus Tour
CON-X	Constellation-X
COOL	Constellation Operations Optimization List
CORE	Central Operation of Resources for Educators
COS	Cosmic Origins Spectrograph
COTF	Classroom of the Future
COTR	Contracting Officer Technical Representative
COTS	Commercial Orbital Transportation Services
CPHS	Committee on the Protection of Human Subjects
CRaTER	Cosmic Ray Telescope for the Effects of Radiation
CRI	Center for Rotorcraft Innovation
CrIS	Cross-track Infrared Sounder (NPOESS Preparatory Project instrument)
CSA	Canadian Space Agency
CSC	Computer Sciences Corporation
CSI	Constellation Services International
CSPE	Colorimetric Solid Phase Extraction
CVB	Constrained Vapor Bubble
Cx	Constellation Systems
CxRS	Constellation Reconfiguration System
CxTF	Constellation Training Facility
CY	Calendar Year
DAAC	Distributed Active Archive Centers
DAFT	Dust and Aerosol Measurement Facility Test
DAN	Dynamic Albedo of Neutrons
DAP	Data Analysis Program
DARPA	Defense Advanced Research Projects Agency
DCAA	Defense Contract Audit Agency
DCAS	Defense Contract Audit Service
DDAP	Discovery Data Analysis Program
DDT&E	Design, Development, Test, and Evaluation
DEVELOP	Digital Earth Virtual Environment and Learning Outreach Program
DFRC	Dryden Flight Research Center
DIXI	Deep Impact Extended Investigation of Comets
DLR	Deutches Zentrum für Luft- Raumfahrt (German Aerospace Center)
DoD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DORIS	Doppler Orbitography by Radiopositioning Integrated by Satellite (Ocean Surface Topography Mission instrument)
DOT	Department of Transportation
DPR	Dual-frequency Precipitation Radar (Global Precipitation Measurement instrument)
DRS	Disturbance Reduction System
DSI	Deutsches SOFIA Institut
DSMS	Deep Space Mission System
DSN	Deep Space Network
DSX	Deployable Structures Experiment
E&PO	Education and Public Outreach
EA	Enterprise Architecture
EAFB	Elmendorf Air Force Base
EAP	Educator Astronaut Program
EAS	Efficient Aircraft Spacing
EASI	Efficient Aerodynamic Shapes and Integration
ECANS	Exploration Communication and Navigation Systems
ECC	Education Coordinating Committee
ECLSS	Environmental Control and Life Support System
ECR	Environmental Compliance and Restoration
ECT	Energetic Particle, Composition and Thermal Plasma
ED	Education
EDL	Entry, Descent, and Landing

EDMD	Exploration Technology Development Program
EDS	Earth Departure Stage
EEE	Evolution of EOSDIS Elements
EELV	Evolved Expendable Launch Vehicle
EFASC	Electric Field and Search Coil
EF	Exposed Facility
EFI	Electric Field Instrument (Thermal Emission Imaging System instrument)
EFPO	Education Flight Projects
EFPM	Efficient Flight Path Management
EGRET	Energetic Gamma Ray Experiment Telescope
EIRB	Extragalactic Infrared Background
EIS	Extreme Ultraviolet Imaging Spectrometer
ELC	ExPRESS Logistics Carrier
ELM-ES	Experiment Logistics Module- Exposed Section
ELV	Expendable Launch Vehicle
EMA	Educational Media Archives
EMC	Exploration Medical Capability
EMFISIS	Electric and Magnetic Field Instrument Suite and Integrated Science
ENA	Energetic Neutral Atom
ENose	Electronic nose
EO-1	Earth Observing One Mission
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EP/TOMS	Earth Probe/ Total Ozone Mapping Spectrometer
EPA	Environmental Protection Agency
EPN	Effective Perceived Noise
EPNdB	Effective Perceived Noise in Decibels
e-PD	e-Professional Development
EPOCh	Extrasolar Planet Observations and Characterization
