Federal Aviation Administration

2008 Commercial Space Transportation Forecasts

May 2008

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

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 2008 to 2017.

The 2008 Commercial Space Transportation Forecasts report includes:

- The *2008 COMSTAC Commercial Geosynchronous Orbit Launch Demand Forecast* 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 2008 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 27.4 commercial space launches worldwide from 2008 to 2017. The combined forecasts are an increase of 17 percent compared to the 2007 forecast of 23.4 launches per year. Twenty-four commercial launches occurred worldwide in 2007. The forecasts project a launch demand increase up to 33 launches during 2008 (22 GSO and 11 NGSO).

In the GSO market, demand averaged 21.8 satellites per year, compared to 21.0 satellites in the 2007 forecast. The resulting demand for launches, after accounting for dual-manifested missions, increased to an average of 16.2 launches per year compared to 15.3 per year in last year's forecast. Launch demand increased in the GSO market in part because of missions delayed from 2007. An analysis of mass trends in the report indicates continued stabilization of the average mass per satellite.

In the NGSO market, the number of satellites expanded 38 percent to an average of 27.6 per year compared to 19.1 per year in last year's forecast. More telecommunications and commercial resupply missions to the International Space Station are included in this year's forecast. After calculating the number of satellites that are multiple-manifested, launch demand increased to an average of 11.2 launches per year. The increase means an average demand of about three more NGSO launches per year, mostly on medium-to-heavy vehicles, versus the 2007 forecast.

COMSTAC and FAA project an average annual demand for:

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

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

- 3.1 launches of small vehicles to NGSO.

Table 1 shows the totals for the 2008 forecast. Figures 1, 2, and 3 compare historical activity in GSO and NGSO to the 2008 forecast.

Table 1. Commercial Space Transportation Satellite and Launch Forecasts

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total	Average
Satellites												
GSO Forecast (COMSTAC)	27	27	23	22	21	21	20	19	19	19	218	21.8
NGSO Forecast (FAA)	24	27	37	29	25	9	38	41	36	10	276	27.6
Total Satellites	**51**	**54**	**60**	**51**	**46**	**30**	**58**	**60**	**55**	**29**	**494**	**49.4**
Launch Demand												
GSO Medium-to-Heavy	22	23	18	16	15	15	14	13	13	13	162	16.2
NGSO Medium-to-Heavy	5	10	6	6	10	4	13	12	11	4	81	8.1
NGSO Small	6	2	5	5	2	2	2	2	2	3	31	3.1
Total Launches	**33**	**35**	**29**	**27**	**27**	**21**	**29**	**27**	**26**	**20**	**274**	**27.4**

