Federal Aviation Administration

2007 Commercial Space Transportation Forecasts

May 2007

FAA Commercial Space Transportation (AST)
and the Commercial Space Transportation Advisory Committee (COMSTAC)

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About the Office of Commercial Space Transportation and the Commercial Space Transportation Advisory Committee

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) licenses and regulates U.S. commercial space launch and reentry activity as authorized by Executive Order 12465 (*Commercial Expendable Launch Vehicle Activities*) and 49 United States Code Subtitle IX, Chapter 701 (formerly the *Commercial Space Launch Act*). AST's mission is to license and regulate commercial launch and reentry operations to protect public health and safety, the safety of property, and the national security and foreign policy interests of the United States. Chapter 701 and the 2004 *U.S. Space Transportation Policy* also direct the Federal Aviation Administration to encourage, facilitate, and promote commercial launches and reentries.

The Commercial Space Transportation Advisory Committee (COMSTAC) provides information, advice, and recommendations to the Administrator of the Federal Aviation Administration within the Department of Transportation (DOT) on matters relating to the U.S. commercial space transportation industry. Established in 1985, COMSTAC is made up of senior executives from the U.S. commercial space transportation and satellite industries, space-related state government officials, and other space professionals.

The primary goals of COMSTAC are to:

- Evaluate economic, technological and institutional issues relating to the U.S. commercial space transportation industry;
- Provide a forum for the discussion of issues involving the relationship between industry and government requirements; and
- Make recommendations to the Administrator on issues and approaches for Federal policies and programs regarding the industry.

Additional information concerning AST and COMSTAC can be found on AST's web site, http://ast.faa.gov.

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Executive Summary

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) and the Commercial Space Transportation Advisory Committee (COMSTAC) have prepared forecasts of global demand for commercial space launch services for the period 2007 to 2016.

The *2007 Commercial Space Transportation Forecasts* report includes:

- The *COMSTAC 2007 Commercial Geosynchronous Orbit Launch Demand Model*, which projects demand for commercial satellites that operate in geosynchronous orbit (GSO) and the resulting commercial launch demand to geosynchronous transfer orbit (GTO); and

- The FAA's *2007 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits*, which projects commercial launch demand for satellites to non-geosynchronous orbits (NGSO), such as low Earth orbit, medium Earth orbit, elliptical orbits, and external orbits beyond the Earth.

Together, the COMSTAC and FAA forecasts project an average annual demand of 23.4 commercial space launches worldwide from 2007 to 2016. The combined forecasts are similar to last year's forecast of 23.6 launches per year. Twenty commercial launches occurred worldwide in 2006. The forecasts project a demand increase up to 34 launches during 2007 (17 GSO and 17 NGSO) including some missions delayed from 2006.

In the GSO market, satellite demand averages 21.0 satellites per year, similar to 20.8 satellites in the 2006 forecast. The resulting demand for launches per year decreased from 16.7 in 2006 to 15.3 because of an adjustment in the number of annual dual-manifested launches from an average of 4.1 per year in 2006 to 5.7 per year in this year's forecast. An analysis in the report indicates that after years of growth, the average mass per GSO satellite has stabilized.

The NGSO market includes 191 satellites in the market from 2007–2016, an increase of about 19 percent compared to the 2006 forecast because of an expansion of telecommunications and technology demonstration satellites. Launch demand overall is up 17 percent. While demand for small launch vehicles is similar compared to last year's forecast, demand for medium-to-heavy NGSO launch vehicles increased by over one launch per year because of heavier satellites in the forecast.

COMSTAC and FAA project an average annual demand for:

- 15.3 launches of medium-to-heavy launch vehicles to GSO;

- 4.9 launches of medium-to-heavy launch vehicles to NGSO; and

- 3.2 launches of small vehicles to NGSO.

Table 1 shows the totals for the 2007 forecast. Figures 1, 2, and 3 compare historical activity in GSO and NGSO to the 2007 forecast.

Table 1. Commercial Space Transportation Satellite and Launch Forecasts

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total	Average
Satellites												
GSO Forecast (COMSTAC)	23	22	21	23	19	22	21	21	19	19	210	21.0
NGSO Forecast (FAA)	34	18	34	30	22	14	13	10	8	8	191	19.1
Total Satellites	**57**	**40**	**55**	**53**	**41**	**36**	**34**	**31**	**27**	**27**	**401**	**40.1**
Launch Demand												
GSO Medium-to-Heavy	17	18	16	17	13	16	15	15	13	13	153	15.3
NGSO Medium-to-Heavy	11	8	8	5	4	3	2	4	2	2	49	4.9
NGSO Small	6	5	5	4	2	2	2	2	2	2	32	3.2
Total Launches	**34**	**31**	**29**	**26**	**19**	**21**	**19**	**21**	**17**	**17**	**234**	**23.4**

Figure 1. GSO Satellite and Launch Demand

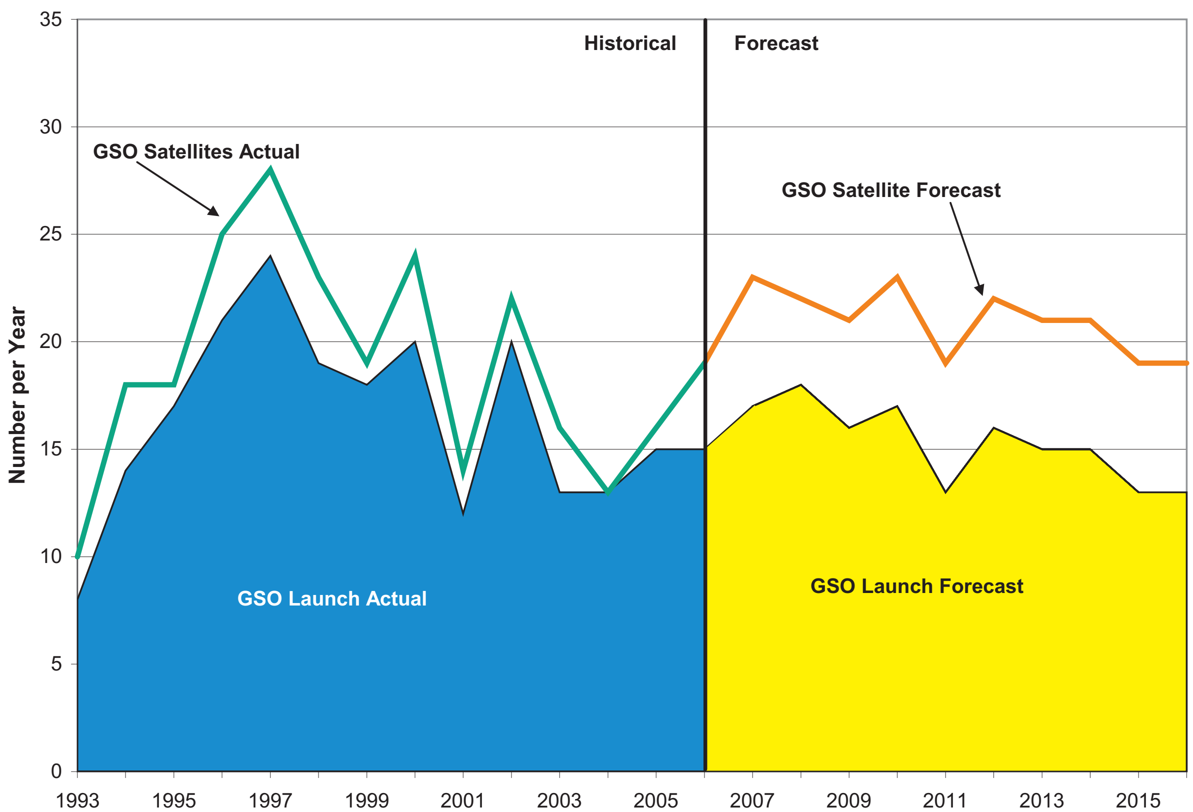


Figure 2. NGSO Satellite and Launch Demand

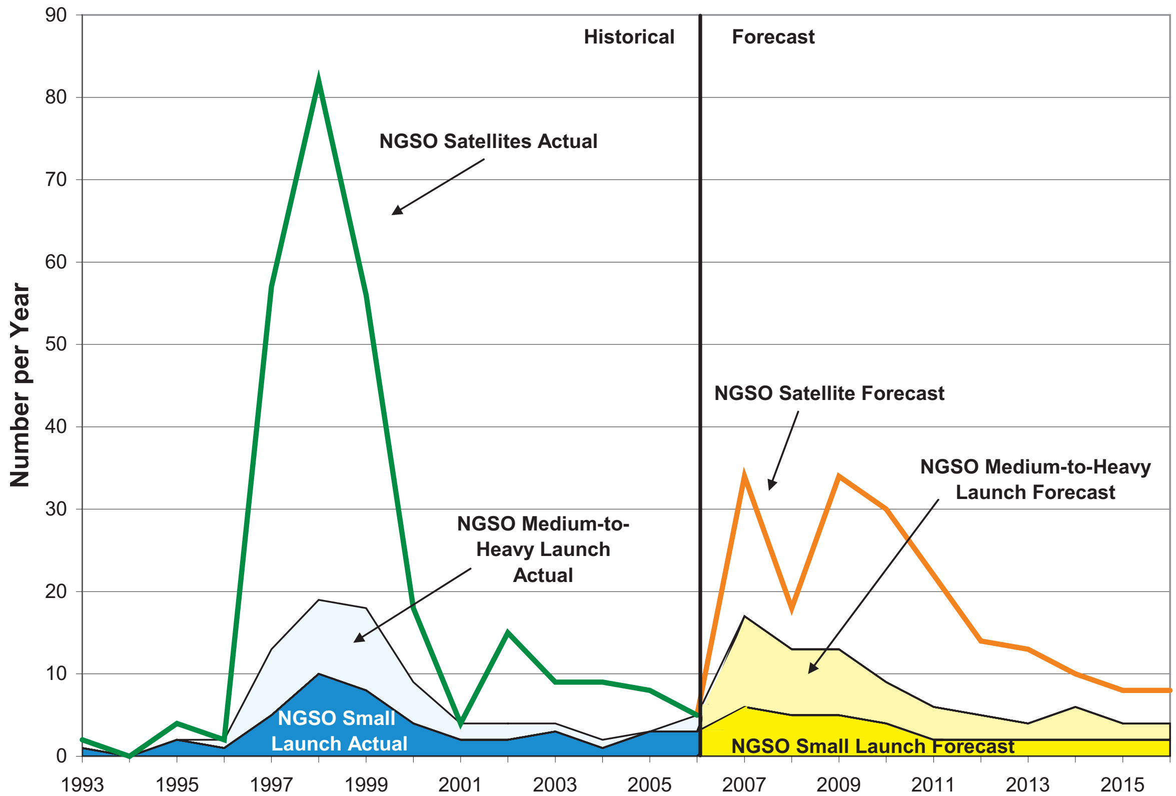
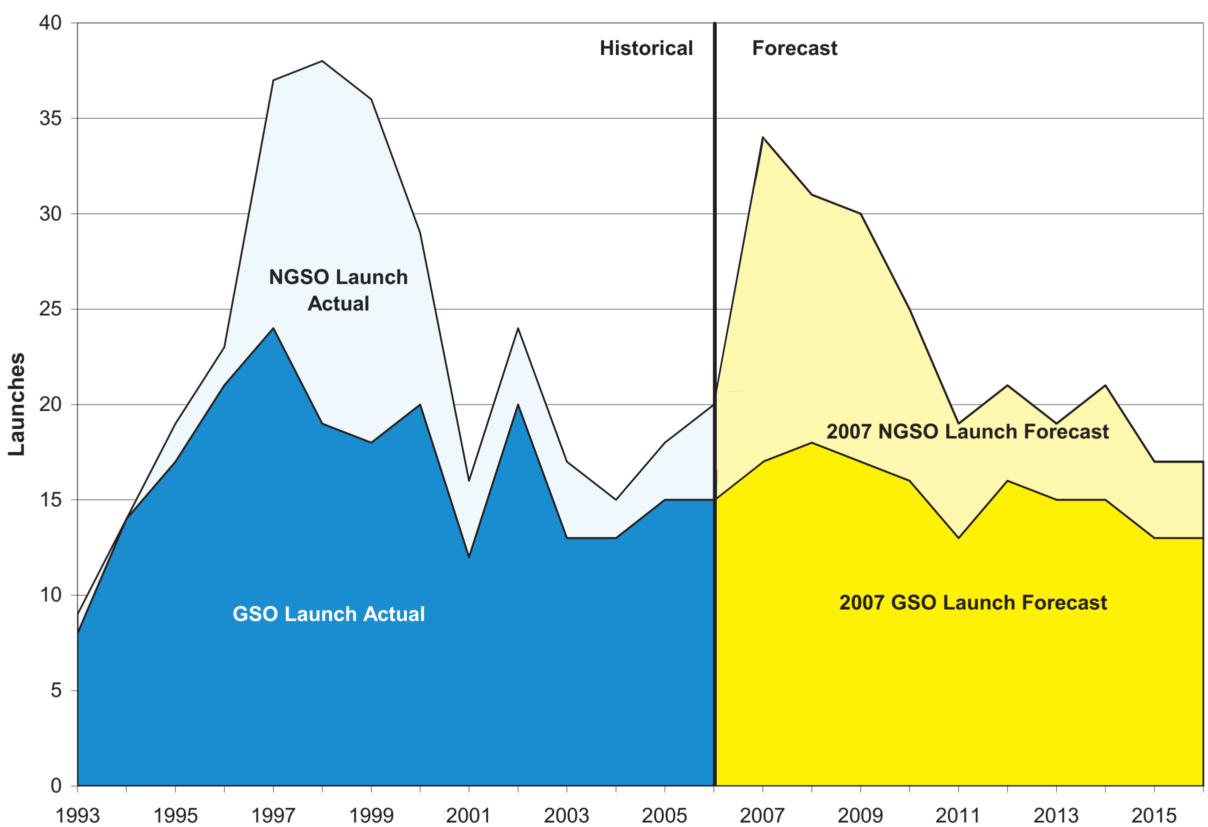


Figure 3. Combined GSO and NGSO Launch Forecasts



Introduction

Each year, the Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) and the Commercial Space Transportation Advisory Committee (COMSTAC) prepare forecasts of international demand for commercial space launch services.

The jointly-published *2007 Commercial Space Transportation Forecasts* report covers the period from 2007 to 2016 and includes two separate forecasts: one for launches to geosynchronous orbit and one for launches to non-geosynchronous orbits.

About the COMSTAC GSO Forecast

The *COMSTAC 2007 Commercial Geosynchronous Orbit Launch Demand Model*, which projects demand for commercial satellites that operate in geosynchronous orbit (GSO) and the resulting commercial launch demand to geosynchronous transfer orbit (GTO).

First compiled in 1993, the COMSTAC geosynchronous launch demand model is prepared using plans and projections supplied by U.S. and international commercial satellite and launch companies. Projected payload and launch demand is limited to those spacecraft and launches that are open to internationally competed launch service procurements. Since 1998, the model has also included a projection of launch vehicle demand, which is derived from the payload demand and takes into account dual manifesting of satellites on a single launch vehicle. COMSTAC is comprised of representatives from the U.S. satellite and launch industry.

About the FAA NGSO Forecast

The FAA's *2007 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits*, which projects commercial launch demand for all space systems in non-geosynchronous orbits (NGSO), including low Earth orbit, medium Earth orbit, elliptical orbits, and external orbits such as to the Moon or other solar system destinations.

Since 1994, the FAA has compiled an assessment of demand for commercial launch services to non-geosynchronous orbits, i.e., those orbits not covered by the COMSTAC GSO forecast. The NGSO forecast is based on a worldwide satellite assessment of science, commercial remote sensing, telecommunications and other spacecraft using commercial launch services. The forecast develops a model for deployment of NGSO satellites that are considered the most likely to launch and estimates launch demand after a review of multiple manifesting.

Characteristics of the Commercial Space Transportation Market

Demand for commercial launch services, a competitive international business, is directly affected by activity in the global satellite market ranging from customer needs and introduction of new applications to satellite lifespan and regional economic conditions. The GSO market has a steady commercial customer demand for telecommunications satellites with a current average satellite mass of about 4,100 kilograms. The NGSO market demand fluctuates, contains an average satellite mass of about 600 kilograms, and has a variety of missions for both commercial and government customers including science, commercial remote sensing, technology demonstrations and telecommunications.

Prior to the 1980s, launching payloads into Earth orbit was a government-run operation. Since then, launch activity led by commercial companies has increased to meet both commercial and government mission needs. From 1997–2001, a peak era in commercial satellite telecommunications, commercial launches accounted for an average of about 42 percent of worldwide launches. During 2006, 20 out of 66 worldwide launches were commercial, representing approximately 30 percent of global activity.

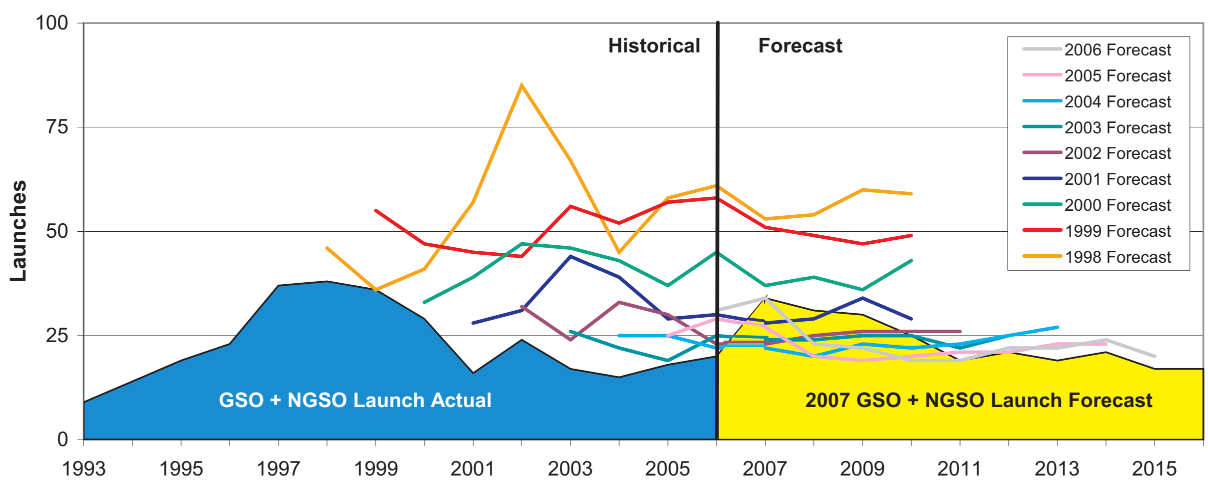
Demand Forecasts

It is important to note that the COMSTAC and FAA forecasts cover market *demand* for launch services and are not predictions of how many launches may actually occur based on historical averages of year-to-year delays or other factors.

Last year there were 15 worldwide commercial GSO launches compared to a demand of 18 in the 2006 forecast. The GSO report contains a description of demand and a future two-year realization factor for greater insight into the number of satellites that would reasonably be expected to launch. Similarly, the NGSO report contains a one-year realization factor for the current year. There were only five actual NGSO launches last year while the 2006 forecast projected a demand for 13 launches.

Figure 4 shows historical launch forecasts from 1998 to 2007 compared with actual launch activity.

Figure 4. Historical Commercial Space Transportation Forecasts



COMSTAC 2007 Commercial Geosynchronous Orbit (GSO) Launch Demand Forecast

Executive Summary

This report was compiled by the Commercial Space Transportation Advisory Committee (COMSTAC) for the Office of Commercial Space Transportation of the Federal Aviation Administration (FAA/AST). The 2007 Commercial Geosynchronous Orbit (GSO) Launch Demand Forecast is the fifteenth annual forecast of the global demand for commercial GSO satellites and launches addressable to the U.S. commercial space launch industry. It is intended to assist FAA/AST in its efforts to foster a healthy commercial space launch capability in the United States.

The commercial forecast is updated annually, and is prepared using the inputs from commercial companies across the satellite and launch industries. Both a satellite and a launch demand forecast are included in this report; the satellite demand is a forecast of the number of GSO satellites that satellite operators intend to have launched, and launch demand is determined by adjusting satellite demand by the number of satellites projected to be launched together, referred to in the report as a "dual-manifest" launch. This forecast includes only commercial satellite launches addressable by the U.S. space launch industry. Addressable is defined as launch service procurements open to international competition.

The 2007 Commercial GSO Launch Demand Forecast for 2007 through 2016 is shown in Figure 5. Table 2 provides the corresponding values of forecasted satellites to be launched, the estimated number of dual-manifested launches, and the resulting number of projected launches for each year.

The 2007 forecast predicts an average demand of 21.0 satellites to be launched annually in the ten-year time frame from 2007 through 2016. An average demand of 15.3 launches per year is forecast over the same time frame. This year's average satellite launch demand of 21.0 per year is effectively the same as the previous two COMSTAC GSO forecasts (20.8 satellite launches per year were forecast in 2006 and 20.5 satellite launches per year were forecast in 2005). The near-term forecast, which is based on specific existing and anticipated satellite programs for 2007 through 2009, shows demand for 23 satellites to be launched in 2007, 22 in 2008, and 21 in 2009.

It is important to distinguish between forecasted demand and the actual number of satellites expected to be launched. Satellite projects, like many high-technology projects, are susceptible to delays, which tend to make the forecasted demand an upper limit of the number of satellites that might actually be launched. A "launch realization factor" has been devised based on historical data of actual satellites launched versus predicted satellite demand from previous commercial GSO forecasts. This factor has been applied to the near-term forecast in order to provide an idea of the actual number of satellites that may reasonably be expected to be launched. For example, while the demand forecast for satellites to be launched in 2007 is 23, the realization factor discounts this to a range of between 15 and 19.