EPOXI	Extrasolar Planet Observation and Deep Impact Extended Investigation
EPSCoR	Experimental Program to Stimulate Competitive Research
ERBS	Earth Radiation Budget Sensor
ESA	European Space Agency
ESAS	Exploration Systems Architecture Study
ESES	Electrical Systems Engineering Services
ESD	Earth Science Division
ESM	Earth Systematic Missions
ESMD	Exploration Systems Mission Directorate
ESRT	Exploration Systems Research and Technology
ESS	Earth Systems Science
ESSAC	NASA Earth System Science and Applications Advisory Committee
ESSP	Earth System Science Pathfinder
ESTO	Earth Science Technology Office
ESTP	Earth Science Technology Program
ET	External Tank
ETD	Exploration Technology Development
ETDP	Exploration Technology Development Program
ETM	Enhanced Thematic Mapper
EUSO	Extreme Universe Space Observatory
EUV	Extreme-Ultraviolet
EVA	Extravehicular Activity
EVE	Extreme-ultraviolet Variability Experiment (Solar Dynamics Observatory instrument)
EVM	Earned Value Management
EXPRESS	Expedite the Processing of Experiments to the Space Station
FA	Fundamental Aeronautics
FAA	Federal Aviation Administration
FACET	Future Air Traffic Management Concepts Evaluation
FAR	Faculty Awards for Research
FAST	Fast Auroral Snapshot
FC	Framing camera
FDCC	Federal Desktop Core Configuration
FEAC	Federal Enterprise Architecture Certification
FFMIA	Federal Financial Management Improvement Act of 1996
FFS	Fee for service
FGM	Fluxgate Magnetometer (Thermal Emission Imaging System instrument)
FGS	Fine Guidance Sensor
FIPS	Federal Information Processing Standard
FIRST	For Inspiration and Recognition of Science and Technology
FLEX	Flame Extinguishment Experiment
FLITECAM	First Light Infrared Test Experiment Camera
FLX	Flight Experiment
FMA	Force = Mass x Acceleration
FMI	Finnish Meteorological Institute
FOC	Full Operational Capability
FOSS	Fiber Optic Strain System
FPA	Focal Plane Array
FPP	Focal Plane Package
FS	First Stage
FTE	Full Time Equivalency
FTP	Foundational Technology Program
FTV	Flight Test Vehicle
FUSE	Far Ultraviolet Spectroscopic Explorer
FUV	Far Ultraviolet
FY	Fiscal Year
G&A	General and Administrative
GALEX	Galaxy Evolution Explorer
GAO	Government Accountability Office
GBM	Gamma-ray Burst Monitor (Gamma-ray Large Area Telescope instrument)
GCRP	Global Change Research Program
GEO	Geosynchronous Earth Orbit
GEOSS	Global Earth Observation System of Systems
GES DAAC	GSFC Earth Science Distributed Active Archive Center
GeV	Gigaelectron volt
GHz	Gigahertz
GI	Guest Investigator

GIFTS	Geosynchronous Imaging Fourier Transform Spectrometer
GISS	Goddard Institute for Space Studies
GLAST	Gamma–ray Large Area Space Telescope
GLOBE	Global Learning and Observations to Benefit the Environment
GMAO	Global Modeling and Assimilation Office
GMI	GPM Microwave Imager (Global Precipitation Measurement instrument)
G-MOO	Geospace Missions of Opportunity
GN	Ground Networks
GNC	Guidance, navigation and control
GO	Ground Operations
GOES	Geostationary Operational Environmental Satellite
GOME-2	Global Ozone Monitoring Experiment-2
GP–B	Gravity Probe–B
GPM	Global Precipitation Measurement
GPRA	Government Performance Results Act of 1993
GPS	Global Positioning System
GRACE	Gravity Recovery and Climate Experiment
GRAIL	Gravity Recovery and Interior Laboratory
GRaND	Gamma Ray and Neutron Detector
GRB	Gamma Ray Burst
G-RBSP	Geospace- Radiation Belt Storm Probes
GRC	Glenn Research Center
GRC-PBS	Glenn Research Center–Plum Brook Station