Figure 1. GSO Satellite and Launch Demand

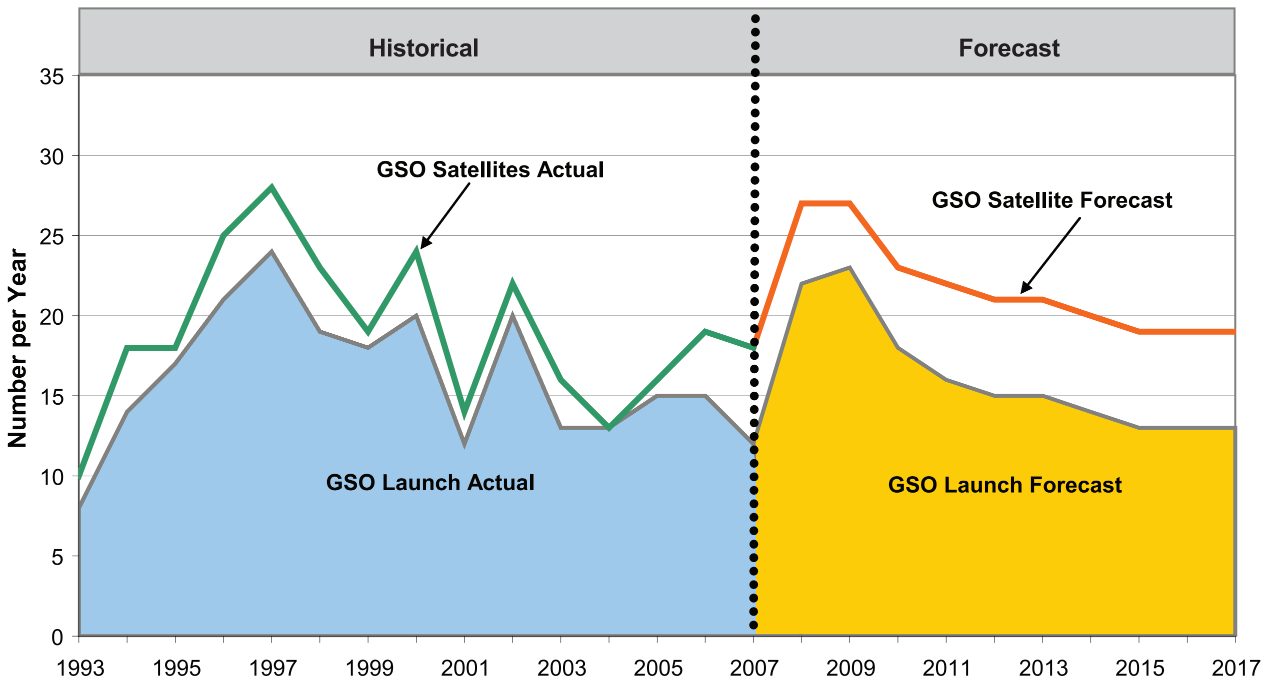


Figure 2. NGSO Satellite and Launch Demand

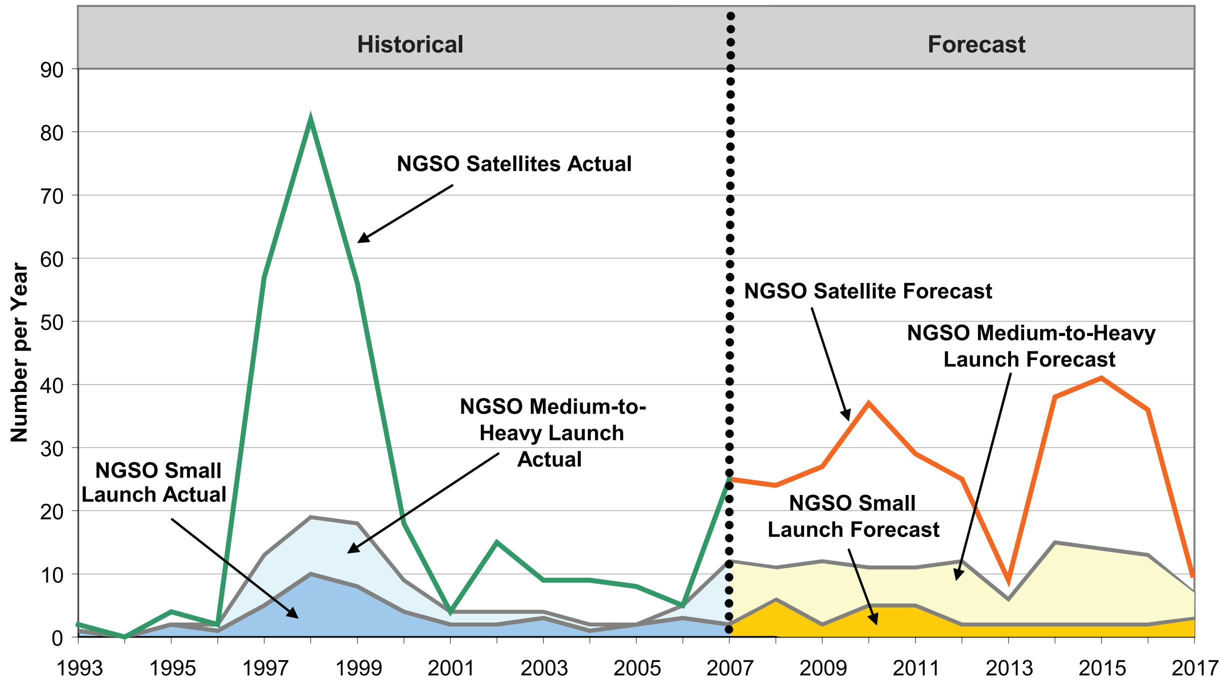
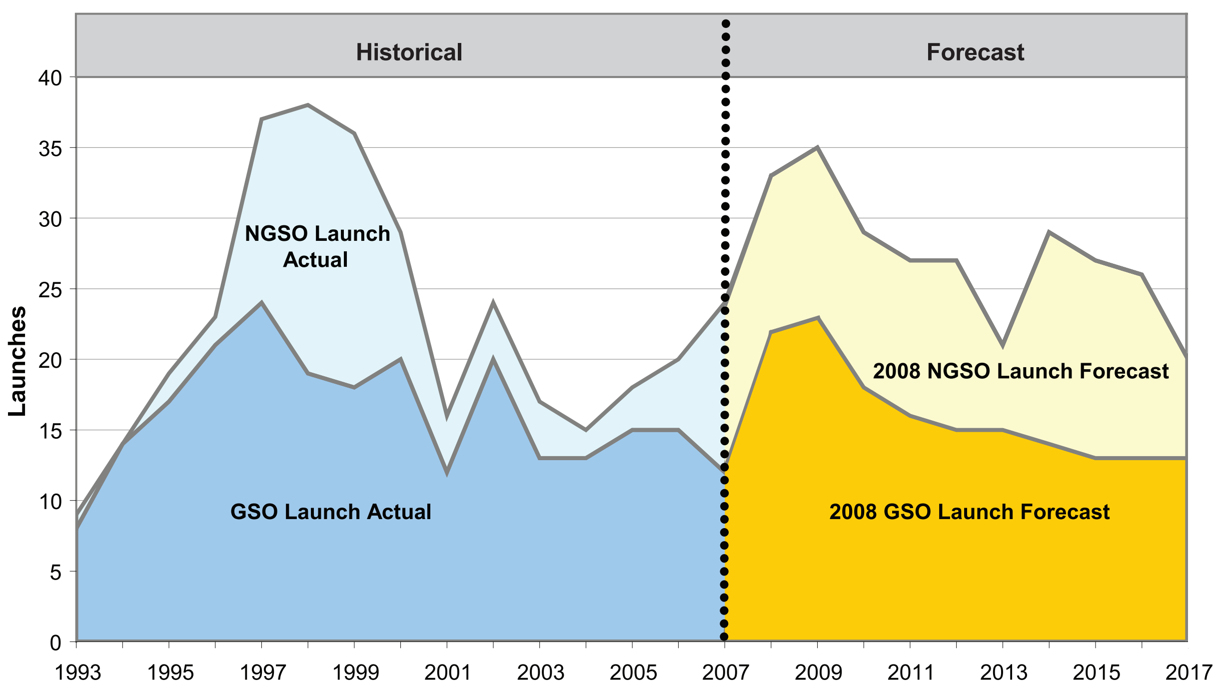