Over the fifteen years that this report has been published, predicted demand in the first year of the forecast period has consistently exceeded the actual number of satellites launched in that year. Since the launch realization factor was added to the COMSTAC

Figure 5. Commercial GSO Satellite and Launch Demand

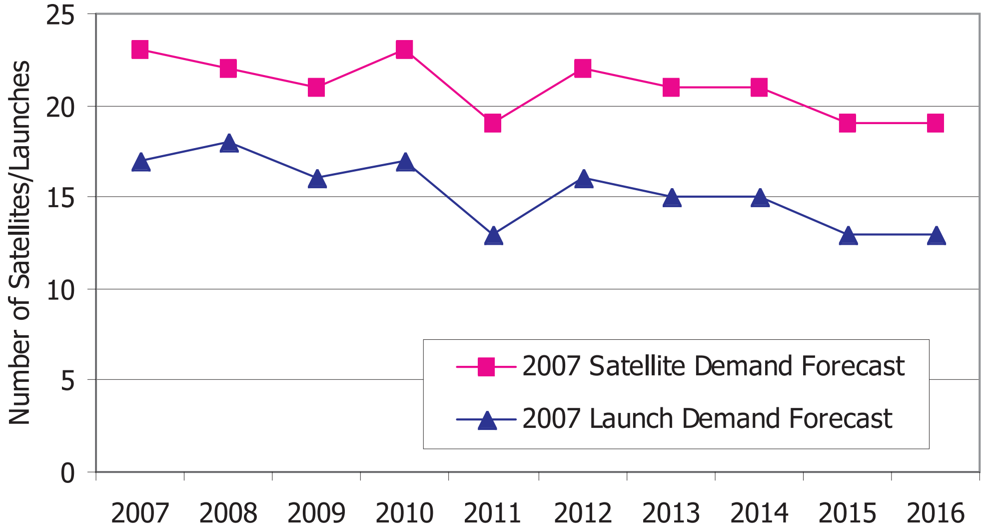


Table 2. Commercial GSO Satellite and Launch Demand Forecast Data

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total	2007 to 2016
Satellite Demand	23	22	21	23	19	22	21	21	19	19	210	21.0
Dual Launch Forecast	6	4	5	6	6	6	6	6	6	6	57	5.7
Launch Demand	17	18	16	17	13	16	15	15	13	13	153	15.3

GSO Demand Forecast in 2002, the actual number of satellites launched has indeed fallen within the discounted realization range.

In 2006, 19 commercial GSO satellites were launched, an increase of three from the 16 commercial satellites launched in 2005. Last year's forecast had projected a demand of 23 satellites to be launched in 2006, with a launch realization range of 13 to 20. Of the 19 satellites launched in 2006, 18 were correctly anticipated and one forecast for 2007 (AMC-18) launched early. The remaining five satellites not launched in 2006 are expected to launch in 2007 and are included in this year's near-term satellite demand forecast.

Several factors impact the demand for commercial GSO satellites, including global economic conditions, operator strategies, new market applications, and availability of financing for satellite projects. A more detailed description of some of these factors is discussed later in the report in conjunction with a survey of satellite service providers on what influences their future satellite purchase plans.

An alternative view of satellite launch statistics is included in an assessment of the number of transponders launched and the mass of satellites launched over time. This data shows a growth trend in both average satellite mass and average number of transponders per satellite. Based on the forecasted satellite launch demand for 2007, a record mass (nearly 100,000 kg) of total satellites to be launched in 2007 is predicted.

Background

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) of the U.S. Department of Transportation (DOT) is interested in fostering a healthy commercial space launch capability in the United States. In 1993, the DOT requested that its industry advisory group, the Commercial Space Transportation Advisory Committee (COMSTAC), annually prepare a commercial geosynchronous orbit (GSO) satellite launch demand forecast to obtain the commercial space launch industry's view of future space launch requirements.

COMSTAC prepared the first commercial demand forecast in April 1993 as part of a report on commercial space launch systems requirements. It was developed by the major U.S. launch service providers and covered the period 1992–2010. The following year, the major U.S. satellite manufacturers and the satellite service providers began to contribute to the demand forecast. In 1995, the Technology and Innovation Working Group (the Working Group) was formally chartered by the FAA/AST to prepare the annual Commercial Payload Mission Model Update. Since 2001, the Commercial Launch Demand Forecast has covered a ten-year rolling forecast, with this year's report covering 2007 through 2016. This year the committee received 22 inputs from satellite service providers, satellite manufacturers, and launch service providers. COMSTAC would like to thank all of the participants in the 2007 Commercial GSO Launch Demand Forecast.

Forecast Methodology

Except for minor adjustments, the Working Group's launch demand forecast methodology has remained consistent throughout the history of the forecast. In brief, the Working Group, via the FAA Associate Administrator for Commercial Space Transportation, requests commercial GSO satellite forecasts from global satellite operators, satellite manufacturers, and launch service providers. Individual input is requested from satellite operators for a projection of their individual company requirements for the period 2007–2016; comprehensive input is requested of satellite manufacturers and launch service providers for the industry forecast of annual addressable commercial GSO satellite demand for the period 2007–2016.

Addressable payloads in the context of this report are defined as commercial satellite launches open to internationally competitive launch service procurement. Excluded from this forecast are satellites captive to national flag launch service providers (i.e., U.S. or foreign government satellites that are captive to their own national launch providers or commercial satellites that are not internationally competed). In 2006, two commercial satellite launches, Kazsat 1 (Kazakhstan) and Sinosat 2 (China), were excluded from the actual number of addressable commercial launches listed in this report because they were not internationally competed.

As more nations without national launch providers enter the commercial satellite marketplace it is likely to be more common to see government-to-government agreements on building and launching spacecraft. This was the case with Kazsat 1, which was negotiated directly with the Russian government and never opened for international competition. China is leading the way with these relationships. In some cases they have won what began as an international competition by bundling satellite, launch, and other incentives as in the Nigcomsat and RASCOM opportunities. In others, they have pre-empted the opening of a competition, as in the Venesat opportunity. These kinds of instances will cause some variation in the forecast.

The commercial GSO satellite demand forecast is divided into four different mass classes based on the mass of the satellite at separation into geosynchronous transfer orbit (GTO). The mass categories are logical divisions based on standard satellite models offered by satellite manufacturers. The four classifications are: below 2,200 kilograms (<4,850 pounds); 2,200 to 4,200 kilograms (4,850 to 9,260 pounds); 4,200 to 5,400 kilograms (9,260 to 11,905 pounds); and above 5,400 kilograms (>11,905 pounds). A list of current

Table 3. Satellite Mass Class Categorization

GTO Launch Mass Requirement	Satellite Bus Models
Below 2,200 kg (<4,850 lbm)	LM A2100A, Orbital Star 2
2,200 - 4,200 kg (4,850 - 9,260 lbm)	LM A2100, Boeing 601/601HP, Loral 1300, Astrium ES2000+, Alcatel SB 3000A/B/B2, Orbital Star 2
4,200 - 5,400 kg (9,269 - 11,905 lbm)	LM A2100AX, Boeing 601HP/702, Loral 1300, Alcatel SB 3000B3
Above 5,400 kg (>11,905 lbm)	Boeing 702/GEM, Loral 1300, Astrium ES 3000, Alcatel SB 4000

satellite models associated with each mass category is shown in Table 3.

This year, the following 22 organizations (noted with the country in which their headquarters are located) responded with data used in the development of the 2007 report:

- Arianespace (France)
- Asia Satellite Telecommunications, Ltd. (China-Hong Kong)
- The Boeing Company* (U.S.)
- EADS Astrium (Europe)
- Echostar (U.S.)
- Indian Space Research Organization (India)
- Intelsat (U.S.)
- JSAT Corporation (Japan)
- Lockheed Martin Space Systems Co.* (U.S.)
- Mitsubishi Heavy Industries (Japan)
- Mobile Satellite Ventures (U.S.)
- Orbital Sciences Corp.* (U.S.)
- Protostar (U.S.)
- Sea Launch* (U.S.)
- SHIN Satellite (Thailand)
- Sirius Satellite Radio (U.S.)
- Space Communications Corporation (Japan)
- Space Systems/Loral* (U.S.)
- Star One S/A (Brazil)
- Telesat Canada (Canada)
- United Launch Alliance* (U.S.)
- WorldSpace (U.S.)

The Working Group uses the comprehensive inputs from the U.S. respondents (marked by an asterisk) to derive the average satellite demand expected per year by mass class. The sum of the demand in the four mass categories then provided total demand per year.

Forecasting commercial satellite launch demand presents significant difficulty and uncertainty. The satellite production cycle for an existing satellite design is approximately two years; it is typically longer for heavier, more complex satellites. Orders within a two-year time period are then generally certain. Satellite orders in the third year and beyond become more difficult to identify by name as many of these satellites are in premature stages of the procurement cycle. Beyond a five-year horizon, new markets or new uses of satellite technology may emerge that were not known during the forecast year.

Some of the factors that were considered by respondents in creating this forecast included:

- Firm contracted missions
- Current satellite operator planned and replenishment missions
- Projection of growth in demand from new and existing satellite services/applications
- Availability of financing for commercial space projects
- Industry health and consolidation

The combined comprehensive input from U.S. respondents was used for the long-term demand forecast 2010–2016. The near-term forecast, covering the first three years (2007–2009) of the ten-year forecast, was developed by the Working Group in conjunction with individual satellite operators' inputs. It is a compilation of launch vehicle providers' and satellite manufacturers' manifests, as well as an assessment of potential satellite systems to be launched.

In order to determine the demand for commercial GSO launches, the satellite demand forecast was adjusted by the projected number of dual-manifested launches per year (i.e., launch of two satellites at once). Based on the future plans and capability of Arianespace's Ariane 5, it is estimated that six launches per year will be dual-manifested in the long-term forecast; the near-term forecast of dual-manifest launches is based on an assessment of the current Arianespace manifest.

2007 COMSTAC Commercial GSO Launch Demand Forecast Results

Near-Term Demand Model

The three-year near-term demand forecast is based on input from each U.S. satellite manufacturer and launch service provider, along with the inputs received from individual satellite operators. Development of the near-term forecast in this way results in a projection of the maximum identifiable demand for satellites to be launched each year. Identified demand for any particular year is defined as the number of satellites that customers wish

Table 4. Commercial GSO Near-Term Manifest

	2007		2008		2009	
Total	**23**		**22**		**21**	
Below 2,200kg (<4,850 lbm)	**1**		**2**		**0**	
	BSAT 3A	Ariane	Vinasat	Ariane		
			Amos 3	Land Launch		
2,2200 - 4,200 kg (4,850 - 9,260 lbm)	**9**		**7**		**9**	
	*Insat 4B	Ariane	AMC 21	Ariane	COMS 1	Ariane
	Star One C1	Ariane	Eutelsat W2M	Ariane	BADR 5	Ariane
	Galaxy 17	Ariane	BADR-6	Ariane	Asiasat 5	Land Launch
	Optus D2	Ariane	Hot Bird 9	Ariane	SES Open	Land Launch
	Intelsat 11	Ariane	Measat 1R	Land Launch	Measat 5	TBD
	JCSat 11	Proton	Telstar 11N	Land Launch	Nilesat 201	TBD
	Thor 5	Proton	HYLAS	TBD	Afristar 2	TBD
	Horizons 2	Ariane			Palapa D	TBD
	Star One C2	Ariane			NSS-9	TBD
4,200 - 5,400 kg (9,260 - 11,905 lbm)	**9**		**6**		**6**	
	Astra 1L	Ariane	Superbird 7	Ariane	Skynet 5C	Ariane
	*Skynet 5A	Ariane	Turksat 3A	Ariane	Eutelsat W7	Sea Launch
	Skynet 5B	Ariane	Nimiq 4	Proton	Hot Bird 10	TBD
	Nigcomsat	LM CZ-3B	Astra 1M	Proton	Astra 3B	TBD
	RASCOM	LM CZ-3B	Galaxy 18	Sea Launch	Nimiq 5	TBD
	*Anik F3	Proton	Galaxy 19	Sea Launch	AMC 19	TBD
	SES Sirius 4	Proton				
	*AMC 14	Proton				
	Thuraya 3	Sea Launch				
Over 5,400kg (>11,905 lbm)	**4**		**7**		**6**	
	Spaceway 3	Ariane	Protostar 1	Ariane	Eutelsat W2A	Sea Launch
	ICO-GEO 1	Atlas V	Terrestar 1	Ariane	Sirius FM 5	Proton
	DirecTV 10	Proton	Ciel 2	Proton	Intelsat 14	TBD
	*NSS-8	Sea Launch	CMBStar	Proton	Echostar 14	TBD
			XM 5	Sea Launch	MSV 1	TBD
			Echostar 11	Sea Launch	Terrestar 2	TBD
			DirecTV 11	Sea Launch		

* Indicates slip from COMSTAC 2006 GSO Forecast

to have launched, with no adjustment for potential launch schedule delays. Table 4 shows the near-term mission model for 2007 through 2009.

Satellite Launch Forecast Mass Class Trend

Figure 6 and Table 5 show the trends in annual GSO satellite mass distribution. Actual data are presented for 1993 through 2006, followed by the distribution projected in this year's demand forecast.

This year's forecast distribution between mass classes has only slight differences from last year's forecast. The forecast still calls for a continued average of approximately 60 percent of satellites to be launched being in the two largest mass class categories (satellites with mass greater than 4,200 kg). The trend toward larger satellites has been demonstrated in the actual satellites launched over the last several years. In 2005, 63 percent of satellites launched had a mass greater than 4,200 kg, with six satellites having a mass greater than 5,400 kg. In 2006, 57 percent of satellites launched had a mass of greater than 4,200 kg, two of which were greater than 5,400 kg. The expectation is that the percentage of satellites in the larger two classes will remain steady with some minor shifting across the top two mass categories.

The more obvious trend seen over the last several years' forecasts has been the reduction of the number of satellites in the smallest, less than 2,200 kg class.

The forecast shows a decline in the number of satellites in the less than 2,200 kg mass

Figure 6. Trends in GSO Satellite Mass Distribution

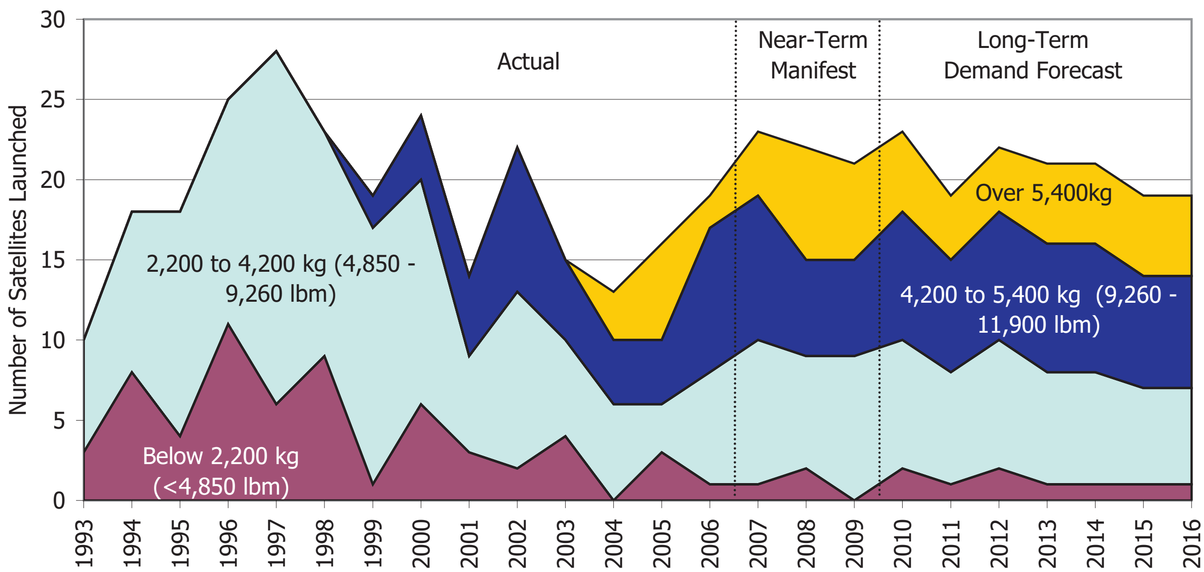


Table 5. Trends in GSO Satellite Mass Distribution

	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	Total 2007 to 2016	Avg 2007 to 2016	% of Total
Below 2,200 kg (<4,850 lbm)	3	8	4	11	6	9	1	6	3	2	4	0	3	1	1	2	0	2	1	2	1	1	1	1	12	1.2	6%
2,200 to 4,200 kg (4,850 - 9,260 lbm)	7	10	14	14	22	14	16	14	6	11	6	6	3	7	9	7	9	8	7	8	7	7	6	6	74	7.4	35%
4,200 to 5,400 kg (9,260 - 11,900 lbm)	0	0	0	0	0	0	2	4	5	9	5	4	4	9	9	6	6	8	7	8	8	8	7	7	74	7.4	35%
Over 5,400 kg (>11,900 lbm)	0	0	0	0	0	0	0	0	0	0	0	3	6	2	4	7	6	5	4	4	5	5	5	5	50	5	24%
Total	**10**	**18**	**18**	**25**	**28**	**23**	**19**	**24**	**14**	**22**	**15**	**13**	**16**	**19**	**23**	**22**	**21**	**23**	**19**	**22**	**21**	**21**	**19**	**19**	**210**	**21**	**100%**

category (1.2 per year compared to 2.2 per year in last year's forecast), though ESA recently announced the development of a small GEO satellite in conjunction with OHB-System called the ARTES 11. In previous years, the reduction was demonstrative of the overall trend to larger satellites. This year, the decrease in the number of these smallest satellites is proportional to the increase in the next larger category, 2,200 kg to 4,200 kg (7.4 per year compared to 6.1 per year in last year's forecast). The migration of the small mass category is most likely due to the changes in satellite manufacturers' product lines. Orbital Science's Star bus has incorporated design changes that bring its mass close to the 2,500-kg range, just over the small mass class cutoff of 2,200 kg. Astrium and ISRO are jointly marketing the INSAT bus which can weigh as much as 3,000 kg. The ability to migrate these small satellites to the next class has been assisted by the introduction of two new launchers with capability between 3,000 and 3,500 kg, Soyuz (from Kourou) and Land Launch.

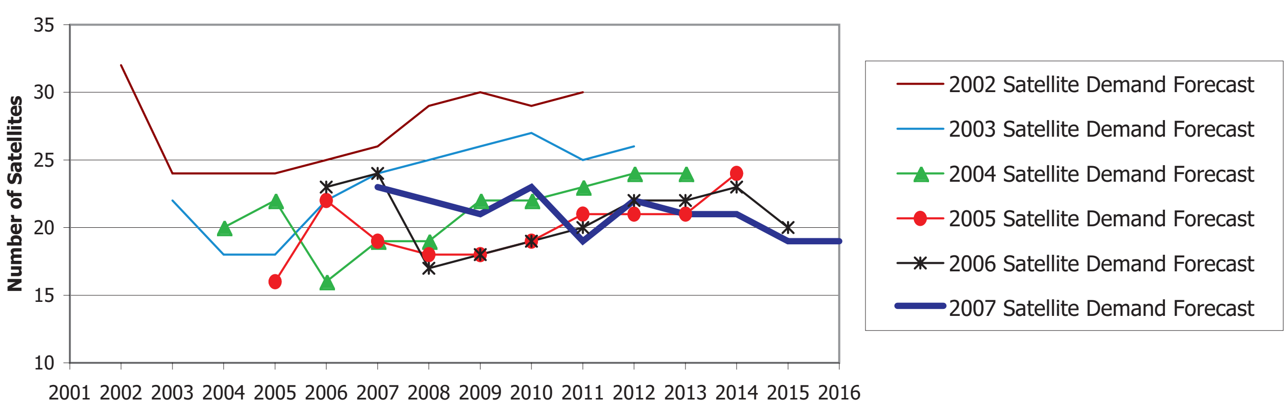
Comparison with Previous COMSTAC Demand Forecasts

The 2007 forecast for commercial GSO satellites launched is compared to the 2002 through 2006 forecasts in Figure 7. The ten-year demand forecast had been dropping by 10–15 percent annually from 2001 to 2004. Since 2004, the ten-year forecast has remained fairly consistent, thus establishing the floor of the demand forecast. Comparing this year's forecast to the previous three years' forecasts, the "traveling bow wave" has been filled in. This "bow wave" effect occurs due to the difference between demand and realized launches, where the demand is typically greater than the actual number of launches due to launch delays. Despite the failure of Proton in early 2006, all launchers saw a fairly successful year with a net sum of only four launches sliding into 2007. This, combined with the impacts of the 2007 Sea Launch failure already being accounted for, has had the effect of flattening that bow wave. As always, the third year of the near-term manifest, when satellites are being planned but have not been named publicly, is the hardest to predict. But, with the currently crowded launch manifests even that third year is becoming more stable. Unlike last year's forecast, a demand recovery to greater than 20 satellite launches per year is predicted to be here already.

Comparison to International Comprehensive Inputs

This year, the Working Group received comprehensive inputs from two major international launch service providers (Arianespace and Mitsubishi Heavy Industries) and one major international satellite manufacturer (EADS Astrium). The combined average of these international inputs is slightly higher than the combined 2007 demand forecast based on U.S. satellite and launch vehicle manufacturer inputs. The international input average annual demand for 2007 through

Figure 7. 2002 Through 2006 vs. 2007 Commercial GSO Satellite Demand Forecast



2016 is 22.6 satellites per year; the U.S.-based average annual demand forecast is 21.0 satellites per year. The distribution between mass classes is effectively the same between U.S. and international respondents.

Launch Vehicle Demand

The commercial GSO launch forecast is based on the forecasted number of satellites expected to launch and an assumption on the amount to which launch vehicles will dual-manifest payloads (launch two satellites at once). Currently only the Ariane 5 has the capability to dual-manifest commercial GSO satellites.