GREAT	German Receiver for Astronomy at Terahetz
GS	Ground Support
GSFC	Goddard Space Flight Center
GSRP	Graduate Student Research Project
GSSR	Goldstone Solar System Radar
HALE	High-Altitude, Long-Endurance
HBCU	Historically Black Colleges and Universities
HCAS	Human Capital Accountability System
HCIE	Human Capital Information Environment
HE	Higher Education Project
HECC	High End Computing Columbia
HETE–2	High Energy Transient Explorer
HETG	High Energy Transmission Grating
HFFF	Hyper-velocity Free Flight Facility
HFI	High Frequency Instrument
HFT	Hypersonic Tunnel Facility
HHC	Health and Human Countermeasures
HH&P	Human Health & Performance
HIFI	Heterodyne Instrument for the Far Infrared
HIPO	High-speed Imaging Photometer for Occultation
HIRDLS	High Resolution Dynamic Limb Sounder
HiRISE	High Resolution Imaging Science Experiment
HMI	Helioseismic and Magnetic Imager (Solar Dynamic Observatory instrument)
HMMES	High-Mass Mars Entry Systems
HMP	Human Measures and Performance
HPS	Heliophysics Subcommittee
HQ	NASA Headquarters
HR	Human Resource
HRC	High Resolution Camera
HRIS	Human Resources Information System
HRP	Human Research Program
HRRLS	Highly Reliable Reusable Launch Systems
HSB	Humidity Sounder for Brazil
HSI	Hispanic Service Institutions
HSRT	Human Systems Research and Technology
HST	Hubble Space Telescope
HSTS	Heuristic Scheduling Test-bed System
HTF	Hypersonic Test Facility
HTV	H-II Transfer Vehicle
HVGR	Hypervelocity Gun Range
Hy-BoLT	Hypersonic Boundary Layer Transition Flight Experiment
I&T	Integration and test
IAM	Integrated Asset Management
IAR	Independent Annual Review
IBEX	Interstellar Boundary Explorer
IBPD	Integrated Budget and Performance Document
ICAO	International Civil Aviation Organization
ICESat	Ice, Cloud, and Land Elevation Satellite
ICSMR	Budget/management review
IDIQ	Indefinite Delivery Indefinite Quantity
IDPS	Interface Data Processing Segment
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IEMP	Integrated Enterprise Management Program
IFMP	Integrated Financial Management Program
IG	Inspector General
IIFD	Integrated Intelligent Flight Deck
IIRT	Integrated Independent Review Team
IMAGE	Imager for Magnetopause–to–Aurora Global Exploration
IMD	Institutional Management and Dissemination
INPE	Brazilian Institute for Space Research
INSPIRE	Interdisciplinary National Science Program Incorporating Research and Education Experiences
InSPACE-2	Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions - 2
IOC	Initial Operational Capability
IOM	Institute of Medicine
IP	Intellectual Property
IPAC	Infrared Processing and Analysis Center
IPAO	Independent Program Assessment Office
IPCC	International Panel on Climate Change
IPD	Integrated Powerhead Demonstrator
IPIA	Improper Payments Improvement Act
IPO	Integrated Program Office
IPP	Innovative Partnerships Program
IPS	Integrated Planning System
IPY	International Polar Year
IR	Infrared
IRA	Institutional Research Awards

IRAC	Integrated Resilient Aircraft Controls
IRAS	Infrared Astronomical Satellite
IRD	Interface Requirement Document
IRM	Information Resources Management
IRMA	Integrated Risk Management Application
IRSA	NASA/IPAC Infrared Science Archive
IRT	Independent Review Team
ISAS	Institute of Space and Astronautical Science
ISIM	Integrated Science Instrument Module
ISM	Interstellar Medium
ISP	In-Space Propulsion Project
ISRO	Indian Space Research Organization
ISRU	In-Situ Resource Utilization
ISS	International Space Station