Figure 3. Combined GSO and NGSO Historical Launches and Launch Forecasts



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 global demand for commercial space launch services.

The jointly-published *2008 Commercial Space Transportation Forecasts* report covers the period from 2008 to 2017 and includes two separate forecasts: one for launches to geosynchronous orbit and one for launches to non-geosynchronous orbits.

About the COMSTAC GSO Forecast

COMSTAC is comprised of representatives from the U.S. satellite and launch industry. The *COMSTAC 2008 Commercial Geosynchronous Orbit Launch Demand Forecast* projects demand for commercial satellites that operate in geosynchronous orbit (GSO) and the resulting commercial launch demand to geosynchronous transfer orbit (GTO).

Established in 1993, the COMSTAC geosynchronous launch demand forecast is prepared using plans and projections supplied by global commercial satellite and launch companies. Projected payload and launch demand is limited to those spacecraft and launches that are open to internationally competed launch services 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.

About the FAA NGSO Forecast

The FAA's *2008 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits* projects commercial launch demand for all space systems to be deployed 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.

First compiled in 1994, the FAA NGSO forecast assesses global satellite and other payloads most likely to seek commercial launch services during the next 10 years. The forecast uses a model to estimate launch demand after a review of multiple-manifesting; i.e., how many satellites will ride per launch vehicle.

The majority of the satellites included in the forecast are open to international launch services procurement. The NGSO forecast also includes satellites or payloads that are sponsored by commercial entities for commercial launch or are commercially competed U.S. launches for orbital facility supply missions.

Characteristics of the Commercial Space Transportation Market

Demand for commercial launch services, a competitive global 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 is served by both medium and heavy lift launch vehicles and has a steady commercial customer demand for telecommunications satellites with a current average satellite mass of about 4,185 kilograms. The NGSO market has a wider variety of satellite and payload missions but with more demand fluctuation. This market is served by small, medium, and heavy lift launch vehicles and the average satellite mass of known satellites in the near-term NGSO forecast is around 540 kilograms.

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 the needs of both government and non-government payload owners. From 1997–2001, a peak era in commercial satellite telecommunications, commercial launches accounted for an average of about 42 percent of worldwide launches. During 2008, 24 out of 68 worldwide launches were commercial, representing 35 percent of global activity.