Given the history of dual-manifest realization and the unlikely expectation that new dual-manifest capabilities will emerge during the forecast period, the Working Group has based its projection of dual-manifest launches on Arianespace's projected manifest. Arianespace has indicated a launch expectation of approximately six Ariane 5 vehicles in 2007, seven in 2008 and eight in 2009, with most, if not all, commercial missions expected to be dual-manifested. Based on Arianespace's launch history, we project that of the projected missions, one per year will likely be of a non-commercial (e.g., European government) payload, and one commercial mission will have to fly on a single-manifested mission due to schedule, manifesting, or customer choice, meaning that six dual-manifested missions can be expected each year for the 2010–2016 forecast period. The 2007–2009 near-term forecast includes dual-manifest launches consistent with the best current understanding of the mission set.

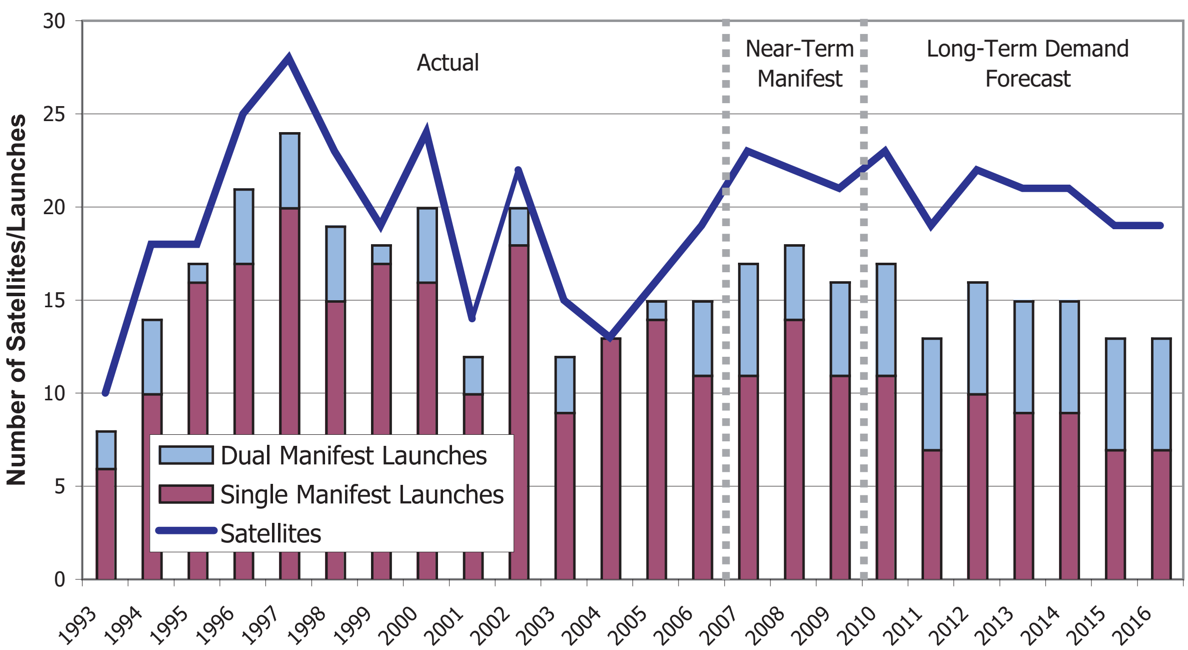
Figure 8 presents the 2007 satellite and launch demand forecast as well as actual values for 1993 through 2006.

COMSTAC Demand Projection vs. Actual Launches Realized

Factors That Affect Satellite Launch Realization

The demand projection is a representation of the number of new or replacement satellites that customers wish to launch in a given year. The demand is typically a larger number than the actual number of satellites launched in a given year.

Figure 8. 2007 COMSTAC GSO Satellite and Launch Demand Forecast



Some of the factors that potentially affect the realization of actual launches for a given year are:

- **Satellite issues.** Satellite manufacturers may have factory, supplier, or component issues that can delay the delivery of a spacecraft to the launch site or halt a launch of the vehicle that is already on the pad. Increased satellite complexity increases the likelihood of a delay due to technical challenges or immature planning.

- **Launch vehicle issues.** Launch vehicle manufacturers may have factory, supplier, or component issues that can delay the availability of the launch vehicle or cause a delay at the launch pad. A launch failure or component problem can cause a stand-down of subsequent launches until the proper anomaly resolution has been identified.

- **Scheduling issues.** One launch delay can impact subsequent launches scheduled in a given year. Missing one launch window may cause a significant delay, especially in a well-packed launch manifest.

- **Dual-manifesting.** The desire to dual-manifest creates additional schedule complexity, in that one launch could be delayed if either satellite is not available at the scheduled time, or if one satellite has a technical problem. Payload compatibility issues may also cause manifesting challenges.

- **Weather.** Weather, including ground winds, flight winds, cloud cover, and currents, can cause launch delays, though these typically are short-term (i.e. on the order of days) delays. Added complexity comes from needing good weather conditions not only at the launch sites but also at range safety sites.

- **Planning.** Failure to perform to plan may result in delays. Corporate reprioritization or changing strategies of satellite operators may delay or cancel currently planned launches.

- **Funding.** Satellite service providers may be unable to obtain the funding needed to carry out planned satellite launches, or they may be delayed until alternate funding is found.

- **Regulatory issues.** Export compliance problems, Federal Communications Commission (FCC) licensing issues, or trouble in dealing with international licensing requirements can slow down or stop progress on a program. The U.S. Government policy regarding satellite and launch vehicle export control is hampering U.S. satellite suppliers and launch vehicle providers in their efforts to work with their international customers, as well as U.S. satellite operators using foreign launch operators and satellite manufacturers. This has caused both delays and cancellations of programs.

Projecting Actual Satellites Launched Using a Realization Factor

The Working Group acknowledges that over the history of this report, the forecasted demand in terms of both satellites and launches has almost always exceeded the actual number of satellites and launchers for the near-term (first three years) forecast. In order to provide an estimate of the number of near-term satellites one might reasonably expect to be launched, the near-term demand for satellites has been adjusted by a "realization factor." Each time the report is published, an historical variance is calculated. This year a five-year rolling window of forecasted demand and the actual number of satellites launched for the first two forecast years was used, versus total historical launches since 1996. The working group believes this provides a more accurate factor for the near term forecast. The average variance for the first year is 29 percent while the average variance for the second year is 27 percent.

The range of expected actual satellites launched is calculated by multiplying the near-term demand forecast for the first and second years by the five year rolling window highest and lowest variance for the first and second years. Applying the calculated realization band to the 2007 forecast demand of 23 satellites yields a probable range of satellites that will actually be launched of 15 to 19. For the 2008 demand forecast of 22 satellites, a realized number of launches of between 14 and 19 are expected. Figure 9 shows the historical first year forecast compared to actual satellites launched from 1993 to 2005, as well as the near-term and long-term demand forecast with realization ranges shown for 2002 through 2008.

Since 2002 when the launch realization factor was added to the COMSTAC GSO Launch Demand Forecast, the actual number of satellites launched has indeed fallen within the discounted launch realization range.

Forecasted Satellite Demand Versus Actual Satellite Launches in 2006

The 2006 COMSTAC Commercial GSO Demand Forecast listed 23 satellites for the 2006 near-term manifest. Nineteen satellites were actually launched in 2006. The difference between actual and manifested satellite launches was due to many reasons:

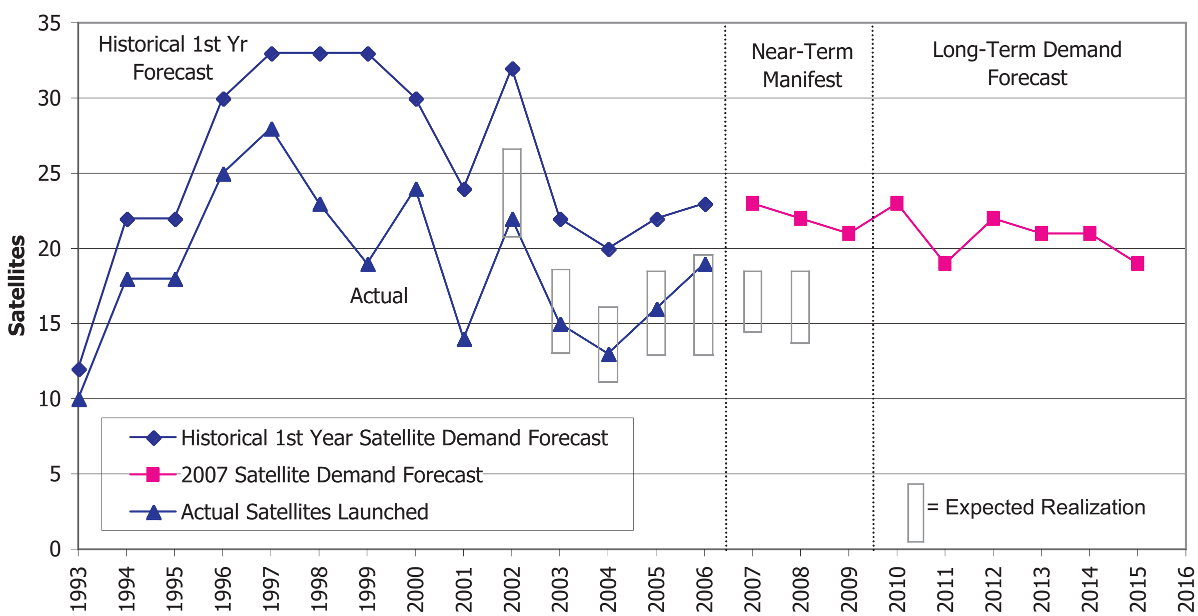
- One satellite launched earlier than forecasted (AMC-18 had been forecast to launch in 2007)
- Two satellites were delayed due to satellite issues
- One was delayed due to launch vehicle issues
- One was delayed due to both satellite and launch vehicle issues
- One was delayed due to scheduling issues for a dual-manifest launch

All of the five delayed satellites are expected to launch in 2007, with four of the satellites already having been launched as of publication of this report (one of these launches, NSS 8, failed).

Launch Assurance Agreements

As discussed earlier in the report, launch delays may drive a customer to explore alternative launch solutions in order to meet revised on-orbit requirements. To address this circumstance, launch service providers have developed schedule assurance offerings that provide for backup arrangements on a different vehicle. The Launch Services

Figure 9. Commercial GSO Satellite Demand: Historical, Near-term and Long-term Forecasts



Alliance (LSA), formed by Arianespace, Sea Launch, and Mitsubishi Heavy Industries, offers dual or triple integration among the Ariane 5, Zenit 3SL, and H-IIA launch systems if this backup option is selected at the time of contract signing.

Factors That May Affect Future Demand

Global and industry environmental factors can affect current and future demand forecasts for commercial GSO satellite launches. The Working Group has identified the following issues as potential factors that may impact satellite demand in the future:

- **Economic conditions** continue to improve. Low interest rates have allowed for a stable to increasing amount of financial venture capital for commercial space businesses. Many global fixed satellite service (FSS) operators are highly leveraged with debt levels more than six times earnings before interest, taxes, depreciation, and amortization (EBITDA). The debt market's willingness to offer financing and the low interest rates have allowed mature operators like SES and Intelsat to refinance to more favorable rates, decreasing their interest expenses. This high level of debt combined with continuing excess satellite transponder capacity in some regions may impede short-term demand for satellites.

- **New commercial competitors** will impact the launch market over the next few years with increased competition. Sea Launch is now offering Land Launch vehicles to be launched from the Baikonur Cosmodrome. Land Launch uses a Zenit 3SLB vehicle, modified slightly from the Sea Launch Zenit 3SL. Its lift capability of 3,600 kg moves Sea Launch Company, LLC into the medium launch market segment (2,200–4,000 kg), complementing the Sea Launch heavy-lift capability. Launch rate capacity will be four to five launches per year. Due to production capacity issues between Sea Launch and Land Launch vehicles, Land Launch launches have been delayed about one year, with the first commercial launch planned for 2008. The debut of Arianespace's Soyuz launch from French Guiana (Kourou) has been delayed until 2009, with construction on the launch site in Kourou starting in late March of this year. This modified Soyuz will provide medium-lift capability: the Soyuz 2-1-a can lift 2,700 kg to GTO, and the Soyuz 2-1-b will be capable of lifting 3,000 kg to GTO. The near-equatorial launch location significantly increases the capacity of the upgraded Soyuz over the launch capacity from Baikonur. This will add another new competitor in the medium launch market segment. A new entrant to the space launch industry is SpaceX, a commercially-funded company designing the Falcon 1 and Falcon 9 launch vehicles. The Falcon 1 has been launched twice, both times failing to put its payload into the correct orbit. While the Falcon 1 is too small to launch payloads to GTO, the larger Falcon 9 will be able to launch 3,100 kg to GTO. Its first launch is scheduled for 2008.

- **Indigenous launch vehicles** will likely decrease the demand for internationally-competed commercial launches as more countries decide to build and launch their own government and commercial payloads. Potential indigenous competitors in the commercial market include the Indian GSLV, the Chinese Long March 3B, and the Japanese H-IIA. The GSLV has a lift capability of 2,200 kg to GTO. However, it is still in the development phase; two out of four of the GSLV launches have failed. India is continuing with its launch vehicle program, and will eventually launch its Insat satellites, which had previously been part of the internationally-competed commercial launch market. The Long March 3B can lift 5,000 kg to GTO. It is currently scheduled to launch two commercial GEO satellites in 2007: Nigcomsat and RASCOM. The H-IIA has a lift capacity of 4,100–5,000 kg to GTO.

Japan has successfully flown 11 out of 12 payloads on the H-IIA. The Japanese Space Agency, JAXA, plans to build an H-IIB vehicle with greater lift capability, and launch by 2009. As more countries become space-faring nations, the degree of open (commercial) competition for launches will decrease.

- **New market applications** have increased the demand for satellite services. Ka-band satellites has become a reality with the launch of high-definition television (HDTV) and broadband satellites. Business success of broadband systems are determining the rate of future demand, while HDTV appears to be headed for success. Other emerging applications that could impact future demand include mobile video broadcast services to wireless handsets/terminals as well as emerging Internet Protocol television (IPTV) applications. Another new service is being developed in the mobile satellite services (MSS) sector. Three systems–ICO, TerreStar, and MSV–will use the new Ancillary Terrestrial Component authorized by the FCC. This enables an integrated terrestrial/satellite network solution for MSS providers. If these systems are successful, similar systems could be developed worldwide. XM and Sirius Satellite Radio, the successful digital audio radio service (DARS) systems in the U.S., are also sparking worldwide interest in this new service.

- **High-speed terrestrial services** have lowered demand for satellite-based data transfer because of existing terrestrial capacity and price competition. There remains an overcapacity of inexpensive land-based fiber optic assets.

- **Data compression technology** has been steadily increasing the amount of information carried over a given satellite channel. Improvement in video compression methods especially has allowed expansion in the number of video channels carried over satellite without increasing transponder demand. In addition, data compression also allows more information to cross terrestrial systems, decreasing the need for space-based systems.

- **U.S. Government regulatory environment** continues to be a factor in the redistribution of market share from the domestic market. More international operators are purchasing their satellites and launchers from international manufacturers to avoid the U.S.-imposed restrictions. As an example, traditional U.S. market operators/customers such as Telesat Canada, INMARSAT, and Space Communications Corporation (SCC) of Japan have recently ordered Alcatel, Astrium, and Mitsubishi Electric Company (Melco) satellites.

- **Private equity firms** have purchased controlling stakes and other significant equity positions in some of the largest satellite operators in the world, including Intelsat and Eutelsat. It has yet to be seen how the strategic plans of these new owners will affect the demand level of new and replacement satellites from these operators.

- **Satellite operator consolidation**, such as the recent Intelsat and PanAmSat merger, the SES Global acquisition of New Skies Satellites, and the proposed XM/Sirius merger are occurring as operators are seeking complementary markets and services to offer global solutions. Low capacity utilization rates allow for consolidation of capacity on fewer satellites. Consolidation appears to impact the timing of and funding for anticipated replacement orders.

Supplementary Questionnaire Results

As part of the COMSTAC request for inputs from industry participants, a supplemental questionnaire was provided to satellite service providers. The questions focused on determining how certain factors have impacted satellite service providers' recent plans to purchase and launch satellites. A summary

Table 6. 2007 COMSTAC Survey Questionnaire Summary

	Significant Negative Impact	Some Negative Impact	No Effect	Some Positive Impact	Significant Positive Impact	Compared to 2006 ⬆ = more pos ⬇ = more neg
Regional or global economic conditions	0%	42%	33%	17%	8%	⬇
Demand for satellite services	0%	25%	8%	50%	17%	-
Ability to compete with terrestrial services	0%	17%	50%	17%	17%	⬆
Availability of financing	8%	17%	58%	17%	0%	⬇
Availability of affordable insurance	0%	33%	50%	17%	0%	⬆
Consolidation of service providers	9%	27%	64%	0%	0%	⬇
Increasing satellite life times	0%	17%	83%	0%	0%	-
Availability of satellite systems that meet your requirements	8%	8%	58%	17%	8%	⬇
Reliability of satellite systems	0%	27%	45%	27%	0%	-
Availability of launch vehicles that meet your requirements	17%	42%	33%	0%	8%	⬇
Reliability of launch systems	0%	50%	33%	17%	0%	⬇
Ability to obtain required export licenses	17%	42%	42%	0%	0%	⬇
Ability to obtain required operating licenses	0%	8%	83%	0%	8%	⬆

Legend	
Large # positive	(green)
Large # negative	(red)
Slightly positive or negative	(yellow)

of the results of this questionnaire is provided in Table 6. The colors indicate areas of impact to the operators, and the last column is a comparison to the 2006 COMSTAC report.

Inputs were received from the following 12 satellite service providers. The Working Group would like to offer special thanks to these organizations for providing this additional input:

- Asia Satellite Telecommunications, Ltd.
- Echostar
- Indian Space Research Organization
- Intelsat/PanAmSat
- Mobile Satellite Ventures
- Protostar
- SHIN Satellite
- Sirius Satellite Radio
- Space Communications Corporation
- Star One S/A
- Telesat Canada
- WorldSpace

The 2007 survey reflects mixed trends in the global environment and satellite market demand drivers, along with positive improvements in industry's ability to meet the needs of satellite service providers.

Near-term demand for new satellite orders remains soft, though improving, in many regions due to continuing excess transponder capacity. The impact of the consolidation of service providers on satellite demand is more negative this year, with 36 percent of respondents indicating significant or some negative impact compared to 25 percent in 2006. Additionally, the reliability and availability of the satellite systems are identified as having a more negative impact according to the survey. Launch vehicle reliability was cited as a negative factor by 50 percent of respondents, versus six percent in 2006, driven by recent launch failures. Finally, launch vehicle availability is cited as a negative factor by 59 percent of respondents, versus six percent in 2006, also driven by launch failures and full near-term manifests.

On the positive side, global economic conditions have improved, although some regions are still experiencing difficulty. Access to financing remains stable and the availability of affordable insurance has improved. Difficulties in obtaining export and operating licenses have also improved in the last year. Finally, the ability to compete with terrestrial services improved, with only 17 percent of the respondents citing it as a negative influence, versus 31 percent in 2006.

Commercial GSO Satellite Trends

Trends in Number of Transponders per Satellite

Figure 10 and Table 7 show the number of C-band, Ku-band, and Ka-band transponders launched per year and the average number of transponders per satellite launched from 1993 to 2006, with a projection for 2007 based on the near-term manifest shown in Table 4. Peaks in total number of transponders launched correspond to peaks in number of satellites launched for a given year. The total number of transponders launched in 2003, 2004, and 2005 were low compared to previous history. However, 2006 saw a 22 percent increase in the total number of transponders due to the increase in number of satellites launched. Only slight growth is expected in 2007 as a couple more satellites are expected to be launched. Looking over the last five years, the growth trend in the average number of transponders per satellite has stabilized. This corresponds with the stabilization of the move to heavier, higher-powered satellites. The average in 2006 dropped as the number of the heaviest class satellites declined. The average will continue to shift slightly, but overall stability seems likely.

For the purpose of this analysis, a small number of satellites were excluded because their application is substantially different from the standard commercial GSO satellite. The satellites excluded are those used primarily for mobile applications because their communication payloads are not easily analyzed in terms of typical C-band, Ku-band,

Figure 10. Total C/Ku/Ka Transponders Launched Per Year and Average Transponders per Satellite

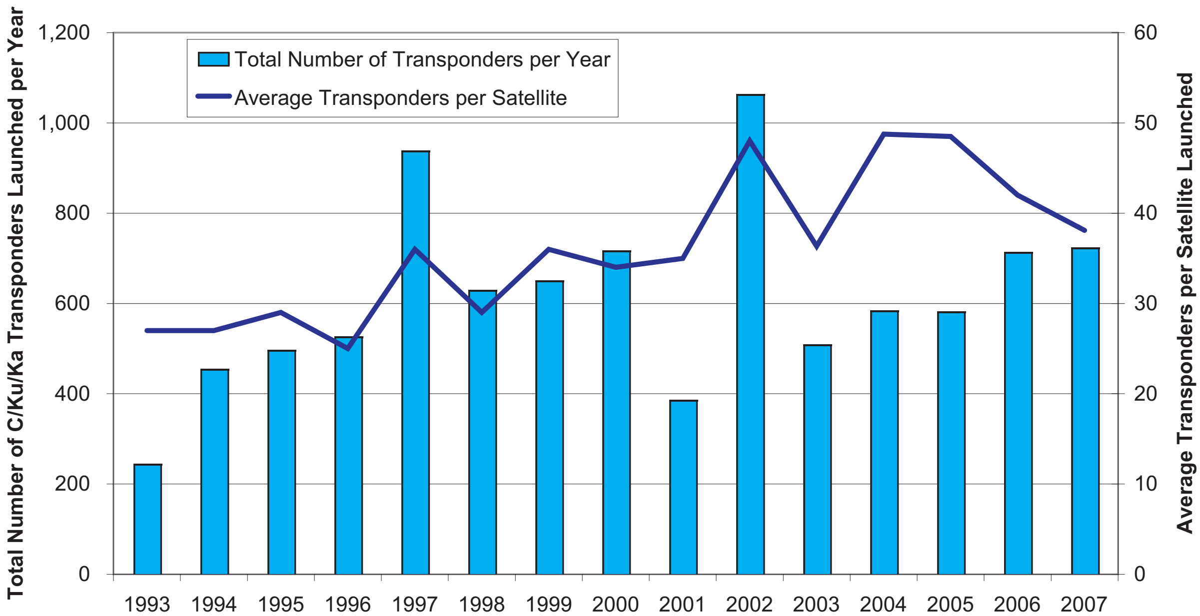


Table 7. Total C/Ku/Ka Transponders Launched Per Year and Average Transponders per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total Number of Transponders per Year	245	455	497	527	939	630	651	717	386	1064	509	585	582	714	724
Average Transponders per Satellite	27	27	29	25	36	29	36	34	35	48	36	49	49	42	38

and Ka-band transponders. Examples include the Inmarsat, Skynet, Thuraya, Spainsat, and XM satellites, which have X-band, L-band, and/or S-band transponders.