ISSC	International Space Science Collaboration
ISSMP	International Space Station Medical Program
ISTP	Integrated Space Transportation Plan
IT	Information Technology
ITA	Independent Technical Authority
ITAR	International Traffic in Arms Regulation
ITAS	Integrated Tailored Aerostructures
ITF	Integrated Training Facility
IVHM	Integrated Vehicle Health Management
JADE	Jovian Auroral Distributions Experiment
JAXA	Japan Aerospace Exploration Agency
JBOSC	Joint Base Operations Support Contract
JCAA	Joint Council on Aging Aircraft
JCSDA	Joint Center for Satellite Data Assimilation
JDEM	Joint Dark Energy Mission
JEDI	Jupiter Energetic particle Detector Instrument
JEM PM	Japanese Experiment Module Pressured Module
JHU	John Hopkins University
JHU-APL	Johns Hopkins University–Applied Physics Laboratory
JOI	Jupiter Orbit Insertion
JPDO	Joint Planning and Development Office
JPDO	Joint Planning and Development Office
JPFP	Harriet Jenkins Pre-doctoral Fellowship Program
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
JSC-WSTF	Johnson Space Center–White Sands Test Facility
JSG	Joint Steering Group
JWST	James Webb Space Telescope
KaPR	Ka-band Precipitation Radar
KDP	Key Decision Point Review
KeV	Kiloelectron Volts
KHz	Kilohertz
KI	Keck Interferometer
KNMI	Royal Netherlands Meteorological Institute
KSC	Kennedy Space Center
KuPR	Ku precipitation radar
kW	Kilowatt
LADEE	Lunar Atmosphere and Dust Environment Explorer
LAMP	Lyman-Alpha Mapping Project
LAN	Local Area Network
LANL	Los Alamos National Laboratory
LaRC	Langley Research Center
LAS	Launch Abort System
LASER	Lunar Advanced Science and Exploration Research
LASP	Laboratory for Atmospheric and Space Physics (University of Colorado, Boulder)
LAT	Large Area Telescope (Gamma-ray Large Area Telescope instrument)
LBT	Large Binocular Telescope
LBTI	Large Binocular Telescope Interferometer
LCC	Launch Control Center
LCROSS	Lunar Crater Observation and Sensing Satellite
LDCM	Landsat Data Continuity Mission
LEAP	Low Emissions Alternative Power
LEED	Leadership in Energy and Environment Design
LEND	Lunar Exploration Neutron Detector
LEO	Low Earth Orbit
LETG	Low Energy Transmission Grating
LFI	Low Frequency Instrument
LH2	Liquid Hydrogen
LISA	Laser Interferometer Space Antenna
LMM	Light Microscopy Module
LMS	Launch and Mission Systems
LN2	Liquid Nitrogen
LOLA	Lunar Orbiter Laser Altimeter
LoB	Lines of Business
LOX	Liquid Oxygen
LPRP	Lunar Precursor Robotic Program
LRA	Laser Retroreflector Array (Ocean Surface Topography Mission instrument)
LRD	Launch Readiness Date
LRO	Lunar Reconnaissance Orbiter
LROC	Lunar Reconnaissance Orbiter Camera
LRR	Launch Readiness Review
LSAH	Longitudinal Study of Astronaut Health
LSAM	Lunar Surface Access Module
L-SDT	Lunar Science Definition Team
LSCE	Laboratoire des Sciences du Climat et de l'Environment
LSH	Life Support and Habitation
LSP	Launch Services Program
LV	Launch Vehicle
LWS	Living with a Star
MA	Multiple Access
MARDI	Mars Descent Imager
MASTAP	Math Science Teacher and Curriculum Enhancement Program
MCC	Mission Control Center
MCR	Mission Confirmation Review
MD	Mission Directorate
MDAO	Multidisciplinary Design Analysis and Optimization
MDCA	Multi-User Droplet Combustion Apparatus

MDI	Mission Dependency Index
MdM	Metadata Manager
MDR	Mission Design Review
MEaSUREs	Making Earth System data records for Use in Research Environments
MECA	Mars Environmental Compatibility Assessment
MEO	Most Efficient Organization