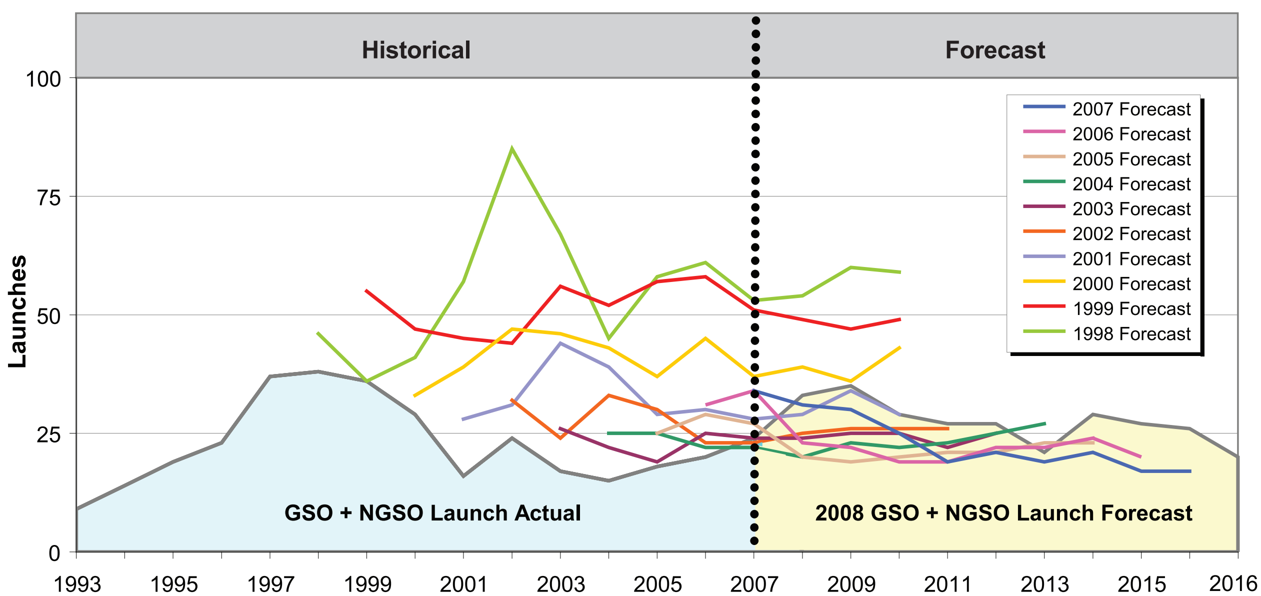
Demand Forecasts

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 12 worldwide commercial GSO launches actually launched compared to a demand of 17 in the 2007 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 12 actual commercial NGSO launches last year while the 2007 forecast projected a demand for 17 launches.

Figure 4 shows historical launch forecasts from 1998 to 2008 compared with actual launch activity.

Figure 4. Historical Commercial Space Transportation Forecasts



COMSTAC 2008 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 *2008 Commercial Geosynchronous Orbit (GSO) Launch Demand Forecast* is the sixteenth annual forecast of the global demand for commercial GSO satellites and launches addressable to the U.S. commercial space launch industry. The forecast extends 10 years and provides more specific detail for the near-term three years. It is intended to assist FAA/AST in its planning for licensing and 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 operator, 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 to the U.S. space launch industry. Addressable is defined as launch service procurements open to international competition.

The 2008 Commercial GSO Launch Demand Forecast for 2008 through 2017 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. This year's data shows increased demand from the two previous forecasts.

The 2008 forecast predicts an average demand for 21.8 satellites to be launched annually in the ten-year time frame from 2008 through 2017.