Trends in Average Satellite Mass

Figure 11 and Table 8 show the total mass launched per year and the average mass per satellite launched. The total mass launched per year correlates with the number of satellites launched per year, as does the total number of transponders. The average satellite mass peaked in 2005 with 2006 showing a slight downturn. Like the discussion on mass classes earlier in the report, the expectation is that the average mass per satellite will trend towards constancy. The last three years have averaged slightly less than 4,300 kg and the expectation is that the next several years will oscillate around this number. This again correlates to the trend toward stabilization of the shift to heavier, higher-power satellites. The projected total mass to be launched in 2007 will be an all-time high, nearly 100,000 kg.

Summary

The 2007 COMSTAC Commercial GSO Launch Demand Forecast predicts an average annual demand of 21.0 satellites to be launched from 2007 through 2016, effectively the same as the 2006 forecast of 20.8 and the 2005 forecast of 20.5 satellites per year. For the fourth year in a row, the actual number of satellites launched has remained less than 20, with 19 launched in 2006.

There had been a decrease in the actual number of dual-manifest launches in recent years (2004 and 2005) due to the transition from the Ariane 4 to the Ariane 5, and due to the Ariane 5 ECA failure in 2002. However, there were 5 dual manifest launches in 2006, with four completely commercial dual manifest launches for the first time since 2000. The Working Group is predicting six dual-manifest launches in 2007, and a long-term forecast of six dual-manifest launches per year corresponding to the increased production of Ariane 5 vehicles to eight per year. Based on this dual-manifest actual and the satellite demand projection, the 2007 Commercial GSO Launch Demand Forecast averages 15.3 launches per year from 2007 through 2016. This is lower than last year's forecast of 16.7 launches per year due to the increase in dual manifest by Ariane.

The trend in satellite mass growth is stabilizing, with the average mass per satellite peaking in 2005 at 4,500 kg. The total mass launched will hit new highs due to the recovery in total satellites launched with almost 100,000 kg forecast for 2007. At the same time, the trend in increasing average number of transponders per satellite is also stabilizing, although the peak number of over 1,000 transponders launched in 2002 has not been topped.

The Working Group has identified market events that have the potential of impacting the space launch industry. Two new launch vehicle entrants, Land Launch and Soyuz from Kourou, will begin to launch medium-class payloads in the near future, and other launch vehicles in development may provide additional capacity. On the satellite industry side, continued consolidation and unfavorable U.S. regulatory conditions may impact the health of U.S. satellite manufacturers. Key factors affecting global satellite market demand at this time include the economic atmosphere, and launch vehicle reliability and availability. New satellite service market applications, like HDTV, may create additional demand for new satellites, beyond the existing satellite replenishment market.

Figure 11. Total Satellite Mass Launched per Year and Average Mass per Satellite

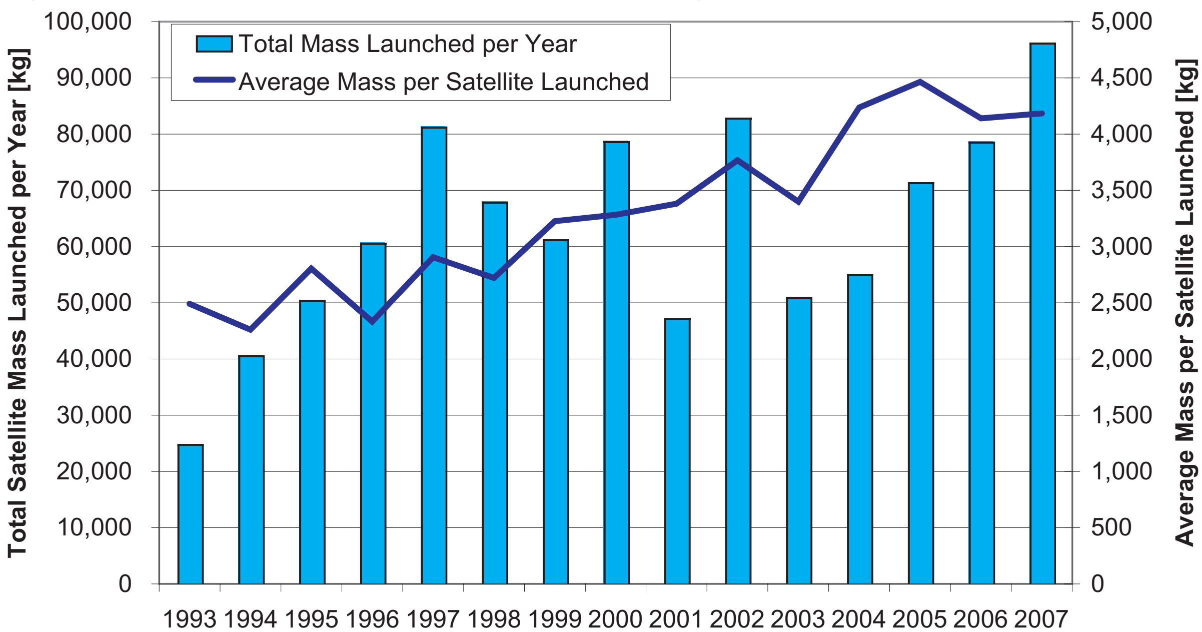


Table 8. Total Satellite Mass Launched per Year and Average Mass per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total Mass Launched per Year [kg]	24,910	40,689	50,502	60,695	81,373	68,015	61,295	78,784	47,329	82,880	50,990	55,070	71,456	78,680	96,251
Average Mass per Satellite [kg]	2,491	2,261	2,806	2,334	2,906	2,721	3,226	3,283	3,381	3,767	3,399	4,236	4,466	4,141	4,185

Table 9. Historical Addressable Commercial GSO Satellites Launched (1993–2006)

		1993			1994			1995			1996			1997	
Total Launches		8			14			17			21			24	
Total Satellites		10			18			18			25			28	
Over 5,400 kg (>11,905 lbm)		0			0			0			0			0	
4,200 - 5,400 kg (9,260 - 11,905 lbm)		0			0			0			0			0	
2,200 - 4,200 kg (4,850 - 9,260 lbm)		7			10			14			14			22	
		Astra 1C	Ariane 42L		Astra 1D	Ariane 42P		Astra 1E	Ariane 42L	DM3	Arabsat 2A	Ariane 44L	DM1	AMC 2	Ariane 44L
	DM2	DBS 1	Ariane 44L		Intelsat 702	Ariane 44LP		DBS 3	Ariane 42P	DM4	Arabsat 2B	Ariane 44L	DMN	Hot Bird 3	Ariane 44LP
		Galaxy 4	Ariane 42P	DM2	PAS 2	Ariane 44L		Intelsat 706A	Ariane 44LP		EchoStar 2	Ariane 42P		Intelsat 801	Ariane 44P
	DM1	Hispasat 1B	Ariane 44L		$\boxed{\text{PAS 3}}$	Ariane 42P		N-Star a	Ariane 44P		Intelsat 707A	Ariane 44LP		Intelsat 802	Ariane 44P
		Intelsat 701	Ariane 44LP	DM4	Solidaridad 2	Ariane 44L		PAS 4	Ariane 42L		Intelsat 709	Ariane 44P		Intelsat 803	Ariane 42L
	DMN	Solidaridad 1	Ariane 44LP		Telstar 402	Ariane 42L		Telstar 402R	Ariane 42L		MSAT 1	Ariane 42P		Intelsat 804	Ariane 42L
		Telstar 401	Atlas IIAS		DBS 2	Atlas IIA		AMSC 1	Atlas IIA		N-Star b	Ariane 44P		JCSat 5	Ariane 44P
					Intelsat 703	Atlas IIAS		Galaxy 3R	Atlas IIA	DM2	Palapa C2	Ariane 44L		PAS 6	Ariane 44P
					Orion 1	Atlas IIA		Intelsat 704	Atlas IIAS	DM1	PAS 3R	Ariane 44L	DM4	Sirius 2	Ariane 44L
					Optus B3	Long March 2E		Intelsat 705	Atlas IIAS		AMC 1	Atlas IIA	DM2	Thaicom 3	Ariane 44LP
								JCSat 3	Atlas IIAS		Hot Bird 2	Atlas IIA		AMC 3	Atlas IIAS
								$\boxed{\text{APStar 2}}$	Long March 2E		Palapa C1	Atlas IIAS		DirecTV 6	Atlas IIA
								ASIASAT 2	Long March 2E		$\boxed{\text{Intelsat 708A}}$	Long March 3B		EchoStar 3	Atlas IIAS
								EchoStar 1	Long March 2E		Astra 1F	Proton K/DM		Galaxy 8i	Atlas IIAS
														JCSat 4	Atlas IIAS
														Superbird C	Atlas IIAS
														Agila II	Long March 3B
														APStar 2R	Long March 3B
														Aatra 1G	Proton K/DM
														$\boxed{\text{Asiasat 3}}$	Proton K/DM
														PAS 5	Proton K/DM
														Telstar 5	Proton K/DM
Below 2,200 kg (<4,850 lbm)		3			8			4			11			6	
	DM1	Insat 2B	Ariane 44L	DM3	Brazilsat B1	Ariane 44LP	DM1	Brazilsat B2	Ariane 44LP	DM2	Amos 1	Ariane 44L	DM2	BSat 1A	Ariane 44LP
	DM2	Thaicom 1	Ariane 44L	DM2	BS-3N	Ariane 44L	DM1	Hot Bird 1	Ariane 44LP	DMN	Italsat 2	Ariane 44L	DM4	Cakrawarta 1	Ariane 44L
		NATO 4B	Delta II	DM1	$\boxed{\text{Eutelsat II F5}}$	Ariane 44LP	DMN	Insat 2C	Ariane 44L	DM1	Measat 1	Ariane 44L	DM3	Inmarsat 3F4	Ariane 44LP
				DM4	Thaicom 2	Ariane 44L		Koreasat 1	Delta II	DM4	Measat 2	Ariane 44L	DM3	Insat 2D	Ariane 44LP
				DM1	$\boxed{\text{TurkSat 1A}}$	Ariane 44LP				DM3	TurkSat 1C	Ariane 44L	DM1	Nahuel 1A	Ariane 44L
				DM3	TurkSat 1B	Ariane 44LP					Inmarsat 3F1	Atlas IIA		Thor II	Delta II
					Galaxy 1RS	Delta II					Inmarsat 3F3	Atlas IIA			
					APStar 1	Long March 3					Galaxy 9	Delta II			
											Koreasat 2	Delta II			
											APStar 1A	Long March 3			
											Inmarsat 3F2	Proton K/DM			

$\boxed{}$ = Launch Failure

DM# = Dual Manifested Launch With Another COMSTAC Satellite
example: DM1 was paired with DM1, DM2 with DM2, etc.

DMN = Dual Manifested Launch With Non-Addressable Satellite
DMN missions are counted as a single launch in the launch count

Note: The 1996 launch of Chinasat 7 was removed in 2004 as it was retroactively determined not to have been competitively bid.

Table 9. Historical Addressable Commercial GSO Satellites Launched (1993–2006) [Continued]

		1998			1999			2000			2001			2002	
Total Launches		19			18			20			12			20	
Total Satellites		23			19			24			14			22	
Over 5,400 kg (>11,905 lbm)		0			0			0			0			0	
4,200 - 5,400 kg (9,260 - 11,905 lbm)		0			2			4			5			9	
					Galaxy 11	Ariane 44L		Anik F1	Ariane 44L		DirecTV 4S	Ariane 44LP		Intelsat 904	Ariane 44L
					$\boxed{\text{Orion 3}}$	Delta III		PAS 1R	Ariane 5G		Intelsat 901	Ariane 44L		Intelsat 905	Ariane 44L
								Garuda 1	Proton K/DM		Intelsat 902	Ariane 44L		Intelsat 906	Ariane 44L
								Thuraya 1	Sea Launch		XM Rock	Sea Launch		NSS-6	Ariane 44L
											XM Roll	Sea Launch		NSS-7	Ariane 44L
														$\boxed{\text{Astra 1K}}$	Proton K/DM
														Echostar 8	Proton K/DM
														Intelsat 903	Proton K/DM
														Galaxy IIIC	Sea Launch
2,200 - 4,200 kg (4,850 - 9,260 lbm)		14			16			14			6			11	
	DM4	Afristar	Ariane 44L		AMC 4	Ariane 44L	DM1	Asiastar 1	Ariane 5G	DM2	$\boxed{\text{Artemis}}$	Ariane 5G	DMN	Atlantic Bird 1	Ariane 5G
	DM3	Eutelsat W2	Ariane 44L	DM1	Arabsat 3A	Ariane 44L	DM3	Astra 2B	Ariane 5G		Atlantic Bird 2	Ariane 44P	DMN	$\boxed{\text{Hotbird 7}}$	Ariane 5ECA
		Hot Bird 4	Ariane 42P		Insat 2E	Ariane 42P		Europe*Star 1	Ariane 44LP	DM1	Eurobird	Ariane 5G		Insat 3C	Ariane 42L
		PAS 6B	Ariane 42L		Koreasat 3	Ariane 42P		Eutelsat W1R	Ariane 44P		Turksat 2A	Ariane 44P	DM1	JCSat 8	Ariane 44L
		PAS 7	Ariane 44LP		Orion 2	Ariane 44LP		Galaxy 10R	Ariane 42L		Astra 2C	Proton K/DM	DM2	Stellat 5	Ariane 5G
		Satmex 5	Ariane 42L		Telkom	Ariane 42P		Galaxy IVR	Ariane 42L		PAS 10	Proton K/DM		Echostar 7	Atlas IIIB
		ST-1	Ariane 44P		Telstar 7	Ariane 44LP		N-Sat-110	Ariane 42L					Hispasat 1D	Atlas IIAS
		Hot Bird 5	Atlas IIA		Echostar V	Atlas IIAS		Superbird 4	Ariane 44LP					Hotbird 6	Atlas V 401
		Intelsat 805A	Atlas IIAS		Eutelsat W3	Atlas IIAS		Echostar VI	Atlas IIAS					Eutelsat W5	Delta IV M+ (4,2)
		Intelsat 806A	Atlas IIAS		JCSat 6	Atlas IIAS		Eutelsat W4	Atlas IIIA					DirecTV 5	Proton K/DM
		$\boxed{\text{Galaxy 10}}$	Delta III		Asiasat 3S	Proton K/DM		Hispasat 1C	Atlas IIAS					Nimiq 2	Proton M/M
		Astra 2A	Proton K/DM		Astra 1H	Proton K/DM		AAP 1	Proton K/DM						
		EchoStar 4	Proton K/DM		LMI 1	Proton K/DM		AMC 6	Proton K/DM						
		PAS 8	Proton K/DM		Nimiq	Proton K/DM		PAS 9	Sea Launch						
					Telstar 6	Proton K/DM									
					DirecTV 1R	Sea Launch									
Below 2,200 kg (<4,850 lbm)		9			1			6			3			2	
	DM4	AMC 5	Ariane 44L	DM1	Skynet 4E	Ariane 44L	DM3	AMC 7	Ariane 5G	DM1	BSat 2A	Ariane 5G	DM1	Astra 3A	Ariane 44L
	DM1	Brazilsat B3	Ariane 44LP				DM4	AMC 8	Ariane 5G	DM2	$\boxed{\text{BSat 2B}}$	Ariane 5G	DM2	N-Star c	Ariane 5G
	DM2	BSat 1B	Ariane 44P				DM4	Astra 2D	Ariane 5G	DMN	Skynet 4F	Ariane 44L			
	DM1	Inmarsat 3F5	Ariane 44LP				DM2	Brazilsat B4	Ariane 44LP						
	DM2	NileSat 101	Ariane 44P				DM1	Insat 3B	Ariane 5G						
	DM3	Sirius 3	Ariane 44L				DM2	Nilesat 102	Ariane 44LP						
		Bonum-1	Delta II												
		Skynet 4D	Delta II												
		Thor III	Delta II												

$\boxed{}$ = Launch Failure

DM# = Dual Manifested Launch With Another COMSTAC Satellite
example: DM1 was paired with DM1, DM2 with DM2, etc.

DMN = Dual Manifested Launch With Non-Addressable Satellite
DMN missions are counted as a single launch in the launch count

Note: The 1998 launches of Chinastar 1 and Sinosat 1 were removed in 2004; they were retroactively determined not to have been competitively bid.

Table 9. Historical Addressable Commercial GSO Satellites Launched (1993–2006) [Continued]

		2003			2004			2005			2006		2007
Total Launches		**12**			**13**			**15**			**15**		
Total Satellites		**15**			**13**			**16**			**19**		**0**
Over 5,400 kg (>11,905 lbm)		**0**			**3**			**6**			**2**		**0**
					Anik F2	Ariane 5G+	DM1	Spaceway 2	Ariane 5ECA	DM2	Satmex 6	Ariane 5ECA	
					Intelsat X	Proton M/M		Thaicom 4	Ariane 5G+	DM3	DirecTV 9S	Ariane 5ECA	
					DirecTV 7S	Sea Launch		Inmarsat 4F1	Atlas V 431				
								IA-8	Sea Launch				
								Inmarsat 4F2	Sea Launch				
								Spaceway 1	Sea Launch				
4,200 - 5,400 kg (9,260 - 11,905 lbm)		**5**			**4**			**4**			**9**		**0**
		Intelsat 907	Ariane 44L		Eutelsat W3A	Proton M/M		AMC-12	Proton M/M	DM4	Wildblue 1	Ariane 5ECA	
	DM2	Optus C1	Ariane 5G		Amazonas	Proton M/M		Anik F1R	Proton M/M		Astra 1KR	Atlas V 411	
		Rainbow 1	Atlas V 521		Estrela do Sul	Sea Launch		AMC-23	Proton M/M		Hotbird 8	Proton M/M	
		EchoStar 9	Sea Launch		APStar V	Sea Launch		XM-3	Sea Launch		Measat 3	Proton M/M	
		Thuraya 2	Sea Launch								Echostar X	Sea Launch	
											JCSat 9	Sea Launch	
											Galaxy 16	Sea Launch	
											Koreasat 5	Sea Launch	
											XM-4	Sea Launch	
2,200 - 4,200 kg (4,850 - 9,260 lbm)		**6**			**6**			**3**			**7**		**0**
	DM1	Insat 3A	Ariane 5G		Superbird 6	Atlas IIAS	DMN	XTAR-EUR	Ariane 5ECA	DM1	$\boxed{\text{Hotbird 7A}}$	Ariane 5ECA	
	DM3	Insat 3E	Ariane 5G		AMC-10	Atlas IIAS		Insat 4A	Ariane 5G+	DM1	Spainsat	Ariane 5ECA	
		Asiasat 4	Atlas IIIB		AMC-11	Atlas IIAS		DirecTV 8	Proton M/M	DM2	Thaicom 5	Ariane 5ECA	
		Hellas-sat	Atlas V 401		MBSat	Atlas IIIA				DMN	JCSat 10	Ariane 5ECA	
		AMC-9	Proton K/M		AMC-16	Atlas V 521				DM3	Optus D1	Ariane 5ECA	
		Galaxy XIII	Sea Launch		AMC-15	Proton M/M					Arabsat 4A	Proton M/M	
											Arabsat 4B	Proton M/M	
Below 2,200 kg (<4,850 lbm)		**4**			**0**			**3**			**1**		**0**
	DM2	Bsat 2C	Ariane 5G				DM1	Telkom 2	Ariane 5ECA	DM4	AMC-18	Ariane 5ECA	
	DM3	e-Bird 1	Ariane 5G				DMN	Galaxy 15	Ariane 5G+				
	DM1	Galaxy XII	Ariane 5G					Galaxy 14	Soyuz				
		Amos 2	Soyuz										

$\boxed{}$ = Launch Failure

DM# = Dual Manifested Launch With Another COMSTAC Satellite
example: DM1 was paired with DM1, DM2 with DM2, etc.