MEP	Mars Exploration Program
MEPAG	Mars Exploration Program Analysis Group
MESSENGER	Mercury Surface, Space Environment, Geochemistry and Ranging
MET	Meterology package
METI	Ministry of Economy Trade and Industry (Japan)
MeV	Mega electron Volts
MEX	Mars Express
MI	Minority Institutions
MIDEX	Medium-Class Explorer
Mini-RF	Radiation Frequency
MIRI	Mid-infrared Instrument (James Webb Space Telescope instrument)
MIs	Minority Institutions
MIT	Massachusetts Institute of Technology
MLP	Mobile Launch Platform
MLS	Microwave Limb Sounder
MMOD	Micrometeoroid/ Orbital Debris
MMRTG	Multi-missions Radioisotope Thermoelectric Generators
MMS	Magnetospheric Multiscale
MO	Missions of Opportunity
MO&DA	Mission Operations and Data Analysis
MOA	Memorandum of Agreement
MOE	Mission Operations Element
MoonROx	Moon Regolith Oxygen
MOPITT	Measurements of Pollution in the Troposphere
MOR	Mission Operations Review
MOU	Memorandum of Understanding
MPAR	Major Program Annual Report
MPE	Max-Planck-Institut für Extra-terrestriche Physik (Germany)
MPLM	Multi-Purpose Logistics Module
MPS	Max-Planck-Institut für Sonnensystemforschung
MRO	Mars Reconnaissance Orbiter
MRR	Mission Requirement Request
MS	Missions Systems
MSFC	Marshall Space Flight Center
MSG	Magnetic Spectrometer
MSI	Minority-Serving Institute
MSL	Mars Science Laboratory
MSR	Mars Sample Return
MSRR	Materials Science Research Rack
MUREP	Minority University Research and Education Project
MUSES-C	Mu Space Engineering Spacecraft–C
MUSS	Multi-User Systems and Support
MUST	Motivating Undergraduate in Science and Technology
MWR	Motivating Undergraduates in Science & Technology
NAC	NASA Advisory Committee
NACC	NASA Ames Conference Center
NAFP	NASA Administrator’s Fellowship Program
NAMMA	NASA African Monsoon Multidisciplinary Analyses
NAPA	National Academy of Public Administration
NAR	Non-Advocacy Review
NAS	National Airspace System
NASDA	National Space Development Agency of Japan
NASSMC	National Alliance of State Science and Mathematics Coalitions
NCAR	National Center for Atmospheric Research
NCAS	NASA Contract Assurance Services
NCSER	National Center for Space Exploration Research
NEAR	Near-Earth Asteroid Rendezvous
NED	NASA/IPAC Extragalactic Database
NEI	NASA Explorer Institute
NEN	Near Earth Network
NEO	Near-Earth Object
NEOO	Near-Earth Object Observations
NEPER	NASA Education Program Evaluation Review
NES	NASA Explorer School
NESC	NASA Engineering and Safety Center
NETS	NASA Educational Technology Services
NEXT	NASA Evolutionary Xenon Thruster
NFS	NASA FAR Supplement
NG	Northrop Grumman
NGATS	Next Generation Air Transportation System
NGLT	Next Generation Launch Technology
NGST	Northrop Grumman Space Technology
NIA	National Institute of Aerospace
NICMOS	Near Infrared Camera and Multi-Object Spectrometer (Hubble Space Telescope instrument)
NIH	National Institute for Health
NIP	New Investigator Program
NIRCam	Near-Infrared Camera
NIRSpec	Near-Infrared Spectrometer
NISN	NASA Integrated Services Network
NIST	National Institute of Science and Technology
NIVR	Netherlands Agency for Aerospace Programs
NLS	NASA Launch Services
NLSI	NASA Lunar Science Institute
NLT	NASA Learning Technologies
NMO	NASA Management Office
NMP	New Millennium Program
NMSU	New Mexico State University
NOAA	National Oceanic and Atmospheric Administration
NOAA-N	National Oceanic and Atmospheric Administration - NASA
NOFS	Navigation Outage Forecast System
NORCAT	Northern Centre for Advanced Technology, Inc.