Figure 5. Commercial GSO Satellite and Launch Demand

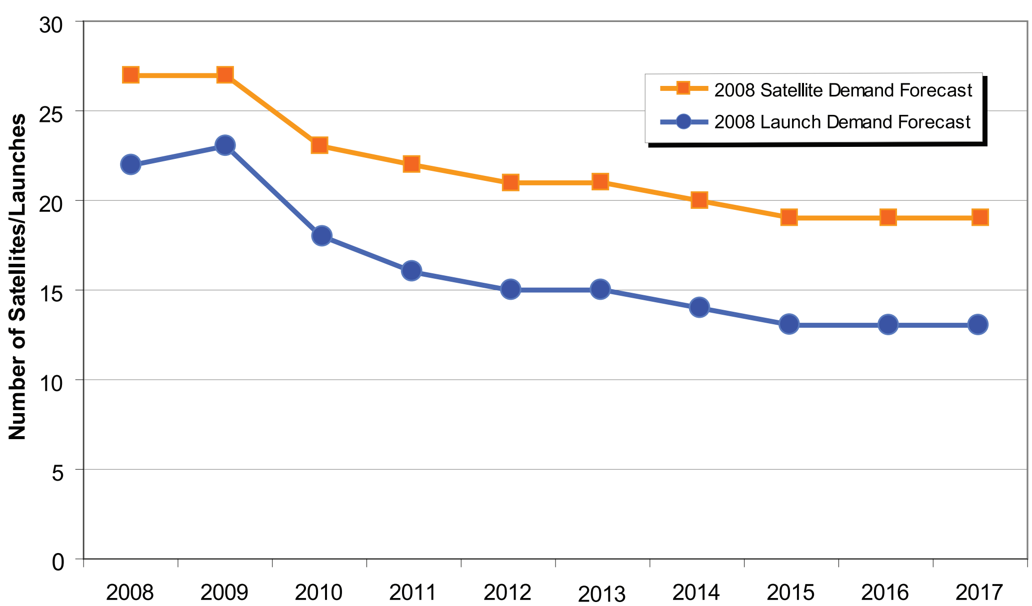


Table 2. Commercial GSO Satellite and Launch Demand Forecast Data

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total	Average 2008 to 2017
Satellite Demand	27	27	23	22	21	21	20	19	19	19	218	21.8
Dual Launch Forecast	5	4	5	6	6	6	6	6	6	6	56	5.6
Launch Demand	22	23	18	16	15	15	14	13	13	13	162	16.2

The associated launch demand for the same period is 16.2 launches per year. This year's average satellite demand represents an increase from the previous two COMSTAC GSO forecasts. An average of 21.0 satellites launched per year were forecast in 2007 and 20.8 satellites launched per year in 2006. The launch demand of 16.2 in 2008 is increased from 15.3 in 2007. The near-term forecast, which is based on specific existing and anticipated satellite programs for 2008 through 2010, shows demand for 22 launches in 2008, 23 in 2009, and 18 in 2010. Last year's forecast predicted 18 launches in 2008, 16 in 2009, and 17 in 2010.

It is important to distinguish between forecasted demand and the actual number of satellites that will be launched. Space related 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. To attempt to account for these differences, a "launch realization factor" has been devised. This factor is 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 2008 is 27, the realization factor discounts this to a range of between 18 and 22.

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

In 2007, 18 commercial GSO satellites were launched, a decrease by 1 from the 19 commercial satellites launched in 2006. The 2007 forecast had projected a demand of 23 satellites to be launched in 2007, with a launch realization range of 15 to 19.

Many factors impact the demand for commercial GSO satellites, including terrestrial infrastructure, global economic conditions, operator strategies, new market applications, and availability of financing for satellite projects. A more detailed description of these factors is discussed later in the report. The factors were generated by the Forecast team's industry experience as well as derived from inputs from the survey respondents.

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. The expectation is that the average mass per satellite will trend towards constancy. The last four years have averaged a little over 4,000 kilograms and the expectation is that the next several years will be similar. The projected total mass to be launched in 2008 will be an all-time high, nearly 100,000 kilograms.

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 period, with this year's report covering 2008 through 2017. This year the committee received 29 inputs from satellite service providers, satellite manufacturers, and launch service providers. COMSTAC would like to thank all of the participants in the 2008 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. 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. Two types of requests are made: Individual input is requested from satellite operators for a projection of their individual company requirements for the period 2008–2017; and comprehensive input is requested for the same period from satellite manufacturers and launch service providers for a broad perspective.

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 2007, two commercial satellite launches (Chinasat 6B (China) and Sinosat 3 (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 continues to lead 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 with Nigcomsat. In others, they have preempted 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 2,500 kilograms (<5,510 pounds); 2,500 to 4,200 kilograms (5,510 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 satellite models associated with each mass category is shown in Table 3. This year, the Working Group modified the definition of the mass classes. The smallest mass class group is now defined as satellites up

Table 3. Satellite Mass Class Categorization

GTO Launch Mass Requirement	Satellite Bus Models
Below 2,500 kg (<5,510 lbm)	LM A2100A, Orbital Star 2
2,500 - 4,200 kg (5,510 - 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 (9,260 - 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

to 2,500 kilograms from a maximum of up to 2,200 kilograms analyzed in prior years. This adjustment was made to capture the recent growth in the mass of the smallest satellites being manufactured.