DMN = Dual Manifested Launch With Non-Addressable Satellite
DMN missions are counted as a single launch in the launch count

Table 10. Historical Non-Addressable Commercial GSO Satellites Launched (1993–2006)

	1993	1994	1995	1996	1997
Total Launches	3	4	1	4	1
Total Spacecraft	3	4	2	5	1

Year		Satellite	Launch Vehicle
1993		Gorizont	Proton K/DM
1993		Gorizont 40	Proton K/DM
1993		Gorizont 41	Proton K/DM
1994		DFH 3-1	Long March 3A
1994		Express	Proton K/DM
1994		Gals-1	Proton K/DM
1994		Gorizont 42	Proton K/DM
1995	DMC	Telecom - 2C	Ariane 44L
1995		Gals 2	Proton K/DM
1996	DMC	Telecom 2D	Ariane 44L
1996		Chinasat 7	Long March 3A
1996		Express 2	Proton K/DM
1996		Gorizont 43	Proton K/DM
1996		Gorizont 44	Proton K/DM
1997		Chinasat 6	Long March 3A

	1998	1999	2000	2001	2002
Total Launches	2	2	2	1	1
Total Spacecraft	2	3	4	1	1

Year		Satellite	Launch Vehicle
1998		ChinaStar-1	Long March 3B
1998		Sinosat-1	Long March 3C
1999		Express A1	Proton K/DM
1999	DM1	Yamal 101	Proton K/DM
1999	DM1	Yamal 102	Proton K/DM
2000		Express A2	Proton K/DM
2000		Express A3	Proton K/DM
2000		Gorizont 45	Proton K/M
2000		SESAT	Proton K/DM
2001		Ekran M	Proton M/M
2002		Express A4	Proton K/DM

	2003	2004	2005	2006	2007
Total Launches	3	2	3	2	0
Total Spacecraft	4	2	3	2	0

Year		Satellite	Launch Vehicle
2003		Express AM-22	Proton K/DM
2003	DM1	Yamal 200 SC1^	Proton K/DM
2003	DM1	Yamal 200 SC2^	Proton K/DM
2003		Zhongxing 20	Long March 3A
2004		Express AM-11	Proton K/DM
2004		Express AM 1	Proton K/DM
2005		Express AM 2	Proton K/DM
2005		Express AM 3	Proton K/DM
2005		Apstar 6	Long March 3B
2006		Kazsat	Proton K/DM
2006		Sinosat 2	Long March 4B

☐ = Launch Failure

DM# = Dual Manifested Launch With Another Non-Addressable GSO Satellite
example: DM1 was paired with DM1, DM2 with DM2, etc.

DMC = Dual Manifested Launch With Commercial Addressable Satellite
DMC missions are not counted as launches in this launch count

2007 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits

Executive Summary

The *2007 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits* is an annual report prepared by the Federal Aviation Administration's Office of Commercial Space Transportation (AST) that assesses the worldwide market for satellites and other spacecraft that are expected to be available for competition among providers of commercial launch services or are otherwise sponsored by commercial companies.

The FAA's 2007 forecast projects a demand for 81 commercial launches to non-geosynchronous orbits (NGSO) worldwide from 2007–2016, an increase of 17 percent or 1.2 launches per year compared to last year's forecast. The increase is attributed to planned replacements of telecommunications systems and more demonstration spacecraft, both a reflection of more positive financial conditions.

The 2007 forecast contains 191 satellites during the next ten years, an increase of 19 percent compared to the ten-year projection in the 2006 forecast of 160 satellites. Diversity characterizes the global NGSO market with combinations of private and government funding for missions ranging from science and commercial remote sensing to technology demonstrations and telecommunications.

2007 Launch Forecast: FAA is forecasting an average demand of 8.1 worldwide launches per year during 2007–2016 with more activity in the near term including demand for 17 launches in 2007, 13 in 2008, and 13 in 2009. However, many of these customers are developing new spacecraft and some launches involve new vehicles that could delay schedules. Last year, for example, eight launches slipped into 2007. Because of these factors, FAA estimates that 10 to 13 launches on the manifest for 2007 will actually occur.

Demand is divided into two vehicle size classes with an average of 4.9 medium-to-heavy launch vehicles per year and 3.2 small vehicle launches per year of the forecast period. While the number of small launches declined slightly from last year's forecast of 33, the number of medium-to-heavy launches increased by more than one launch per year compared to last year. Overall there are 12 more launches in the 2007 forecast compared to 2006.

The largest growth sector of the satellite market is for telecommunications which comprises about 42 percent of the market with 81 satellites, up from 43 satellites last year because of the addition of Globalstar's second generation constellation to the forecast. Approximately 48 percent of the 191 satellites in the market are international science or "other" satellites such as technology demonstrations. Commercial remote sensing satellites account for the remaining 10 percent of the market. Nearly half of the satellites assigned to launch vehicles in the near term weigh more than 600 kilograms. The overall estimate of multiple-manifested missions is about 2.35 satellites per launch.

Introduction

The 2007 non-geosynchronous orbit forecast is the third consecutive forecast to contain an overall increase in the number of launches in the ten-year projection, continuing the trend away from a weakened market during 2001 to 2003. Strong financial conditions have produced a noticeable impact on the near-term forecast with increases in telecommunications and technology demonstration missions that are new to the forecast compared to last year. Up to 43 launches are scheduled from 2007 to 2009, the most robust three-year forecast since 2000.

However, there were only five actual launches in 2006, in contrast to the 13 scheduled launches—essentially the demand—in 2006. The FAA estimates this gap between what has actually been launching and the demand will likely continue. Reasons for delays in 2006 range from satellite financing and technology development to a Russian Dnepr launch failure and other factors. Eight launches from last year have carried over into 2007.

Instead of changing the basic launch demand methodology used by all previous FAA NGSO forecasts, the FAA is introducing an additional marker in the 2007 report by adopting an estimated "realization" for the current year. Based on historical trends and additional analysis of individual vehicles, satellites and market conditions, the FAA is estimating that of the 17 projected launches for 2007, only 10 to 13 will actually launch (see Table 16). It is important to state that each of the 17 launches is currently scheduled for 2007 and if some are unable to launch, most will reset for 2008. Since 2002, only a small number of near-term primary satellites scheduled for launch in the NGSO market have been delayed indefinitely or canceled.

Today's NGSO launch market is characterized by a steady demand from international science payloads with an increase in other satellites (such as technology demonstrations), a recent increase in demand for telecommunications satellites, and a small but steady number of commercial remote sensing satellites.

Table 11. Commercially Competed Launches

	NGSO	GSO	**Total**
1997	13	24	**37**
1998	19	19	**38**
1999	18	18	**36**
2000	9	20	**29**
2001	4	12	**16**
2002	4	20	**24**
2003	4	13	**17**
2004	2	13	**15**
2005	3	15	**18**
2006	5	15	**20**
2007 est.	17	17	**34**

Includes payload missions open to international launch services procurement and other commercially-sponsored payloads. Does not include government-captured or dummy payloads launched commercially.

The build up of activity in the NGSO market involves several factors: positive increases in private sector and government funding; more countries, companies, and international non-profit organizations interested in deploying satellites with diverse missions; the availability of low-cost launch vehicles to fit increasingly sophisticated small satellites; and replacement of next-generation telecommunications and commercial remote sensing satellites. In some cases, missions are behind schedule because of delays in finance and satellite and launch vehicle technology development, creating a backlog.

The market continues to have a wide diversity of international participation. Only 10 of 37 identified launches in the next four years will involve a satellite owner/operator and launch vehicle from the same country. This is largely due to a majority of owners selecting launches on Russian/Ukrainian vehicles. Contrary to recent years, the U.S. launch share of the near-term NGSO identified market has surged to 40 percent with Russia at 57 percent. Previously, Russia held around 80 percent of the near-term market. The U.S. increase is due mostly to private sector demonstration launches for NASA's Commercial Orbital Transportation Services (COTS) program and selection of Boeing's Delta 2 for Italy's Cosmo-Skymed series of satellites.

International science and other payloads such as technology demonstrations remain the largest NGSO sector and also the most difficult for which to predict launch demand because they are often small, custom spacecraft that appear when funding is available and some could fly solo or be multiple-manifested depending on launch vehicle selection.

The NGSO telecommunications satellite sector is experiencing the largest growth with ORBCOMM and Globalstar committed to second-generation satellite systems in the near term. Both companies expect to complete competitions during 2007 to determine who will launch their follow-on systems and when. ORBCOMM could have up to four launches in addition to a demonstration launch in 2007. Globalstar is evaluating acceleration of their next generation system schedule and has two replacement launches of previously-built satellites scheduled during 2007. Because Globalstar has been successful in obtaining new investors and launches of its next-generation system of 48 satellites could begin in late 2009, the FAA has included Globalstar in this year's forecast model.

Meanwhile, Iridium continues to experience a healthy constellation as it begins plans for the launch of 72 replacement satellites starting around 2013–2014. Because commitment of significant spending and contracts are still a few years away, replacement launches for Iridium are not included in the 2007 forecast model.

After the business failures and bankruptcies of NGSO telecommunications systems in the late 1990s, the investment community lost confidence in the low Earth orbit market. But in the last year or so, investors are revisiting the mobile satellite services market and owners and operators are more optimistic about the future.

The change in climate for NGSO investment is due to several factors, starting with favorable lending terms, which have been driven by the overall increase in global private equity investment programs and a healthy economy. Dramatic returns from large fixed satellite operators have increased interest in mobile service operators in both GSO (such as ICO and Mobile Satellite Ventures) and NGSO. Other factors include increased subscribers, more advanced and smaller handset technology, and lower user prices.

Unlike the 1990s when primary investors were the companies building the NGSO satellites, major backers today include private equity investors and global banking interests. Investors in NGSO systems during 2006 include Wachovia Securities, J.P. Morgan, Jefferies and Company Inc., Lehman Brothers, and Morgan Stanley. In addition, initial public offerings in 2006 raised over $100 million each for Globalstar and ORBCOMM.

Financial stability has returned to the U.S. commercial remote sensing sector in 2006 with the consolidation of Space Imaging and ORBIMAGE into GeoEye, a publicly-traded company. Competitor DigitalGlobe is privately held, with Morgan Stanley as a key investor. With contracts from the National Geospatial-Intelligence Agency (and other commercial customers), these two companies have multi-year stability.

Another indicator of attractive financial conditions is the addition of more technology demonstration spacecraft (in particular by Bigelow Aerospace) and NASA's COTS program, which requires joint private investment in demonstration launches and rendezvous spacecraft development by SpaceX and Rocketplane Kistler.

The FAA Office of Commercial Space Transportation compiles the *Commercial Space Transportation Forecast for Non-Geosynchronous Orbits* on an annual basis. The forecast covers commercial launch demand for global space systems expected to be deployed in orbits other than GSO, including low Earth orbit (LEO), medium Earth orbit (MEO), elliptical orbit (ELI), and external orbit (EXT) such as to the Moon, Mars, and beyond.

This forecast only contains demand for orbital launches. It remains too early to forecast when new orbital passenger-carrying launch vehicles will emerge on a commercial basis although substantial hardware progress has been made by a few well-financed U.S. companies. Some companies are starting with suborbital flight vehicles and others are pursuing International Space Station launch services supply contracts from NASA that could lead to a passenger vehicle.

It is important to recognize that this report represents the FAA's assessment of how many satellites are seeking launch services to determine the overall demand for launches and is therefore not a prediction of how many launches might actually occur. The forecast also does not evaluate operators' ability to attract enough business to prosper after launch. The results of this forecast do not indicate FAA support or preference for any particular satellite system. The satellites in the forecast are (or were) open for international launch services procurement or were sponsored by commercial entities for commercial launch.

The following sections review each market segment and describe the results of the 2007 forecast.

NGSO Satellite Systems

International Science and Other Payloads

The growth of satellite development efforts in countries without indigenous launch capabilities has generated steady demand for commercial launch services that has outpaced demand from other markets, including telecommunications and commercial remote sensing, over the last several years. Most of these missions involve small satellites on modest budgets, so the demand leans toward low-cost, small launch vehicles. The continued availability of inexpensive launches on refurbished Russian and Ukrainian ballistic missiles, and new U.S. vehicles, promises to support increased demand for such launch services. In the past few years, science or technology demonstration payloads have been launched commercially for operators in a number of countries, including China, France, Italy, Saudi Arabia, South Korea, Taiwan, Turkey, and the United Kingdom. The U.S. Space Transportation Policy, enacted in December 2004, generally restricts U.S. government payloads from launching on non-U.S.-built vehicles, so demand for these payloads is not included in this report.

International science satellites can be classified into three groups. The first are remote sensing satellites that are operated non-commercially, typically by government agencies, but are often built by commercial firms in other countries. The imagery products generated from these satellites are usually offered for free or at cost. RazakSat, built by Astronautic Technology (M) Sdn Bhd for the Malaysian government, is a small remote sensing satellite that will operate in a low-inclination orbit to permit frequent passes over Malaysia. The satellite is scheduled for launch in late 2007 on a Falcon 1. SumbandilaSat is an 81-kilogram spacecraft built by SunSpace and Stellenbosh University for South Africa's Department of Science and Technology; it will provide medium-resolution multispectral remote sensing data for the country. The spacecraft will be placed in orbit in May 2007 by a Shtil launched from a Russian submarine near Severemorsk, Russia. The Disaster Monitoring Constellation (DMC) features five spacecraft in orbit, all built by Surrey Satellite Technology Ltd. (SSTL) for Algeria, China, Nigeria, Turkey, and the UK, that provide multispectral imaging in support of disaster relief operations. Two additional DMC spacecraft, for Spain and the UK, are being built by SSTL for launch in 2008.

A second class of satellites includes spacecraft designed to carry out other scientific work in space, ranging from specialized Earth sciences research to planetary missions. One example is Gravity Field and Steady-State Ocean Circulation Explorer (GOCE), a European Space Agency (ESA) mission to generate high-resolution maps of the Earth's gravity field; it is scheduled for launch on a Rockot in 2008. A similar example is AGILE, a gamma-ray astronomy satellite funded by the Italian Space Agency, which was launched on an Indian Polar Satellite Launch Vehicle (PSLV) in April 2007. The launch is the first commercial competition won by India for the launch of a primary payload.

The third class of satellites features spacecraft designed to perform technology demonstrations. An example is the Cascade, Smallsat, and Ionospheric Polar Explorer (CASSIOPE) spacecraft. CASSIOPE will carry a suite of experiments to study the ionosphere and demonstrate small satellite and high data rate communications technologies. The spacecraft is funded by the Canadian Space Agency and Technology Partnerships Canada, a government agency that supports industry research and development. In addition to an expected $100 million in government funding, MacDonald, Dettwiler and Associates Ltd. (MDA), the mission prime contractor, is also contributing funding. CASSIOPE will launch on a Falcon 9 in 2008.

Success of the Cascade communications payload onboard is expected to lead to a fleet of Cascade spacecraft weighing about 300 kg each. The commercial Cascade system would be operated by MDA and launched in 2010 with up to four satellites per launch. The satellites will have the capability to transmit at 1.4 gigabits per second and onboard flash memory storage of more than six terabits.

Small, one-kilogram satellites measuring about ten centimeters square, called CubeSats, are increasingly popular with universities worldwide as educational tools. The CubeSat specification, conceived by Stanford University's Bob Twiggs and developed for launch by California Polytechnic University, can form the basis for picosatellites costing less than $50,000. Over 40 universities are building CubeSats for a variety of applications. Seventeen CubeSats have been successfully launched to date, including seven that were launched on a commercial Dnepr mission in April 2007; 14 CubeSats were lost in the failure of the noncommercial launch of a Dnepr rocket in July 2006. Launch costs per CubeSat can be as low as $40,000. Because of the small size of the satellites and their developers' limited budgets, these payloads do not stimulate commercial launch demand on their own.

Digital Audio Radio Services

Satellite radio, also known as digital audio radio services (DARS), is already among the fastest adopted consumer electronics products in U.S. history. By the end of 2006 Sirius Satellite Radio reported having over 6 million subscribers, while rival XM Satellite Radio had over 7.6 million. The companies have struggled to achieve profitability as they rolled out their services and ramped up marketing efforts, but both companies reported positive cash flow in the fourth quarter of 2006.

Changes in the DARS landscape have created uncertainty about future demand for satellites and launches. In February 2007 Sirius and XM announced plans to merge, an agreement that requires approval from both the Federal Communications Commission and the Federal Trade Commission. Company officials said that they have not made a decision on how to integrate the two companies' satellite systems, which are quite different: Sirius operates three satellites in highly elliptical orbits, and has a GEO satellite scheduled for launch later in the decade, while XM has launched four GEO satellites and has a fifth on order. The three Sirius satellites were launched in 2000 with 15-year lifetimes and are all operating well. Should the merged company decide to standardize on an XM-like GEO architecture, assuming the merger is approved, it would likely mean that it would not launch future NGSO spacecraft.

While the DARS market has been limited to North America to date, there is growing interest in satellite radio systems elsewhere, principally in Europe. WorldSpace, which currently operates two GSO satellites with listeners in Europe, Africa, Asia, and the Middle East, is planning to launch a third GSO satellite to serve Europe. Ondas Media, a Spanish company, and Europa Max, based in Luxembourg, are each planning NGSO DARS systems modeled on Sirius, with three satellites in ELI. However, neither company has made significant progress on its business plans, nor have they signed satellite manufacturing or launch services contracts. Given the uncertainty these systems face at this time, neither system has been included in the 2007 forecast.

Military

On rare occasions governments will procure commercial launches for military satellites. One example is SAR-Lupe, a constellation of five satellites that will provide high-resolution radar imagery for the German Armed Forces and potentially other European militaries. The 770-kilogram (1,968-pound) satellites will be placed into three 500-kilometer (311-mile) orbital planes, from which they will be able to observe the Earth's surface between 80 degrees north and south latitude. The satellites were built by a team led by German satellite manufacturer OHB-System under a 15-year, €300-million (US$405-million) contract with the German Defense Ministry that began in 2002. The German government has contracted with Rosoboronexport, the Russian state corporation that handles the import and export of military systems, to launch the satellites on several Cosmos 3M boosters. The first SAR-Lupe satellite was launched in December 2006; two more are scheduled for launch in 2007 with the remaining two to be launched in 2008.

Market Demand Scenarios

FAA/AST projects that approximately 91 satellites of the international science or other category will be launched during the forecast period. These payloads will be deployed on 52 launches, including 26 medium-to-heavy vehicles. This is the largest single market sector of the satellite and launch demand forecast, accounting for nearly half of the payloads and over 60 percent of the launches.

Commercial Remote Sensing Satellites

Commercial satellite remote sensing is one small, but important, part of a much larger industry that creates products based on geospatial information. The greater industry for remote sensing and geographic information systems (GIS) consists of maps and databases linking geographic data with demographic or other economic information, or scientific data. Besides satellites, the other major sectors of the industry include aerial imaging, ground stations for data collection and processing, and value-added systems that include GIS and other analytic tools that prepare image and map products for end-users.

Commercial remote sensing satellites provide imagery to a range of government and commercial clients worldwide. Government partnerships and contracts are the critical foundations of this sector, but an increasing commercial client base is creating new markets and applications for commercial imagery. New value-added services, such as web-based GIS applications, are expanding the demand for commercial satellite imagery and are driving many of the commercial satellite operators to invest in the vertical value-added markets themselves. Despite this expansion of commercial imagery demand, government demand continues to be imperative for the commercial remote sensing sector. Even though governments operate high-resolution imaging systems, agencies find great value in commercial imagery because it can be easily shared with allies and coalition partners.

There are emerging government applications that provide increased demand for imagery beyond the current needs of the military and intelligence community. While low- and medium-resolution imagery is critical for civil government activities in scientific studies (forestry, geology, coastal change), agriculture, disaster response, and homeland security, these applications also seek high-resolution imagery. These civil applications are developing in conjunction with commercial opportunities, strengthening the sector's customer base.

In the United States, the National Geospatial-Intelligence Agency (NGA) continues to support the commercial satellite remote sensing sector through NextView contracting. GeoEye and DigitalGlobe plan to launch next-generation high-resolution imaging satellites in 2007. These satellites are partly funded by the NextView program. The funding available for future NGA contracts may influence the pace of growth for this industry over the next decade.

Trends in the overall remote sensing sector point towards continued low, but steady, commercial launch demand for commercial satellites. Though there is growth in imagery demand, the current rate is not great enough to generate a significant amount of new satellite and launch opportunities. Although the government may have a significant influence on the expansion of remote sensing space assets, one company raised sufficient capital to fund a new satellite with no government funds.

There have been 28 licenses issued to date by the National Oceanic and Atmospheric Administration (NOAA), the U.S. agency with the authority to license commercial remote sensing systems, since 1993. Twelve of these licenses were granted to ORBIMAGE doing business as (d/b/a) GeoEye and DigitalGlobe, or their predecessor companies, for their respective systems. Fourteen other companies have received licenses, however, eight of these companies have retired their licenses.

The major companies operating or actively developing remote sensing satellites in the U.S. and around the world are profiled below. A summary of the commercial remote sensing systems is in Table 12, and a listing of current NOAA licenses is provded in Table 13.

DigitalGlobe

DigitalGlobe was established in 1993 and was granted the first NOAA license (under the name WorldView Imaging Corporation) in the same year. The company contracted with Boeing for the launch of the QuickBird satellite aboard a Delta 2 on October 18, 2001. QuickBird is capable of imaging objects 0.6 meters (2 feet) in size or greater, and became available for commercial service in early 2002. QuickBird is scheduled to remain in operation through at least 2009.