NOx	Nitrogen Oxide
NPAT	National Partnership for Aeronautic Testing
NPD	NASA Policy Directive
NPOESS	National Polar–orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
NPR	NASA Procedural Requirement
NRA	NASA Research Announcement
NRC	Nuclear Regulatory Commission
NRC	National Research Council
NRL	Naval Research Laboratory
NRO	National Reconnaissance Office
NSBRI	National Space Biomedical Research Institute
NSC	NASA Safety Center
NSF	National Science Foundation
NSRL	NASA Space Radiation Laboratory
NSSC	NASA Shared Services Center
NSSDC	National Space Science Data Center
NSTA	National Science Teachers Association
NSTC	National Science and Technology Council
NSTI-MI	NASA Science and Technology Institute for Minority Institutions
NuSTAR	Nuclear Spectroscopic Telescope Array
NVO	National Virtual Observatory
NWP	Numerical Weather Prediction
O&SS	Operations and Sustaining Support
OA	Office of Audits
OCE	Office of the Chief Engineer
OCFO	Office of Chief Financial Officer
OCHMO	Office of the Chief Health and Medical Officer
OCIO	Office of Chief Information Officer
OCO	Orbiting Carbon Observatory
OFT	Orbital Flight Test
OGAs	Other Government Agencies
OHCM	Office of Human Capital Management
OI	Office of Investigations
OIG	Office of Inspector General
OLI	Operational Land Imager (Landsat Data Continuity Mission instrument)
OMB	Office of Management and Budget
OMC	Operations Management Council
OMI	Ozone Monitoring Instrument
OMPS	Ozone Mapping and Profiler Suite (NPOESS Preparatory Project instrument)
OMU	Other Minority Universities
ONERA	Office National d'Études et de Recherches Aérospatiales
OPAG	Outer Planets Assessment Group
OPF	Orbiter Processing Facility
ORR	Operations Readiness Review
OSC	Orbital Sciences Corporation
OSD	Office of Secretary of Defense
OSIRIS	Origins Spectral Interpretation Resource Identification and Security
OSMA	Office of Safety and Mission Assurance
OSTM	Ocean Surface Topography Mission
OSTP	Office of Science and Technology Policy
OSU	Ohio State University
OTE	Optical Telescope Element
PAAC	Program Analysis And Control
PACS	Photodetector Array Camera and Spectrometer
PA&E	Program Analysis and Evaluation
PAIR	Partnership Awards for the Integration of Research into Undergraduate Education
PAR	Program Acceptance Review
PARASOL	Polarization & Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar
PART	Program Assessment Rating Tool
PB	President’s Budget
PBR	President’s Budget Request
PBS	President’s Budget Submit
PCA	Program Commitment Agreement
PDR	Preliminary Design Review
PDS	Planetary Data System
PI	Principal Investigator
PICA	Phenolic Impregnated Carbon Ablator
PII	Performance Improvement Initiative
PIR	Program Implementation Review
PLM	Project Lifecycle Management
PLdB	Perceived Level in decibels
PMA	President's Management Agenda
PMC	Program Management Council
PMII	Project Management Improvement Initiative
PMP	Program Management Plan
PMS	Program Mission Support
PNAR	Preliminary Non-Advocate Review
POES	Polar Operational Environmental Satellites
PP&E	Property, Plant, and Equipment
PPAR	Preliminary Program Acceptance Review
PPBE	Planning Programming Budget and Evaluation
PR	Precipitation Radar
PROX	Proximity Communication System
PRV	Plant Replacement Value
PSM	Program Science Management
PSR	Physical Sciences Research
PTF	Plan, Train, Fly
PWR	Pratt and Whitney Rocketdyne
QAT	Quiet Aircraft Technology
QTR	Quarter
QuickSCAT	Quick Scatterometer
R&A	Research and Analysis
R&D	Research and Development
RAC	Robotic Arm Camera
RBSP	Radiation Belt Storm Probes
RBSPICE	Radiation Belt Science of Protons, Ions, Composition, and Electrons
REASoN	Research, Education and Applications Solutions Network

REMS	Rover Environmental Monitoring System