This year, the following 29 organizations (noted with the country in which their headquarters are located) responded with data used in the development of the 2008 report:

- Arianespace (France)
- AR-SAT S.A. (Argentina)
- Asia Satellite Telecommunications, Ltd. (China-Hong Kong)
- Astrium satellites (France)
- The Boeing Company* (U.S.)
- Eutelsat (France)
- Hisdesat (Spain)
- Hispasat (Spain)
- Hughes Network Systems (U.S.)
- Intelsat (U.S.)
- JSAT Corporation (Japan)
- Lockheed Martin Space Systems Co.* (U.S.)
- Lockheed Martin Commercial Launch Services * (U.S)
- MEASAT ITU Coordination (Malaysia)
- Mobile Broadcasting Corporation (Japan)
- Mobile Satellite Ventures (U.S.)
- Ondas (Spain)
- Orbital Sciences Corp.* (U.S.)
- Protostar (U.S.)
- Sea Launch* (U.S.)
- Sirius Satellite Radio (U.S.)
- Space Communications Corporation (Japan)
- Space Systems/Loral* (U.S.)
- Telenor Satellite Broadcasting AS (Norway)
- Telesat (Canada/U.S.)
- Thales Alenia (Europe)
- Thuraya (United Arab Emirates)
- Wild Blue (U.S)
- XM Radio (U.S.)

Forecasting commercial satellite launch demand presents significant difficulty and thus there is uncertainty in the predictions. 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 thus generally more 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 and applications
- Availability of financing for commercial space projects
- Industry health and consolidation

* The Working Group uses the comprehensive inputs from the U.S. respondents to derive the average satellite demand expected per year by mass class. The sum of the demand in the four mass categories then provides total demand per year.

The combined comprehensive input from U.S. respondents was used to generate the long-term demand forecast 2011–2017. The remaining inputs were used for a cross check. The Working Group, using individual satellite operators' inputs, developed the near-term forecast, covering the first three years (2008–2010) of the ten-year forecast. 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.

2008 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 services provider, along with the inputs received from individual satellite operators. Developing the near-term forecast

Table 4. Commercial GSO Near-Term Manifest

	2008		2009		2010	
Total	**27**		**27**		**23**	
Below 2,500kg (<5,510 lbm)	**3**		**5**		**3**	
	Amos 3	Land Launch	Hylas	Falcon 9	ABS 2	TBD
	Measat 3a	Land Launch	Intelsat 15	Land Launch	AMC 5R	TBD
	*Thor 5	Proton	Intelsat 16	Land Launch	Telkom 3	TBD
			AMC 1R	Land Launch		
			Optus D3	Soyuz		
2,500 - 4,200 kg (5,510 - 9,260 lbm)	**7**		**8**		**7**	
	AMC 21	Ariane	COMS 1	Ariane	RASCOM 1R	Ariane
	BADR-6	Ariane	JCSat 12	Ariane	Nilesat 201	TBD
	Eutelsat W2M	Ariane	Thor 6	Ariane	Arabsat 5C	TBD
	Hot Bird 9	Ariane	NSS-9	Ariane	Hispasat 1E	TBD
	*Star One C2	Ariane	Insat 4G	Ariane	Intelsat 17	TBD
	Vinasat	Ariane	Asiasat 5	Land Launch	Koreasat 6	TBD
	Telstar 11N	Land Launch	Palapa D	Long March	Paksat 1R	TBD
			Protostar II	Proton		
4,200 - 5,400 kg (9,260 - 11,905 lbm)	**11**		**5**		**7**	
	Protostar 1	Ariane	Amazonas 2	Ariane	Yahsat 1A	Ariane
	Superbird 7	Ariane	Arabsat 5A	Ariane	BADR 5	Proton
	Turksat 3A	Ariane	Nimiq 5	Proton	Eutelsat W3B	Proton
	Skynet 5C	Ariane	Eutelsat W7	Sea Launch	Yahsat 1B	Proton
	*AMC 14	Proton	Astra 3B	TBD	Intelsat	TBD
	Astra 1M	Proton			KA-Sat	TBD
	Nimiq 4	Proton			Quetzsat	TBD
	Galaxy 18	Sea Launch				
	Galaxy 19	Sea Launch				
	*Thuraya 3	Sea Launch				
	Sicral 1B	Sea Launch				
Over 5,400kg (>11,905 lbm)	**6**		**9**		**6**	
	*ICO-GEO 1	Atlas V	Terrestar 1	Ariane	MSV 2	Sea Launch
	Ciel 2	Proton	NSS-12	Ariane	DirecTV 12	TBD
	Echostar (CMBStar)	Proton	Sirius FM 5	Proton	ICO G2	TBD
	Inmarsat 4F3	Proton	MSV 1	Proton	NSS-14	TBD
	DirecTV 11	Sea Launch	Eutelsat W2A	Sea Launch	Protostar III	TBD
	Echostar 11	Sea Launch	XM 5	Sea Launch	Echostar 14	TBD
			Hot Bird 10	TBD		
			Intelsat 14	TBD		
			Terrestar 2	TBD		