In January 2003, NGA awarded DigitalGlobe a firm, fixed-price, $96-million order and an indefinite-delivery, indefinite-quantity contract worth up to $500 million to provide space

Table 12. Commercial Satellite Remote Sensing Systems

System	Operator	Manufacturer	Satellites	Mass kg (lbm)	Highest Resolution (m)	Launch Year	Status
Operational							
EROS	ImageSat International	Israel Aircraft Industries	EROS A EROS B EROS C	280 (617) 350 (771) 350 (771)	1.5 0.7 0.7	2000 2006 2010	EROS A and B are operational. EROS C planned for early next decade.
IKONOS	ORBIMAGE (GeoEye)	Lockheed Martin	IKONOS 1 IKONOS	816 (1,800) 816 (1,800)	1 1	1999 1999	IKONOS 1 lost due to launch vehicle malfunction. IKONOS continues to operate.
OrbView	ORBIMAGE (GeoEye)	Orbital Sciences Corp.	OrbView-1 OrbView-2 OrbView-3 OrbView-4	74 (163) 372 (819) 304 (670) 368 (811)	10,000 1,000 1 1	1995 1997 2003 2001	OrbView-2 continues to operate. OrbView-3 is no longer operational. OrbView 4 lost due to launch vehicle failure.
QuickBird	DigitalGlobe	Ball Aerospace	EarlyBird QuickBird 1 QuickBird	310 (682) 815 (1,797) 909 (2,004)	3 1 0.6	1997 2000 2001	EarlyBird failed in orbit shortly after launch. First QuickBird launch failed in 2000. QuickBird started commercial operations in 2002.
RADARSAT	MacDonald, Dettwiler and Associates	MacDonald, Dettwiler and Associates	RADARSAT-1 RADARSAT-2 RCM	2,750 (6,050) 2,195 (4,840) 1,200 (2,645)	8 3 TBD	1995 2006 2012	RADARSAT-1 and -2 are operational. RCM is the three-satellite RADARSAT Constellation Mission.
Under Development							
GeoEye	ORBIMAGE (GeoEye)	General Dynamics Advanced Info. Systems	GeoEye-1	907 (2,000)	0.41	2007	Formerly known as OrbView-5.
RapidEye	RapidEye AG	Surrey Satellite Technology Ltd.	RapidEye 1-5	150 (330)	6.5	2008	String of five satellites provides high temporal frequency and redundancy.
TerraSAR	InfoTerra Group	Astrium	TerraSAR-X TanDEM-X TerraSAR-L	1,023 (2,255) 1,023 (2,255) 2,060 (4,540)	3 3 5	2006 2009 TBD	TerraSAR-X and TanDEM-X will provide commercial imagery. TerraSAR-L implementation decision pending.
TrailBlazer	TransOrbital	TransOrbital	TrailBlazer	420 (926)	1	2008-2009	TrailBlazer will conduct remote sensing of the Moon in 1-meter resolution, but requires NOAA license to image the Earth from a distance.
WorldView	DigitalGlobe	Ball Aerospace	WorldView 1 WorldView 2	2,500 (5,510) 2,800 (6,175)	0.5 0.5	2007 2008	WorldView 2 will operate in a higher orbit than WorldView 1 and take imagery in additional spectral bands.

imagery as part of NGA's ClearView program. The contract enables NGA to use commercial satellite imagery across a broad spectrum of value-added applications. The original contract was for three years and is dependent on availability of funds. There have been multiple contract modifications allowing NGA to increase its acquisition of QuickBird imagery, with the latest occurrence adding $12 million to the ClearView contract in March 2006.

In September 2003, NGA awarded DigitalGlobe a NextView contract valued in excess of $500 million to build a next-generation commercial remote sensing spacecraft. In March 2004, DigitalGlobe announced the company's next-generation WorldView 1 satellite, which is currently scheduled to launch in the third quarter of 2007 on a Delta 2. The WorldView 1 satellite's high-capacity imaging system features half-meter resolution. With an average revisit time of 1.7 days and a swath width of 16 kilometers (10 miles), this satellite will be capable of collecting up to 500,000 square kilometers (200,000 square miles) per day of half-meter imagery. A second satellite for the WorldView constellation, WorldView 2, is anticipated to launch in late 2008. WorldView 2 will operate in an 800-kilometer (500-mile) orbit designed to reduce revisit times and has an estimated lifetime of seven years.

GeoEye

GeoEye, Inc. is a producer of satellite, aerial, and geospatial information. The company was formed as a result of the ORBIMAGE acquisition of Space Imaging in January 2006. Although GeoEye, Inc. is the parent company, ORBIMAGE, Inc., is the NOAA Commercial Remote Sensing satellite license holder of record. Headquartered in Dulles, Virginia, GeoEye has over 370 employees, operates two earth imaging satellites, two mapping aircraft, possesses an international network of regional ground stations, and operates advanced geospatial imagery processing facilities. The GeoEye satellite imagery archive consists of some 278 millions square kilometers (107 million square miles) of map-accurate imagery.

GeoEye's next-generation Earth-imaging satellite, GeoEye-1, is scheduled to launch in 2007 on a Boeing Delta 2 from Vandenberg Air Force Base. When operational, it will be the world's highest resolution commercial imaging satellite. The satellite will operate in a sun-synchronous polar orbit at an altitude of 684 kilometers (425 miles). The ITT sensor will have the ability to take panchromatic images with a ground resolution of 0.41 meters (16 inches) and multispectral images with a resolution of 1.65 meters (5.4 feet). Imaging technology will allow 0.41-meter color imagery to be produced. The spacecraft will be able to collect about 700,000 square kilometers (270,000 square miles) of images per day in the panchromatic mode and half that in the multispectral mode. Commercial customers, however, will be limited to half-meter GeoEye-1 imagery due to current U.S. Government regulations.

GeoEye operates the IKONOS and OrbView-2 imaging satellites. On September 24, 1999, an Athena 2 launched the IKONOS satellite into a 680-kilometer (423-mile) polar orbit. IKONOS is the world's first high-resolution commercial remote sensing satellite, with a ground resolution of 0.82 meters (2.7 feet). The OrbView-2 satellite, launched by a Pegasus XL booster on August 1, 1997, continues to provide low-resolution images of up to 1.1 kilometers (0.71 miles). Imagery from this satellite is primarily used by the fishing industry and for research. GeoEye operated the high-resolution OrbView-3 satellite, but the company declared it inoper-

Table 13. Current Commercial Satellite Remote Sensing Licenses

Licensee	Date License Granted	Remarks
DigitalGlobe	1/4/1993	Originally issued to WorldView.
ORBIMAGE (d/b/a GeoEye)	5/5/1994	Originally issued to Orbital Sciences Corp.
ORBIMAGE (d/b/a GeoEye)	7/1/1994	Originally issued to Orbital Sciences Corp.
DigitalGlobe	9/2/1994	
AstroVision	1/23/1995	First license issued for a commercial GSO system.
Ball Aerospace/Technologies	11/21/2000	
DigitalGlobe	12/6/2000	First licenses issued to commercial operators for 0.5 meter resolution.
DigitalGlobe	12/14/2000	
TransOrbital	3/6/2002	TransOrbital license for imaging Earth from lunar orbit.
DigitalGlobe	9/29/2003	License for four-satellite high-resolution system.
Northrop Grumman	2/20/2004	MEO system with 0.5-meter resolution.
ORBIMAGE (d/b/a GeoEye)	8/12/2004	Originally issued to ORBIMAGE Inc.
Technica	12/8/2005	Planned four satellite EaglEye system.
ORBIMAGE (d/b/a GeoEye)	1/10/2006	IKONOS system license transfer from Space Imaging to ORBIMAGE.
ORBIMAGE (d/b/a GeoEye)	1/10/2006	IKONOS system license transfer from Space Imaging to ORBIMAGE.
ORBIMAGE (d/b/a GeoEye)	1/10/2006	IKONOS system license transfer from Space Imaging to ORBIMAGE.
Echostar	3/6/2007	GSO satellite with television camera for low-resolution images.

Note: A license is active from the date of issuance and remains active if specific progress towards system deployment occurs, such as providing documentation of satellite design and development progress, as well as execution of a launch contract.

able in April 2007 after it experienced a problem with its camera electronics.

The NGA is GeoEye's largest customer. While funding about half of the cost of the company's next-generation imaging system, the NGA also buys imagery from the IKONOS as well as archive imagery from the OrbView-3 satellite.

ImageSat International NV

ImageSat, founded as West Indian Space in 1997, provides commercial high-resolution imagery from its Earth Remote Observation Satellite (EROS) family of remote sensing satellites. A Netherlands Antilles company, ImageSat's strategic partners include Israel Aircraft Industries Ltd. and ELBIT-Electro Optics Industries, developers of the company's satellites and cameras, respectively. ImageSat currently operates two satellites, EROS A and EROS B. EROS A was launched from Svobodny, Russia in December 2000. In April 2006, their second satellite, EROS B, a very-high-resolution satellite with panchromatic resolution of 0.7 meters, was launched from Svobodny. EROS B, like its predecessor, offers flexible imaging capabilities at various angles, azimuth, and light conditions. The EROS A and EROS B spacecraft were both placed into orbit by START 1 vehicles. ImageSat is developing the mission requirements for its next satellite, EROS C, which the company plans to launch at the beginning of the next decade.

Infoterra Group

Infoterra GmbH, a subsidiary of EADS Astrium GmbH and part of the European Infoterra Group, holds the exclusive commercial exploitation rights for the German TerraSAR-X one-meter (3.3-feet) resolution radar satellite. The German Aerospace Center (Deutsches Zentrum für Luft und Raumfahrt, DLR) selected EADS Astrium to jointly develop the TerraSAR-X satellite, which is an X-band synthetic aperture radar (SAR) observation spacecraft with an expected orbital lifetime of at least five years. The spacecraft was built in Friedrichshafen, Germany and is expected to be placed into polar orbit by a Dnepr vehicle in the second quarter of 2007. Infoterra GmbH will be responsible for the commercial exploitation of TerraSAR-X data, while DLR will oversee science operations.

A satellite to complement TerraSAR-X, designated TanDEM-X, is planned. This TanDEM-X mission is an enhancement of TerraSAR-X through a second, similar spacecraft that will fly in a twin satellite constellation with TerraSAR-X, allowing the generation of a high-quality global digital elevation model. The satellite is projected to launch in early 2009.

Plans for a complementary L-band spacecraft, TerraSAR-L, financed by ESA, have been developed with Infoterra Ltd. in the United Kingdom, another company in the Infoterra Group. An implementation decision is still pending for TerraSAR-L and a potential launch of the satellite is not envisioned before early next decade.

MDA

MacDonald, Dettwiler and Associates Ltd. (MDA) holds the exclusive distribution rights to Canada's RADARSAT-1 data. RADARSAT-1, launched in November 1995 aboard a Delta 2, has gathered SAR data over nearly the entire Earth's surface. The spacecraft provides data with resolutions between 8 and 100 meters (26.2 and 328.1 feet) and has a repeat cycle of 24 days. RADARSAT-2, planned for launch in the third quarter of 2007 on a Soyuz rocket, will continue the mission of its predecessor while offering significant technical advancements, including greater imaging flexibility, dual polarization and full polarimetric imaging options, and 3-meter (10-foot) resolution.

The RADARSAT-2 program marks a transition from the government-led RADARSAT-1 program to one now led by the private sector.

MDA will own and operate the satellite and ground segment and will be responsible for satellite mission management operations and satellite programming, as well as international marketing and data distribution.

In 2004, the Canadian Space Agency (CSA) commissioned MDA to develop concepts for a follow-on mission to RADARSAT-2. In February 2005, the CSA announced funding for a three-satellite SAR constellation to succeed RADARSAT-2, the RADARSAT Constellation Mission. The satellites, projected to weigh approximately 1,200 kilograms (2,600 pounds) each, are scheduled for deployment early next decade, with the first spacecraft launch preliminarily projected around 2012.

RapidEye AG

RapidEye, a German company providing satellite-based geo-information services, is pursuing a five-satellite system designed to provide data for customers interested in agricultural and cartographic applications, with other markets possible. Each RapidEye satellite will be placed into the same orbital plane, and will be supported by an S-band command center and an X-band downlink ground component. The five satellites, each providing resolution of up to 6.5 meters (21.3 feet), will be launched together in 2008 on a single Dnepr vehicle.

RapidEye and MDA signed a supply agreement in May 2004 to work jointly on the project, with MDA providing satellite system integration, launch arrangements, and ground infrastructure. SSTL will build the satellite platforms, and the German company Jena-Optronik GmbH will provide the optical payload for the RapidEye satellites. Among others, MDA's Geospatial Services and U.S.-based MDA Federal Inc. will provide support to RapidEye by marketing and selling its products. RapidEye performs product development and customer service at its Brandenburg, Germany facilities.

Market Demand Scenarios

FAA/AST projects that the commercial satellite remote sensing sector will yield about 19 payloads throughout the forecast period, with a peak in 2008 due to the launch of five RapidEye satellites and WorldView 2 for DigitalGlobe. The commercial remote sensing satellites will be deployed on 15 launches, including 14 on medium-to-heavy vehicles.

NGSO Telecommunications Systems

NGSO telecommunications systems fall into two classes, Little LEO and Big LEO. The names derive from the frequencies used by these systems: Little LEO systems operate at frequencies below 1 GHz while Big LEO systems use frequencies in the range of 1.6–2.5 GHz. Little LEO systems provide narrowband data communications such as e-mail, two-way paging, and simple messaging for automated meter reading, vehicle fleet tracking, and other remote data monitoring applications. Big LEO systems provide mobile voice telephony and data services. A third class of NGSO telecommunications systems, called Broadband LEO, was proposed in the 1990s to provide high-speed data services at Ka- and Ku-band frequencies. There are new proposals to develop similar systems, using a mix of NGSO and GSO satellites, but these have not advanced beyond the planning stages.

To date one Little LEO system, ORBCOMM, and two Big LEO systems, Globalstar and Iridium, have been deployed. Details about these three systems, and other NGSO telecommunications operations, are provided below. Little LEO systems are summarized in Table 14 and Big LEO systems in Table 15.

Globalstar

Globalstar, Inc. currently operates a 40-satellite constellation of LEO satellites. Globalstar originally launched 52 satellites between 1998 and 2000, and owns eight spare satellites which it plans to launch in 2007 on a pair of Soyuz rockets procured in October 2005 in a contract with Starsem. The eight spares will replenish the aging constellation and enable Globalstar to maintain its service until its second generation is launched beginning in 2009. The first four satellites are scheduled for launch in May 2007, with the second four to be launched around the middle of the year. The satellites are ground spares that were built under the original 1994 contract between Globalstar, L.P. and Space Systems/Loral. Globalstar estimates the total cost of launching the eight replacement satellites to be approximately $110 million.

In November 2006 Globalstar signed a €661-million ($871-million) contract with Alcatel Alenia Space (now Thales Alenia Space) for the construction of 48 satellites that Globalstar will use to replace its existing satellite constellation. The contract requires Thales to commence delivery of satellites in the third quarter of 2009, with deliveries continuing until 2013 unless Globalstar elects to accelerate delivery. A decision to accelerate would not affect the delivery dates for the first 24 satellites. Globalstar has issued a request for proposals for launch services, and has not finalized the number of launches and number of satellites per launch that will be used to deploy the new constellation. In March 2007 Globalstar and Alcatel Alenia Space announced a separate agreement for the construction of satellite control centers and related ground equipment for use with the next-generation satellite system.

Globalstar, Inc., is the successor-in-interest to in Globalstar, L.P., having purchased most of Globalstar, L.P.'s assets in a Chapter 11 bankruptcy sale in December 2003. The company ended 2006 with 262,802 subscribers, up over 66,000 from the end of 2005. The company reported an operating income of $15.7 million on revenues of $136.7 million in 2006. Globalstar completed an initial public offering (IPO) of its stock in November 2006, raising over $100 million; the company also raised $500 million in equity capital and debt financing during the year.

In February 2007, Globalstar announced that it was continuing to experience problems with the S-band amplifiers on its spacecraft. Globalstar had been experiencing sporadic S-band anomalies in some of its satellites since 2001 but had been able to return the majority of them to service. In that announcement, the company stated that the amplifiers in the operational satellites originally launched between 1998 and 2000 were degrading faster than previously expected, and in a worst-case scenario most of the amplifiers in these original satellites will fail by 2008. Such failures would cause significant coverage gaps in its two-way phone service, but would not affect its one-way "simplex" data service, which uses only the L-band return link from the user's terminal to the satellite. The company said it is looking into a number of options to remedy the problem, including accelerating the construction and launch of its next-generation

Table 14. FCC-Licensed Little LEO Systems

System	Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
			Number	Mass kg (lbm)			
Operational							
ORBCOMM	ORBCOMM Global LP	Orbital Sciences Corp.	35/30 (in orbit/ operational)	43 (95)	LEO	1997	Operational with 35 satellites on orbit; FCC licensed, October 1994. Filed for bankruptcy protection in September 2000, emerged from bankruptcy protection in March 2002. Launches of replacement satellites scheduled to begin in 2007.
Under Development							
AprizeStar (LatinSat)	Aprize Satellite	SpaceQuest	4/2 (in orbit/ operational)	10 (22)	LEO	2002	Planned 48-satellite system. Licensed by Argentine CNC in 1995.

satellites. Globalstar, which originally operated a 48-satellite "Walker" constellation (8 planes of 6 satellites each), transitioned to a 40-satellite Walker constellation (5 satellites per plane) in 2005. In February 2007 Globalstar repositioned the 40 operational satellites into a hybrid Walker configuration to improve call coverage and to accommodate the launch of the 8 spare satellites later this year.

In January 2006 the FCC approved Globalstar's application to add an ancillary terrestrial component (ATC) to its satellite system. Globalstar plans to use its ATC system to provide enhanced coverage in urban areas, where buildings can block satellite signals, and to create temporary "mini-cells" to support emergency operations in remote areas. The company has not released details regarding the rollout of its ATC system, although published estimates suggest that the cost of a nationwide ATC system for any satellite company would be several billion dollars.

Iridium

In February 2007, Iridium Satellite LLC announced plans to develop its next-generation satellite system, called Iridium NEXT. The system is still in its early planning stages, but the company is investigating a number of new services that could be added to the satellite system, from high-bandwidth data links to wide-area broadcasting, while remaining backwards compatible with devices that use the existing system. The company anticipates launching the next-generation satellites starting in 2013 or 2014, completing the deployment of the 72-satellite system (66 operational satellites plus an initial 6 on-orbit spares) in about three years. No satellite manufacturing or launch services contracts for the next-generation system have been announced, although Iridium estimates the total cost of developing this system will exceed $2 billion.

Iridium announced that it had 175,000 subscribers for its voice and data services worldwide at the end of 2006, a 23-percent increase over 2005. The company reported an EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) of $53.9 million on revenues of $212.4 million in 2006, the first year the company reported absolute figures for earnings and revenue. The company has experienced growth in several market niches, including military and government agencies, aviation, maritime, and machine-to-machine. The Defense Department was an early major customer of Iridium and remains a major user of the system–the Defense Information Systems Agency (DISA) signed a sole-source contract with Iridium in April 2006 for voice, data, and pager services–although the company states that a majority of its revenue now comes from commercial users.

A total of 95 Iridium satellites have been launched, including seven spare satellites launched in 2002: five on a Delta 2 and two on a Rockot. The company has no spare

Table 15. FCC-Licensed Big LEO Systems

System	Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
			Number	Mass kg (lbm)			
Operational							
Globalstar	Globalstar Inc.	Alenia Spazio	52/40 (in orbit/ operational)	447 (985)	LEO	1998	Constellation on-orbit and operational; FCC licensed, January 1995. Company filed for Chapter 11 bankruptcy protection in February 2002; Thermo Capital Partners acquired a majority interest in the company in December 2003. Eight spare satellites planned for launch in 2007.
Iridium	Iridium Satellite LLC	Motorola	95/77 (in orbit/ operational)	680 (1,500)	LEO	1997	Assets acquired in December 2000 bankruptcy proceeding. Five spare satellites launched in February 2002, two additional spares launched June 2002. No additional launches of spares planned.

satellites remaining on the ground and has no plans to build any until it decides to deploy its second-generation satellite system. Iridium estimates that its current constellation of 66 operational spacecraft and 10 in-orbit spares will last through at least 2014, with some satellites remaining functional beyond 2020.

ORBCOMM

ORBCOMM's current intention is to replenish its existing constellation in a number of phases. First, ORBCOMM is under contract with the U.S. Coast Guard to conduct a demonstration test to validate the ability to receive AIS signals from marine vessels over 300 tons using a single satellite that is also fully functional with ORBCOMM's communications system. The satellite is in the final integration and test phase, with a launch expected to occur in 2007. Second, ORBCOMM intends to launch six "Quick Launch" satellites by the end of 2007 to supplement its Plane A satellites with satellites having slightly upgraded communications capabilities. Finally, ORBCOMM intends to launch "Generation 2" satellites with increased communications capabilities in 2009 and 2010. As a result, through a series of up to five launches, the company intends to replenish its existing constellation with a total of twenty-five satellites. In addition, ORBCOMM intends to require its satellite manufacturers to include options for additional satellites that can be launched on an accelerated schedule if the market demands such an increase or if lower latencies are required or to mitigate a launch failure.

On November 8, 2006, the company closed its initial public offering in which it sold 9,230,800 shares of common stock at a price of $11 per share. In 2005 through January 2006, ORBCOMM raised over $72.5 million from various investors, including $30 million from Pacific Corporate Group. ORBCOMM plans to use the majority of these proceeds to fund capital expenditures relating to both the Quick Launch and the Generation 2 satellites. Consolidated revenues increased 57.9% from $15.5 million in 2005 to $24.5 million in 2006. For the year ended 2006, the company reported a net loss of $11.2 million on revenues of $24.5 million compared to a net loss of $9.1 million on revenues of $15.5 million in 2005. ORBCOMM ended 2006 with 225,000 billable subscriber communicators, double the number from the end of 2005.

Other Systems

Other potential providers of Little LEO satellite services struggled to gain necessary funding, which forced them to fall behind the milestones for spacecraft assembly and launch mandated in their FCC licenses. There is little licensing activity regarding Little LEO spectrum at this time.

Some Little LEO satellite systems are so small that they do not necessarily generate launch demand. Aprize Satellite, Inc. is deploying one such system. Two AprizeStar (also known by its ITU registration as LatinSat) satellites weighing 10 kilograms (22 pounds) each were launched as secondary payloads on a Russian Dnepr rocket in 2002, and two more were launched as seconardaries on another Dnepr in June 2004. Two AprizeStar satellites will be launched as secondary payloads on a Dnepr launch in late 2008, with two more to be launched in 2010. A constellation with 48 satellites is planned by Aprize, depending on customer demand for additional data-communication capacity and frequency of contact. AprizeStar received an experimental license from the FCC in 2004 for the two satellites launched that year. The system also received licenses from the Argentine National Communications Commission (CNC) in 1995 and Industry Canada in 2003.

ICO—a name derived from the acronym for intermediate circular orbit—had planned to deploy a Big LEO system of ten operational satellites plus two on-orbit spares located in medium Earth obit at an altitude of 10,390 kilometers (6,450 miles). One ICO satellite was lost in a launch failure in March 2000. A second satellite was successfully launched in June 2001.

In January 2005, ICO filed an application with the FCC seeking approval to modify its non-geosynchronous satellite service authorization to substitute a geosynchronous satellite system to access the United States market. The FCC approved this application in May 2005. Space Systems/Loral is building the GSO satellite for ICO, which is scheduled for launch in late 2007 to meet its 2-GHz license deadline. In May 2007, ICO stated intentions to pursue a European operating license and hoped to still launch its ten NGSO satellites in storage, four of which are in various stages of assembly.