RFI	Request for Information
RFP	Request for Proposal
RHESSI	Reuven Ramaty High Energy Solar Spectroscopic Imager
RI	Research Institutions
RLEP	Robotic Lunar Exploration Program
RMB	Reimbursable
RMP	Risk Mitigation Phase
RND	Results Not Demonstrated
ROA	Remotely Operated Aircraft
ROSES	Research Opportunities in Space and Earth Science
RPCT	Radioisotope Power Conversion Technology
RpK	Rocket Plane-Kistler
RPS	Radioisotope Power System
RPT	Rocket Propulsion Testing
RR	Readiness Review
RS	Russian Segment
RSDO	Rapid Spacecraft Development Office
RSP	Radioisotope Power Systems
RSRB	Reusable Solid Rocket Booster
RSRM	Reusable Solid Rocket Motor
RTG	Radioisotope Thermoelectric Generators
RXTE	Rossi X–ray Timing Explorer
S&MA	Safety and Mission Assurance
SA	Single Access
SAA	Space Act Agreement
SAC-D	Satellite de Aplicaciones Cientificas–D (Argentina)
SAGE	Stratospheric Aerosol and Gas Experiment
SAIC	Science Applications International Corporations
SAMPEX	Solar Anomalous and Magnetospheric Particle Explorer
SAMS	Space Acceleration Measurement System
SAO	Smithsonian Astrophysical Observatory
SAR	Synthetic Aperture Radar
SATS	Small Aircraft Transportation System
SAU	Strategic Airspace Usage
SBC	Small Business Concern
SBIR	Small Business Innovative Research
SBRS	Santa Barbara Remote Sensing
SBT	Space-Based Technology
SBUV	Solar Backscatter Ultraviolet
SC	Shared Capabilities
SCAN	Space Communications and Navigation
SCAP	Shared Capability Assets Program
SCIP	Space Communications Constellation Integration Project
SCM	Search Coil Magnetometer (Thermal Emission Imaging System instrument)
SCP	Space Communications Program
SDLC	System Development Life Cycle
SDO	Solar Dynamics Observatory
SDR	System Design Review
SDSC	Satish Dhawan Space Center
SDT	Science Definition Team
SEC	Sun–Earth Connection
SELENE	Selenological and Engineering Explorer (Japan)
SEMAA	Science Engineering Mathematics Aerospace Academy
SES	Senior Executive Service
SESFA	Space Environments Simulation Facilities Alliance
SET	Space Environmental Spacecraft
SETI	Search for Extra-Terrestrial Intelligence
SEWP	Solutions for Enterprise-Wide Procurement
SFS	Space and Flight Support
SFW	Subsonic Fixed Wing
SHERE	Shear History Extensional Rheology Experiment
SHFH	Space Human Factors and Habitability
SHM	Scalar Helium Magnetometer
SIG	Systems Integration Group
SIM	Space Interferometry Mission
SIMBAD	Set of Identifications, Measurements, and Bibliography for Astronomical Data
SIRTF	Space Infrared Telescope Facility
SLI	Student Launch Initiative
SLR	Satellite Laser Ranging
SM-4	Servicing Mission–4
SMA	Safety and Mission Assurance
SMC/TEL	Space and Mission Command/Test and Evaluation Directorate
SMD	Science Mission Directorate
SMEX	Small Explorer
SMOR	Science Management Operations Review Team
SMOV	Servicing Mission Orbital Verification
SMP	Software Management Plan
SN	Space Network
SNSB	Swedish National Space Board
SOAREX	Sub-Orbital Aerodynamic Re-entry Experiment
SOC	Solar Orbiter Collaboration
SOFIA	Stratospheric Observatory for Infrared Astronomy
SOHO	Solar Heliospheric Observer
SOMD	Space Operations Mission Directorate
SORCE	Solar Radiation and Climate Experiment
SORT	SOFIA Options Review Team
SpaceX	Space Exploration and Technology
SPC	Solar Orbiter Collaboration
SPD	Space Product Development
SPDM	Special Purpose Dexterous Manipulater
SPF	Software Production Facility
SPIRE	Spectral and Photometric Imaging Receiver
SPL	Solar Probe Lite
SPOC	Space Program Operations Contract
SPoRT	Short-term Prediction Research and Transition Center
SR	Space Radiation
SRB	Solid Rocket Booster
SRD	Systems Requirements Document

SRG	Stirling Radioisotope Generator
SRLI	Surgical Research Laboratory, Inc.