* Indicates slip from COMSTAC 2007 GSO Forecast

in this way results in 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 to have launched, with no adjustment for potential launch schedule delays. Table 4 shows the near-term mission model for 2008 through 2010.

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 2007, followed by the distribution projected in this year's demand forecast.

The distribution of forecasted satellites to be launched for the two smallest mass classes has changed since last year's forecast. The change follows an update to the satellite mass class category definitions in the forecast survey sent out for this year's forecast, as seen in Table 3 and discussed in the Forecast Methodology section. The smallest mass class group has been changed to include satellites up to 2,500 kilograms from a

Figure 6. Trends in GSO Satellite Mass Distribution

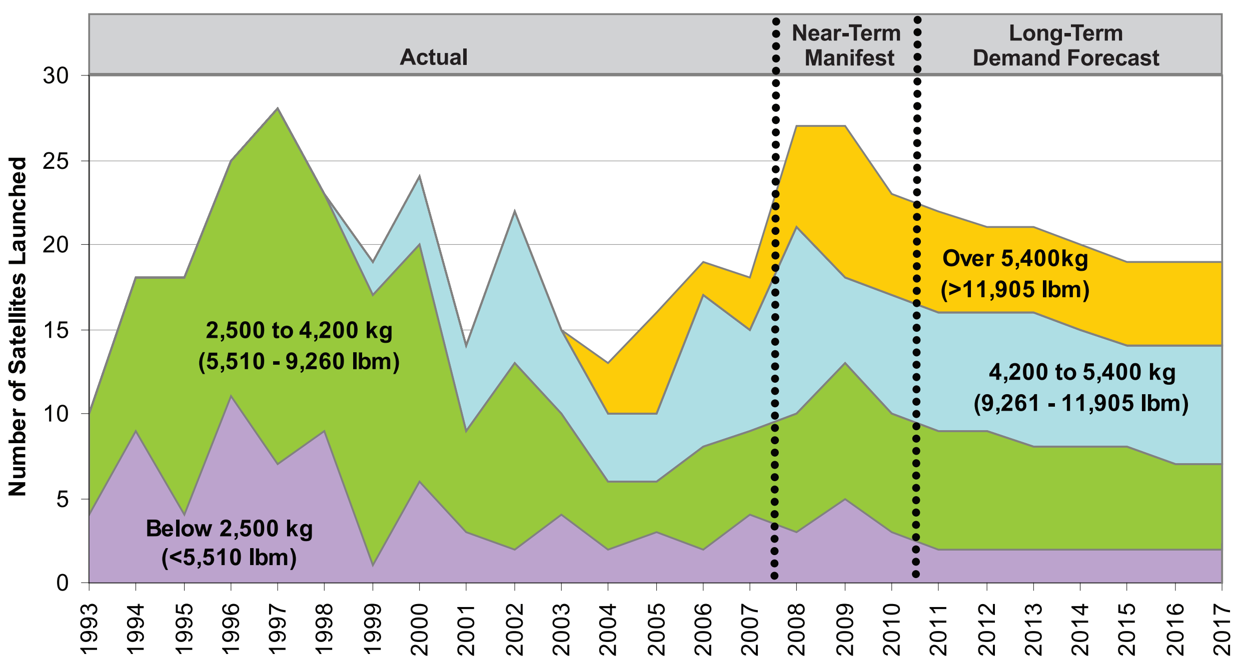
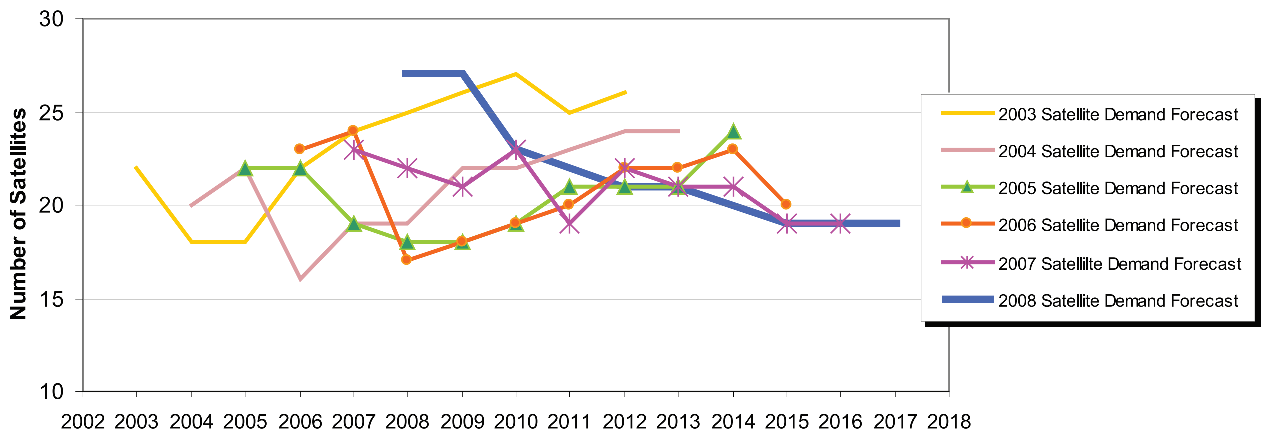