The original ICO firm raised around $3.1 billion before filing for Chapter 11 bankruptcy protection in August 1999. In December 1999, the U.S. bankruptcy court overseeing ICO's restructuring approved an additional $1.2-billion investment by a group of investors led by Craig McCaw, a successful wireless cellular-telephone network owner who had previously invested in the now-defunct Teledesic system.

Two companies have made initial plans to develop broadband satellite systems using a combination of GSO and NGSO satellites. Both @Contact (formerly ContactMEO) and Northrop Grumman have filed applications with the FCC for such hybrid GSO/NGSO systems, each incorporating four GSO satellites plus three satellites in highly elliptical orbits. @Contact received a license from the FCC for its Ka-band system in April 2006; the license includes milestones that require the company to launch all of its NGSO satellites by April 2012. The company has not announced any launch contracts for its system, but entered into a non-contingent satellite manufacturing contract with Space Systems/Loral in April 2007. Northrop Grumman has been actively updating the FCC application for its Global EHF Satellite Network (GESN), which will operate at Ka- and V-band frequencies. The company anticipates using GESN to offer broadband communications services to U.S. Government agencies and Fortune 100 companies.

Market Demand Scenarios

FAA/AST projects that 25 Little LEO satellites will be launched during the coming decade and generate a demand for five launches of small vehicles. FAA/AST projects that 56 Big LEO satellites will be launched during the coming decade to cover the replenishment of one existing system. These payloads will be deployed on nine launches of medium-to-heavy vehicles.

Future Markets

Recent years have seen the gradual development of a suborbital space tourism industry, fostered in part by events such as the Ansari X Prize and the successful flights of SpaceShipOne in 2004. New companies, some with considerable financial resources available, are developing suborbital spacecraft with the goal of regular passenger flights beginning by the end of this decade. Since this report only includes orbital commercial missions, the outlook for suborbital vehicles is not included in this forecast. The question is: when will orbital public space travel emerge?

To date there have been five orbital space tourist flights, all of which were one- to two-week scheduled missions launched by Russia as part of regular crew visits to the International Space Station (ISS). Dennis Tito launched on a Soyuz to the ISS in 2001, Mark Shuttleworth in 2002, Gregory Olsen in 2005, Anousheh Ansari in 2006, and Charles Simonyi in 2007. Additional tourists are expected to fly on future ISS taxi missions, depending on the availability of seats on the twice-yearly flights.

Bigelow Aerospace is ramping up its efforts to develop orbital habitats that can be used for a variety of purposes including commercial microgravity and research, astronaut training, and tourism. The company launched its first prototype module, Genesis 1, on a Dnepr rocket in July 2006. A second prototype, Genesis 2, will be launched in the second quarter of 2007, again on a Dnepr, followed by a larger prototype, Galaxy, in late 2008. These modules are designed to test, demonstrate, and validate technologies that will be used on future spacecraft. Bigelow plans to launch its first human habitable module, called Sundancer, in 2010.

Sundancer will offer 175 cubic meters of habitable volume and be able to support up to three people. Bigelow anticipates launching the larger BA 330, which will provide roughly 300 cubic meters of habitable volume, as early as 2012, depending on the availability of affordable commercial transportation to ferry cargo and passengers to and from its orbital outposts. Bigelow plans to sell four-week trips to its modules to astronauts from various national space agencies for $14.95 million (in 2012 dollars) including transportation; full modules can be leased from the company for $88 million a year.

NASA's "Centennial Challenges" prize competition program, part of the Innovative Partnerships Program Office, may include future Challenges for spacecraft missions, including breakthrough technology demonstration missions and missions to the Moon and other destinations that could stimulate demand for low-cost, emergent launch capabilities. The largest competition to date, the Lunar Lander Challenge, features $2 million in prizes for vehicles that can simulate the liftoff and landing of a lunar spacecraft; the same technology can be used for the development of future commercial suborbital and orbital spacecraft. No prize money was awarded in the competition in 2006, but several teams are expected to participate in the 2007 competition, to be held during the X Prize Cup in New Mexico in October. A provision of the National Aeronautics and Space Administration Authorization Act of 2005 allows NASA to award multimillion-dollar prizes, although awards in excess of $10 million require Congressional notification.

Another future market that NASA is attempting to stimulate is the commercial servicing of the ISS. NASA's COTS program is a $500-million, four-year effort where NASA will help fund the development of commercial vehicles that can carry cargo, and eventually crew, to and from the ISS. In August 2006 NASA announced it had awarded funded Space Act Agreements to two companies, Rocketplane Kistler (RpK) and SpaceX. RpK received a $207-million contract to support the development of its K-1 two-stage reusable launch vehicle, while SpaceX received a $278-million contract for the development of its Falcon 9 launch vehicle and Dragon spacecraft. Both contracts will be supplemented by private investment raised by the two companies, and the NASA awards will be paid out in installments tied to program milestones. Demonstration launches of both vehicles are expected to take place during 2008–2010, and will be licensed by the FAA.

Risk Factors That Affect Satellite and Launch Demand

Several factors could negatively or positively impact the NGSO forecast:

- **U.S. national and global economy**—It is not coincidental that the NGSO market's peak activity was during a time of continued U.S. economic expansion when investment capital soared during the 1990s. Similarly, economic good times in other countries generated high interest in new telecommunications services from space. As with other businesses, growth or decline in space markets is often affected by national economies.

- **Investor confidence**—After investors suffered large losses from the bankruptcies of high-profile NGSO systems, confidence in future and follow-on NGSO telecommunications systems plummeted.

There are signs of renewed investor confidence in this market, but skepticism remains about broadband NGSO systems, especially because of high entry costs. Investors may be waiting for examples of success in the GSO broadband market.

- **Increase in government purchases of commercial services**—For a variety of reasons, government entities have been purchasing more space-related services from commercial companies. For example, the DoD has purchased significant remote sensing data from commercial providers, funded the continuation of Iridium service as a major customer, and has made extensive use of Iridium in Afghanistan and Iraq. NGSO systems such as Globalstar and Iridium were used extensively by government agencies during hurricane relief operations on the Gulf Coast in 2005.

- **Satellite lifespan**—Many satellites outlast their planned design life. The designated launch years in this forecast for replacement satellites are often estimates for when a new satellite would be needed. Lifespan estimates are critical for the timing of replacements of existing NGSO satellite systems, given the high capital investment required for deploying a replacement system.

- **Need for replacement satellites**—Although a satellite might have a long lifespan, it could be replaced early because it is no longer cost effective to maintain, or an opportunity could arise that would allow a satellite owner/operator to leap ahead of the competition with a technological advancement. An example of this factor is higher-resolution commercial remote sensing satellites.

- **Business case changes**—The satellite owner/operator can experience budget shortfalls, change strategies, or request technology upgrades late in the manufacturing stage, all of which can contribute to schedule delay. There could also be an infusion of cash from new investors that could revive a stalled system or accelerate schedules.

- **Corporate mergers**—The merging of two or more companies may make it less likely for each to continue previous plans and can reduce the number of competing satellites that launch. Conversely, mergers can have a positive impact by pooling the resources of two weaker firms to enable launches that would not have otherwise occurred.

- **Regulatory and political changes**—Changes in FCC or NOAA processes, export control issues associated with space technology, and political relations between countries can all affect demand. The FCC adopted a new licensing process in 2003 to speed up reviews that put pressure on companies that are not making progress towards launching satellites.

- **Terrestrial competition**—Satellite services can complement or compete with ground-based technology such as cellular telephones or communications delivered through fiber optic or cable television lines. Aerial remote sensing also competes with satellite imagery. Developers of new space systems have to plan ahead extensively for design, construction, and testing of space technologies, while developers of terrestrial technologies can react and build to market trends more quickly and possibly convince investors of a faster return on investment.

- **Launch failure**—A launch vehicle failure can delay plans, delay other satellites awaiting a ride on the same vehicle, or cause a shift to other vehicles and, thus, possibly impact their schedules. Failures, however, have not caused customers to terminate plans. The entire industry is affected by failures, however, because insurers raise rates on all launch providers.

- **Satellite manufacturing delay**—Increased efforts on quality control at large satellite-manufacturing firms seen in the past few years can delay delivery of completed satellites to launch sites. Schedule delays could impact timelines for future demand.

- **Failure of orbiting satellites**—From the launch services perspective, failure of orbiting satellites could mean ground spares are launched or new satellites are ordered. This would only amount to a small effect on the market, however. A total system failure has not happened to any NGSO constellation, although Globalstar is experiencing difficulties with its existing satellites.

- **Increase in government missions open to launch services competition** —Some governments keep launch services contracts within their borders to support domestic launch industries. The European Space Agency has held international launch competitions for some of its small science missions. Some remote sensing satellite launches are also competed. While established space-faring nations are reluctant to open up to international competition, the number of nations with new satellite programs but without space launch access is slowly increasing.

- **Introduction of a low price launch vehicle**—Although relatively inexpensive launches are available on Russian launch vehicles and emerging U.S. vehicles, low prices have not increased demand for the past several years for either large or small satellites. In addition to market factors already discussed, all the other costs to do business in space are expensive, from satellite design and construction to insurance to ground systems and continued operations. However, to open an entirely new market in NGSO, such as for public space travel, an expendable or reusable vehicle offering low launch prices would likely increase demand, according to the *2003 NASA ASCENT Study Final Report*.

- **New markets**—The emergence of new markets, such as orbital public space travel, can be difficult to forecast with certainty. The development of these markets can be delayed or accelerated by a combination of technical, financial, and regulatory issues. The NASA COTS program is an example of government promotion of a new commercial market. Prize competitions can also stimulate the development of new markets, allowing both winning and losing competitors to pursue a return on the investment made to capture a prize. A successful competition can inspire other competitions.

Methodology

This report is based on FAA/AST research and discussions with industry, including satellite service providers, satellite manufacturers, launch service providers, system operators, government offices, and independent analysts. The FCC was also interviewed for this report. The forecast considers progress for publicly-announced satellites, including financing, regulatory developments, spacecraft manufacturing and launch services contracts, investor confidence, competition from space and terrestrial sectors, and overall economic conditions. Future deployments of satellites that have not yet been announced are projected based on market trends, the status of existing satellites, and the economic conditions of potential satellite developers.

Traditionally, very small satellites—those with masses of less than 100 kilograms (220 pounds)—ride as secondary payloads and thus do not generate “demand” for a single launch in this forecast. However, the launch providers for the Russian/Ukrainian Dnepr and Russian Cosmos are flexible enough to fly several small satellites together without a single large primary payload. Therefore, these missions can act as a driver of demand in this report. Satellites below 10 kilograms (22 pounds) in mass are excluded from the forecast model because they do not create demand for a single launch, and therefore, have negligible effect on global launch demand.

Follow-on systems and replacement satellites for existing systems are evaluated on a case-by-case basis. In some cases, expected future activity is beyond the timeframe of the forecast or is not known with enough certainty to merit inclusion in the forecast model.

Satellite systems considered likely to be launched are entered into an Excel-based “traffic model.” The model tracks satellites and launches in this forecast based on the research discussed above, known replacement cycles, and other industry trends for existing and planned telecommunications and remote sensing systems. For the international science and other miscellaneous markets, near-term primary payloads that generated individual commercial launches were used in the model while future years were estimated based on historical activity.

In past years, the number of launches that have taken place has often been substantially less than the number in that year’s forecast. This mismatch is due to a number of factors, including funding, satellite manufacturing, and launch vehicle delays, that cause the launch to be postponed to the following year. Historically only a small number of primary satellites scheduled for launch have been delayed indefinitely or canceled. In this year’s forecast FAA/AST has included a “realization factor” that provides an estimate of the number of launches that will take place in 2007, based on historical trends in past forecasts.

International launch providers were surveyed for the latest available near-term manifests. Table 16 shows the announced near-term manifests for the markets analyzed in this report, as well as the realization factor for launches in the near-term manifest for 2007.

Vehicle Sizes and Orbits

Small launch vehicles are defined as those with a payload capacity of less than 2,268 kilograms (5,000 pounds) to LEO, at

Table 16. Near-Term Identified NGSO Satellite Manifest

Service Type	2007	2008	2009	2010
Commercial Remote Sensing	RADARSAT 2* - Soyuz	WorldView 2 - Delta 2	TanDEM X - Dnepr	EROS C - START
	WorldView 1 - Delta 2	RapidEye 1-5 - Dnepr		
	TerraSAR X* - Dnepr			
	GeoEye 1 - Delta 2			
International Science	THEOS - Dnepr	CASSIOPE - Falcon 9	Cryosat 2 - Rockot	Microscope - TBA
	RazakSAT* - Falcon 1	DEIMOS - TBA	SERVIS 2 - Rockot	Kompsat 5 - TBA
	AGILE* - PSLV	UK DMC 2	Kompsat 3 - TBA	
	Egyptsat* - Dnepr	GOCE - Rockot		
	Saudisat 3*	SMOS - Rockot		
	SaudiComsat 3-7*	DubaiSat-1 - Dnepr		
	SumbandilaSat - Shtil			
Telecommunications	ORBCOMM CDS-3 - TBA		ORBCOMM (6) - TBA	ORBCOMM (6) - TBA
	ORBCOMM (6) - Cosmos		ORBCOMM (6) - TBA	Globalstar (8) - TBA
	Globalstar (4) - Soyuz		Globalstar (8) - TBA	Globalstar (6) - TBA
	Globalstar (4) - Soyuz			
Other	Genesis 2* - Dnepr	Galaxy - TBA	TBA - Falcon 1	Sundancer - Falcon 9
	SAR Lupe 2* - Cosmos	SAR Lupe 4 - Cosmos	Dragon COTS Demo 2- Falcon 9	K-1 COTS Demo 3 - K-1
	SAR Lupe 3 - Cosmos	SAR Lupe 5 - Cosmos	Dragon COTS Demo 3- Falcon 9	
	Cosmo-Skymed 1* - Delta 2	Cosmo-Skymed 2 - Delta 2	K-1 COTS Demo 1 - K-1	
		Cosmo-Skymed 3 - TBA	K-1 COTS Demo 2 - K-1	
		Dragon COTS Demo 1- Falcon 9	Cosmo-Skymed 4 - TBA	
Total Payloads	34	18	30	25
Total Launches	17	13	13	8
FAA Realization Launches	10–13			

***Carryover from 2006.**
Note: This manifest includes only those satellites announced as of May 4, 2007.
It does not include secondary payloads that do not generate launch demand.

185 kilometers (100 nautical miles) altitude and 28.5° inclination. Medium-to-heavy launch vehicles are capable of carrying more than 2,268 kilograms at 185 kilometers altitude and 28.5° inclination.

Commercial NGSO systems use a variety of orbits, including the following:

- Low Earth orbits (LEO) range from 160-2400 kilometers (100–1,500 miles) in altitude, varying between 0° inclination for equatorial coverage and 101° inclination for global coverage;

- Medium Earth orbits (MEO) begin at 2,400 kilometers (1,500 miles) in altitude and are typically at a 45° inclination to allow for global coverage using fewer higher-powered satellites. However, MEO is often a term applied to any orbit between LEO and GSO;

- Elliptical orbits (ELI, also known as highly-elliptical orbits, or HEO) have apogees ranging from 7,600 kilometers (4,725 miles) to 35,497 kilometers (22,000 miles) in altitude and up to 116.5° inclination, allowing satellites to "hang" over certain regions on Earth, such as North America; and

- External or non-geocentric orbits (EXT) are centered on a celestial body other than the Earth. They differ from highly-elliptical orbits (ELI) in that they are not closed loops around Earth and a spacecraft in EXT will not return to an Earth orbit. In some cases, this term is used for payloads intended to reach another celestial body (e.g., the Moon) even though part of the journey is spent in a free-return orbit that would result in an Earth return if not altered at the appropriate time to reach its destination orbit.

Satellite and Launch Forecast

In this forecast, the 191 satellites seeking future commercial launch is significantly greater than the 2006 forecast, which predicted 160 satellites to be launched in the 2006–2015 timeframe. This increase is similar to the difference between 2005 and 2006, with the 2005 forecast predicting 144 satellites. An increase in the number of international science and other satellites as well as plans for replacement satellites for both Big LEO and Little LEO systems are the primary drivers of this year's increase. The number of launches in this year's forecast, 81, is somewhat greater than the 2006 forecast, which estimated 69 launches.

The baseline forecast anticipates the following satellite market characteristics from 2007–2016:

- International science and other satellites (such as technology demonstrations) will comprise about 48 percent of the NGSO satellite market with 91 satellites, slightly lower than the 97 satellites in the 2006 forecast.

- Telecommunications satellites account for about 42 percent of the market with 81 satellites, an increase from the 43 satellites in last year's forecast because of new plans regarding the deployment of next-generation Big LEO and Little LEO systems.

- Remote sensing satellites that serve commercial missions encompass roughly 10 percent of the market with 19 satellites, comparable to forecasts from the previous four years, which ranged between 16 and 21 satellites.

Table 17 and Figures 12 and 13 show the baseline forecast in which 191 satellites will be deployed between 2007 and 2016. Table 18 shows the mass distributions of known manifested satellites over the next four years. Unlike the recent past, large satellites are prevalent in the near-term manifest: 49 percent of the satellites in the near-term manifest weigh over 600 kilograms, compared to 31 percent in the 2006 forecast and 32 percent in the 2005 forecast.

Figure 12. Satellite Forecast

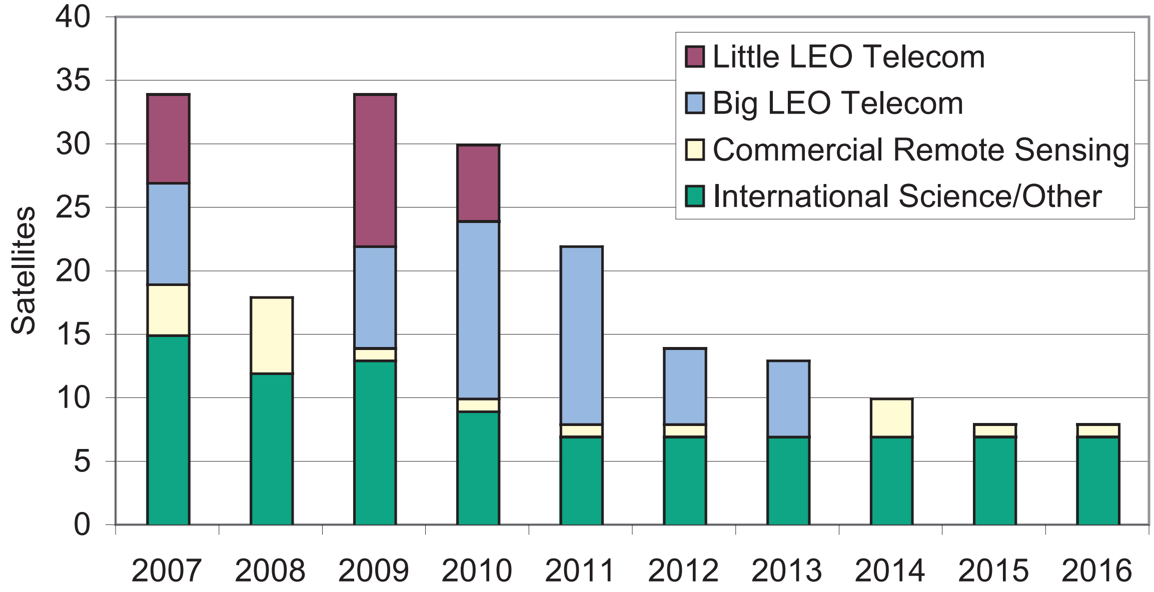


Figure 13. Launch Demand Forecast

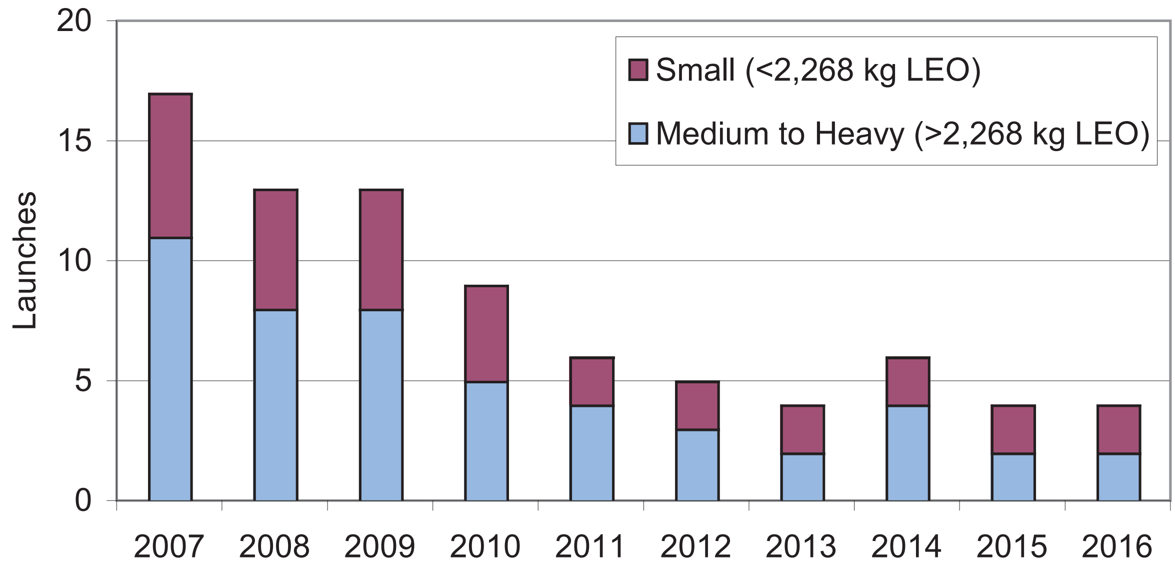


Table 17. Satellite and Launch Demand Forecast

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	TOTAL	Avg
Satellites												
Big LEO	8	0	8	14	14	6	6	0	0	0	56	5.6
Little LEO	7	0	12	6	0	0	0	0	0	0	25	2.5
International Scientific/Other	15	12	13	9	7	7	7	7	7	7	91	9.1
Commercial Remote Sensing	4	6	1	1	1	1	0	3	1	1	19	1.9
Total Satellites	**34**	**18**	**34**	**30**	**22**	**14**	**13**	**10**	**8**	**8**	191	19.1
Launch Demand												
Medium-to-Heavy Vehicles	11	8	8	5	4	3	2	4	2	2	49	4.9
Small Vehicles	6	5	5	4	2	2	2	2	2	2	32	3.2
Total Launches	**17**	**13**	**13**	**9**	**6**	**5**	**4**	**6**	**4**	**4**	81	8.1

After accounting for multiple manifesting, the 191 satellites in the forecast yields a commercial launch demand of 81 launches over the forecast period. This demand breaks down to an average of just over three launches annually on small launch vehicles and nearly five launches annually on medium-to-heavy launch vehicles. The total number of launches is greater than the 2006 forecast, with the increase in launches primarily in more medium-to-heavy vehicles, with the amount of small vehicles about the same. This is attributable to the increased use of medium-class vehicles to launch next-generation Big LEO, remote sensing, and other heavier satellites. The peak launch activity in the forecast is in 2007, 2008, and 2009, with 17, 13, and 13 launches, respectively; the first four years of the forecast see the greatest launch activity. However, using the realization factor described in the Methodology section, the actual number of launches expected in 2007 will be between 10 and 13.