SRR	System Requirement Review
SRU	Stellar Reference Unit
SRW	Subsonic Rotary Wing
SS	Steady State
SSC	Stennis Space Center
SSE	Solar System Exploration
SSME	Space Shuttle Main Engines
SSP	Space Shuttle Program
SSS	Sea Surface Salinity
SST	Solid State Telescope (Thermal Emission Imaging System instrument)
ST	Space Technology
STaR	Shuttle Transition and Retirement
STEM	Science, Technology, Engineering, and Mathematics
STEREO	Solar Terrestrial Relations Observatory
STIS	Space Telescope Imaging Spectrograph (Hubble Space Telescope instrument)
STOCC	Space Telescope Operations Control Center
STP	Solar Terrestrial Probes
STS	Space Transportation System
STScI	Space Telescope Science Institute
STSS	Space Tracking Surveillance System
STTR	Small Business Technology Transfer Program
SVA	Strategic Vehicle Architecture
SVD	System Vulnerability Detection
SwRI	Southwest Research Institute
T2	Technology transfer
TA	Technical Authority
TAA	Technology Assistance Agreements
TBM	Time-based metering
TCU	Tribal Colleges and Universities
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TE	Technical Excellence
TEGA	Thermal and Evolved Gas Analyzer
THEMIS	Time History of Events and Macroscale Interactions during Substorms
TIM	Total Irradiance Monitor (Glory instrument)
TIMED	Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics
TIMS	Thermal Infrared Multispectral Scanner
TMC	Technical, Management and Cost
TMI	TRMM Microwave Imager
T-NAR	Technology Non-Advocate Review
TNO TPD	Netherlands Organization for Applied Scientific Research - Institute of Applied Physics
TOC	Test Operations Contract
TOF	Time of Flight
TOMS	Total Ozone Mapping Spectrometer
TOMS-EP	Total Ozone Mapping Spectrometer - Earth Probe
TOPEX	Topographic Experiment for ocean circulation
TPF	Terrestrial Planet Finder
TPS	Thermal Protection System
T&R	Transition and Retirement
TRACE	Transition Region and Coronal Explorer
TRL	Technology Readiness Level
TRMM	Tropical Rainfall Measuring Mission
TTA	Technical Task Agreement
TT&C	Flight Tracking Telemetry and Command
TVC	Thermal Vacuum Chambers
TWINS	Two Wide–angle Imaging Neutral–atom Spectrometers
UAS	Uninhabited Air Systems
UAV	Unmanned Aerial Vehicle
UAZ	University of Arizona
UCLA	University of California at Los Angeles
UEET	Ultra–efficient Engine Technology
UI	University of Iowa
ULDB	Ultra Long Duration Balloon
ULF	Utilization and Logistics Flight
UNCFSP	United Negro College Fund Special Programs
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNITeS	Unified NASA Information Technology Services
URC	University Research Center
URETI	University Research Engineering, and Technology Institute
USA	United Space Alliance
USAF	United States Air Force
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USOS	United States Orbital Segment
USRA	Universities Space Research Association
USRP	Undergraduate Student Research Project
UTD	University of Texas at Dallas
UTMB	University of Texas Medical Branch
UV	Ultraviolet
UVS	UV Spectrometer
VAB	Vehicle Assembly Building
VAMS	Virtual Airspace Modeling and Simulation
VCAMS	Vehicle Cabin Atmosphere Monitoring
VCL	Vegetation Canopy Lidar
VExAG	Venus Exploration Analysis Group
VIIRS	Visible-Infrared Imager Radiometer Suite (NPOESS Preparatory Project instrument)
VIR	Visible and Infrared mapping spectrometer
VSE	Vision for Space Exploration
VSP	Vehicle Systems Program
VST	Vehicle Safety Technologies
WATR	Western Aeronautical Test Range
WAVES	Radio and Plasma Waves Instrument (Wind)
WCF	Working Capital Fund
WFC-3	Wide Field Camera–3 (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations instrument)
WISE	Wide-field Infrared Survey Explorer
WMAP	Wilkinson Microwave Anisotropy Probe

WRS	Water Recovery System
WSC	White Sands Complex
WST	Weather Safety Technologies
WSTF	White Sands Test Facility
XRT	X-Ray Telescope
XMM	X-ray Multi-mirror Mission (Newton Observatory)