As shown in Table 19, 52 of the 81 launches in the current forecast will carry international science and other payloads. Fifteen launches are forecast to carry commercial remote sensing satellites with 14 forecast for telecommunications satellites. International science and other payloads are split evenly between small and medium-to-heavy vehicles, a slight increase in the use of larger vehicles than in past years. Commercial remote sensing satellites, on the other hand, will be launched almost exclusively on medium-to-heavy vehicles because these satellites are generally larger. Telecommunications satellites will use medium-to-heavy vehicles for Big LEO satellites and small vehicles for Little LEO payloads.

Historical NGSO Market Assessments

The 2007 FAA/AST baseline forecast of commercial NGSO launches and payloads for 2007–2016 has a slightly greater total of satellites and launches than in the 2006. The forecast does show similar overall trends, though, such as the greatest amount of activity in the forecast's first five years. Historically, there have been significant changes in the amount of payloads and launches that are expected in the forecast period, particularly with a large increase from 1996 to 1998 and then a decrease from 1999 to 2001. Figure 14 provides a historical comparison of FAA/AST baseline forecasts from 2001 to the present, with actual launches to date included. After the high rate of demand

Table 18. Distribution of Satellite Masses in Near-Term Manifest

	2007	2008	2009	2010	Total	Percent of Total
< 200 kg (< 441 lbm)	16	8	12	7	43	40%
200-600 kg (441-1323 lbm)	9	1	1	1	12	11%
601-1200 kg (1324-2646 lbm)	4	4	12	15	35	33%
> 1200 kg (> 2646 lbm)	5	5	5	2	17	16%
Total	34	18	30	25	107	100%

Table 19. Distribution of Launches Among Market Sectors

		Launch Demand		
	Satellites	Small	Medium to Heavy	Total
Telecommunications	81	5	9	14
International Science/Other	91	26	26	52
Commercial Remote Sensing	19	1	14	15
Total	**191**	**32**	**49**	**81**

for launches in the late 1990s and forecasts projecting continued high rates of launches, FAA/AST reduced its annual forecasts as it saw the demand for launches fall.

The last few years' forecasts show a gradual upward trend in the amount of forecasted payloads and launches. The 2007 forecast continues this trend with 191 payloads projected to launch on 81 vehicles from 2007 to 2016. This represents an increase of 31 payloads from last year's forecast, the fifth consecutive year of increased payload projections. The 81 launches is a twelve-launch increase from the 2006 forecast, which is the second year in a row that has seen an increased forecast of total launches. The total number of forecasted launches since 1998 generally decreases until the 2006 forecast. Figure 15 illustrates these trends by displaying the average number of launches each year in forecasts dating back to 1998, as well as the maximum number of launches in any given year of each forecast.

The number of international science and commercial remote sensing satellites creates steady launch demand throughout the forecast period. In comparison, the telecommunications sector only provides launch demand in six years of the forecast, 2007 and 2009 to 2013. This telecommunications trend exists because of replacement and next-generation system schedules for Globalstar and ORBCOMM in the upcoming years. The 2002 forecast was the first occurrence of this sector turnaround from the late 1990s when telecommunications satellites dominated the creation of launch demand. The constellations of Iridium, Globalstar, and ORBCOMM created the most active year for NGSO launches in 1998, when 19 launches occurred. Comparatively, the 2007 forecast expects the telecommunications sector to create four launches in its most active year.

Table 20 lists actual payloads launched by market sector and total commercial launches that were internationally competed or commercially sponsored from 1993–2006. Medium-to-heavy and small vehicles both performed 43 launches during this period. This trend of equality between class of vehicles is not predicted to continue. The 2007 forecast estimates that more medium-to-heavy vehicle launches (49) will occur during 2007–2016 than small vehicle launches (32).

Historical satellite and launch data from 1993–2006 are shown in Table 21. Secondary and piggyback payloads on launches with larger primary payloads were not included in the payload or launch tabulations.

Table 20. Historical Commercial NGSO Activity*

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Satellites															
Big LEO	0	0	0	0	46	60	42	5	1	7	0	0	0	0	161
Little LEO	1	0	3	0	8	18	7	0	0	2	0	2	0	0	41
International Science/Other	1	0	0	2	1	4	5	11	1	6	1	7	8	4	51
Commercial Remote Sensing	0	0	1	0	2	0	2	2	2	0	8	0	0	1	18
Total Satellites	**2**	**0**	**4**	**2**	**57**	**82**	**56**	**18**	**4**	**15**	**9**	**9**	**8**	**5**	271
Launches															
Medium-to-Heavy Vehicles	0	0	0	1	8	9	11	6	2	2	1	1	0	2	43
Small Vehicles	1	0	2	1	5	10	7	3	2	2	3	1	3	3	43
Total Launches	**1**	**0**	**2**	**2**	**13**	**19**	**18**	**9**	**4**	**4**	**4**	**2**	**3**	**5**	86

* Includes payloads open to international launch services procurement and other commercially-sponsored payloads. Does not include dummy payloads. Also not included in this forecast are those satellites that are captive to national flag launch service providers (i.e., USAF or NASA satellites, or similar European, Russian, Japanese, or Chinese government satellites that are captive to their own launch providers). Does not include piggyback payloads. Only primary payloads that generate a launch are included unless combined secondaries generate the demand.

Figure 14. Comparison of Past Baseline Launch Demand Forecasts

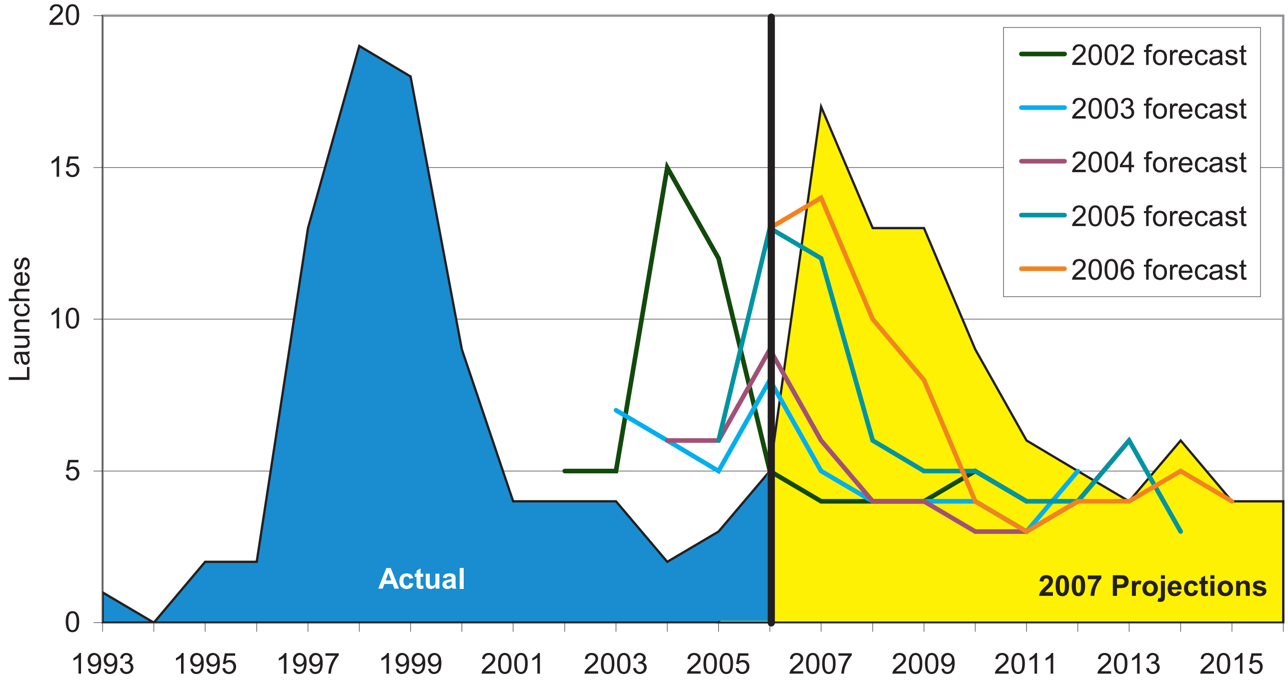


Figure 15. Average and Maximum Launches per Year from NGSO Forecasts 1998–2007

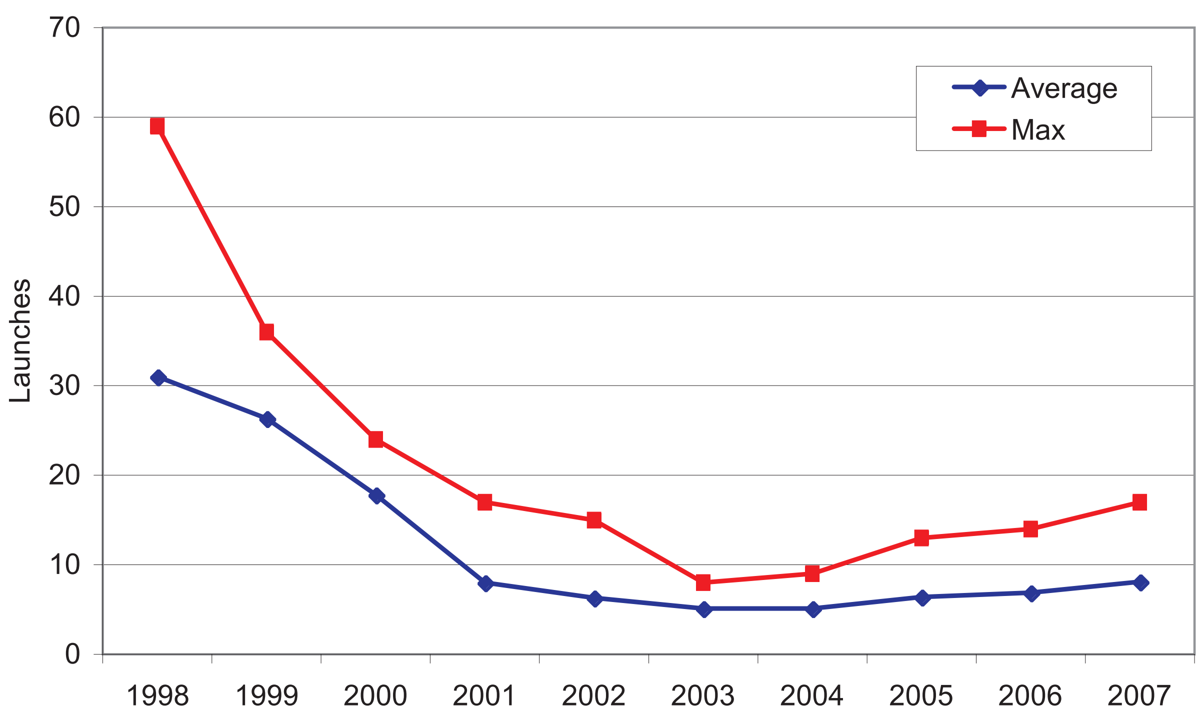


Table 21. Historical NGSO Satellite and Launch Activities (1993–2006)†

Summary	Market Segment	Date	Satellite	Launch Vehicle	
2006					
5 Satellites	**Remote Sensing**	4/25/06	EROS B	START 1	Small
1 Remote Sensing					
2 Int'l Science	**International Science**	7/28/06	Kompsat 2	Rockot	Small
2 Other		12/27/06	Corot	Soyuz 2 1B	Medium-to-Heavy
5 Launches	**Other**	7/12/06	Genesis 1	Dnepr	Medium-to-Heavy
2 Medium-to-Heavy		12/19/06	SAR Lupe 1	Cosmos	Small
3 Small					
2005					
8 Satellites	**International Science**	6/21/05	Cosmos 1	Volna[F]	Small
8 Int'l Science		10/8/05	CryoSat	Rockot[F]	Small
		10/27/05	Beijing 1	Cosmos	Small
			Mozhayets 5		
			Rubin 5		
3 Launches			Sinah 1		
0 Medium-to-Heavy			SSETI Express		
3 Small			Topsat		
2004					
9 Satellites	**Little LEO**	6/29/04	LatinSat (2 sats)*	Dnepr	Medium-to-Heavy
2 Little LEO					
7 Int'l Science	**International Science**	5/20/04	Rocsat 2	Taurus	Small
		6/29/04	Demeter	Dnepr	Medium-to-Heavy
			AMSat-Echo		
2 Launches			SaudiComSat 1-2		
1 Medium-to-Heavy			SaudiSat 2		
1 Small			Unisat 3		
2003					
9 Satellites	**Remote Sensing**	6/26/03	OrbView 3	Pegasus XL	Small
1 Remote Sensing					
8 Int'l Science	**International Science**	6/2/03	Mars Express	Soyuz	Medium-to-Heavy
			Beagle 2		
		9/27/03	BilSat 1	Cosmos	Small
			BNSCSat		
			KaistSat 4		
4 Launches			NigeriaSat 1		
1 Medium-to-Heavy			Rubin 4-DSI		
3 Small		10/30/03	SERVIS 1	Rockot	Small
2002					
15 Satellites	**Big LEO**	2/11/02	Iridium (5 sats)	Delta 2	Medium-to-Heavy
7 Big LEO		6/20/02	Iridium (2 sats)	Rockot	Small
2 Little LEO					
6 Int'l Science	**Little LEO**	12/20/02	LatinSat (2 sats)**	Dnepr	Medium-to-Heavy
	International Science	3/17/02	GRACE (2 sats)	Rockot	Small
		12/20/02	SaudiSat 1C	Dnepr	Medium-to-Heavy
			Unisat 2		
4 Launches			RUBIN 2		
2 Medium-to-Heavy			Trailblazer Structural		
2 Small			Test Article		

† Includes payloads open to international launch services procurement and other commercially-sponsored payloads. Does not include dummy payloads. Also not included in this forecast are those satellites that are captive to national flag launch service providers (i.e., USAF or NASA satellites, or similar European, Russian, Japanese, or Chinese government satellites that are captive to their own launch providers). Does not include piggy-back payloads. Only primary payloads that generate launch demand are included unless combined secondaries generated the demand.

F Launch Failure
* Launched on same mission as Demeter et al.
** Launched on same mission as SaudiSat 2 et al.

Table 21. Historical NGSO Satellite and Launch Activities (1993–2006) [Continued]

Summary	Market Segment	Date	Satellite	Launch Vehicle	
2001					
4 Satellites	**Big LEO**	6/19/01	ICO F-2	Atlas 2AS	Medium-to-Heavy
1 Big LEO					
2 Remote Sensing	**Remote Sensing**	9/21/01	OrbView 4	Taurus[F]	Small
1 Int'l. Science		10/18/01	QuickBird 2	Delta 2	Medium-to-Heavy
4 Launches	**International Science**	2/20/01	Odin	START 1	Small
2 Medium-to-Heavy					
2 Small					
2000					
18 Satellites	**Big LEO**	2/8/00	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
5 Big LEO		3/12/00	ICO F1	Zenit 3SL[F]	Medium-to-Heavy
2 Remote Sensing					
8 Int'l. Science	**Remote Sensing**	11/21/00	QuickBird 1	Cosmos[F]	Small
3 Other		12/5/00	EROS A1	START 1	Small
	International Science	7/15/00	Champ	Cosmos	Small
			Mita		
			RUBIN		
		9/26/00	MegSat 1	Dnepr 1	Medium-to-Heavy
			SaudiSat 1-1		
			SaudiSat 1-2		
			Tiungsat 1		
			Unisat		
9 Launches	**Other**	6/30/00	Sirius Radio 1	Proton	Medium-to-Heavy
6 Medium-to-Heavy		9/5/00	Sirius Radio 2	Proton	Medium-to-Heavy
3 Small		11/30/00	Sirius Radio 3	Proton	Medium-to-Heavy
1999					
56 Satellites	**Big LEO**	2/9/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
42 Big LEO		3/15/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
7 Little LEO		4/15/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
2 Remote Sensing		6/10/99	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
5 Int'l. Science		6/11/99	Iridium (2 sats)	LM-2C	Small
		7/10/99	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
		7/25/99	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
		8/17/99	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
		9/22/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
		10/18/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
		11/22/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
	Little LEO	12/4/99	ORBCOMM (7 sats)	Pegasus	Small
	Remote Sensing	4/27/99	IKONOS 1	Athena 2[F]	Small
		9/24/99	IKONOS 2	Athena 2	Small
	International Science	1/26/99	Formosat 1	Athena 1	Small
		4/21/99	UoSat 12	Dnepr 1	Medium-to-Heavy
18 Launches		4/29/99	Abrixas	Cosmos	Small
11 Medium-to-Heavy			MegSat 0		
7 Small		12/21/99	Kompsat	Taurus	Small

Table 21. Historical NGSO Satellite and Launch Activities (1993–2006) [Continued]

Summary	Market Segment	Date	Satellite	Launch Vehicle	
1998					
82 Satellites	**Broadband LEO**	2/25/98	Teledesic T1 (BATSAT)	Pegasus	Small
1 Broadband LEO					
60 Big LEO	**Big LEO**	2/14/98	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
18 Little LEO		2/18/98	Iridium (5 sats)	Delta 2	Medium-to-Heavy
3 Int'l. Science		3/25/98	Iridium (2 sats)	LM-2C	Small
		3/29/98	Iridium (5 sats)	Delta 2	Medium-to-Heavy
		4/7/98	Iridium (7 sats)	Proton	Medium-to-Heavy
		4/24/98	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
		5/2/98	Iridium (2 sats)	LM-2C	Small
		5/17/98	Iridium (5 sats)	Delta 2	Medium-to-Heavy
		8/20/98	Iridium (2 sats)	LM-2C	Small
		9/8/98	Iridium (5 sats)	Delta 2	Medium-to-Heavy
		9/10/98	Globalstar (12 sats)	Zenit 2[F]	Medium-to-Heavy
		11/6/98	Iridium (5 sats)	Delta 2	Medium-to-Heavy
		12/19/98	Iridium (2 sats)	LM-2C	Small
	Little LEO	2/10/98	ORBCOMM (2 sats)	Taurus	Small
		8/2/98	ORBCOMM (8 sats)	Pegasus	Small
		9/23/98	ORBCOMM (8 sats)	Pegasus	Small
19 Launches					
9 Medium-to-Heavy	**International Science**	7/7/98	Tubsat N & Tubsat N 1	Shtil	Small
10 Small		10/22/98	SCD 2	Pegasus	Small
1997					
57 Satellites	**Big LEO**	5/5/97	Iridium (5 sats)	Delta 2	Medium-to-Heavy
46 Big LEO		6/18/97	Iridium (7 sats)	Proton	Medium-to-Heavy
8 Little LEO		7/9/97	Iridium (5 sats)	Delta 2	Medium-to-Heavy
2 Remote Sensing		8/20/97	Iridium (5 sats)	Delta 2	Medium-to-Heavy
1 Int'l. Science		9/14/97	Iridium (7 sats)	Proton	Medium-to-Heavy
		9/26/97	Iridium (5 sats)	Delta 2	Medium-to-Heavy
		11/8/97	Iridium (5 sats)	Delta 2	Medium-to-Heavy
		12/8/97	Iridium (2 sats)	LM-2C	Small
		12/20/97	Iridium (5 sats)	Delta 2	Medium-to-Heavy
	Little LEO	12/23/97	ORBCOMM (8 sats)	Pegasus	Small
	Remote Sensing	8/1/97	OrbView 2	Pegasus	Small
13 Launches		12/24/97	EarlyBird 1	START 1	Small
8 Medium-to-Heavy					
5 Small	**International Science**	4/21/97	Minisat 0.1	Pegasus	Small
1996					
2 Satellites	**International Science**	4/30/96	SAX	Atlas 1	Medium-to-Heavy
2 Int'l. Science		11/4/96	SAC B	Pegasus	Small
2 Launches					
1 Medium-to-Heavy					
1 Small					
1995					
4 Satellites	**Little LEO**	4/3/95	ORBCOMM (2 sats)	Pegasus	Small
3 Little LEO		8/15/95	GEMStar 1	Athena 1[F]	Small
1 Remote Sensing					
	International Science	4/3/95	OrbView 1 (Microlab)	Pegasus	Small
2 Launches					
2 Small					
1994					
0 Satellites					
0 Launches					
1993					
2 Satellites	**Little LEO**	2/9/93	CDS 1	Pegasus 1	Small
1 Little LEO					
1 Int'l. Science	**International Science**	2/9/93	SCD 1	Pegasus 1	Small
1 Launch					
1 Small					