Table 5. Trends in GSO Satellite Mass Distribution

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total 2008 to 2017	Avg 2008 to 2017	% of Total
Below 2,500 kg (<5,510 lbm)	4	9	4	11	7	9	1	6	3	2	4	2	3	2	4	3	5	3	2	2	2	2	2	2	2	25	2.5	11%
2,500 to 4,200 kg (5,510 - 9,260 lbm)	6	9	14	14	21	14	16	14	6	11	6	4	3	6	5	7	8	7	7	7	6	6	6	5	5	64	6.4	29%
4,200 to 5,400 kg (9,260 - 11,905 lbm)	0	0	0	0	0	0	2	4	5	9	5	4	4	9	6	11	5	7	7	7	8	7	6	7	7	72	7.2	33%
Over 5,400 kg (>11,905 lbm)	0	0	0	0	0	0	0	0	0	0	0	3	6	2	3	6	9	6	6	5	5	5	5	5	5	57	5.7	26%
Total	**10**	**18**	**18**	**25**	**28**	**23**	**19**	**24**	**14**	**22**	**15**	**13**	**16**	**19**	**18**	**27**	**27**	**23**	**22**	**21**	**21**	**20**	**19**	**19**	**19**	**218**	**21.8**	**100%**

Figure 7. 2003 Through 2007 vs 2008 Commercial GSO Satellite Demand Forecast



maximum of up to 2,200 kilograms analyzed in prior years. This adjustment was made to capture the recent growth in the mass of the smallest satellites being manufactured. Orbital's Star bus has incorporated design changes that bring its mass close to the 2,500-kilogram range, now within the small mass class category. Astrium and ISRO are jointly marketing the INSAT bus which can weigh as much as 3,000 kilograms; this bus is categorized in the next largest mass class. The ability to grow these small satellites to the 2,500 and 3,000 kilogram mass class has been assisted by the introduction of two new launchers with capability between 3,000 and 3,500 kilograms: Soyuz (from Kourou) and Land Launch (from Baikonur). The increase in the forecast of satellites to be launched in the smallest mass class was offset exactly by the decrease in the forecast for the second mass category.

There is no change in the percentage of satellites to be built in the two largest mass class categories (satellites with mass greater than 4,200 kilograms) between this year's forecast and last year's forecast. This indicates that the forecasted growth in large satellites has stabilized at an average of 5.6 satellites per year for satellites over 5,400 kilograms and an average of 7.3 satellites per year for those with mass 4,200 to 5,400 kilograms.

COMPARISON WITH PREVIOUS COMSTAC DEMAND FORECASTS

The 2008 forecast for commercial GSO satellites launched is compared to the 2003 through 2007 forecasts in Figure 7. The ten-year demand forecast dropped 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. Based upon this year's input, there has been a marked increase in the 2008 and 2009 launch forecast, with a leveling in the later years. A portion of the increase can be accounted for in the five launches that moved from 2007 to 2008 due to return-to-flight delays and Land Launch production delays. Additionally, many of the satellites that were launched in 1995–1997 are nearing the end of mission life and replacements will have to be launched. 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, and is comparable to the 2007 forecasts. The Proton failure in March 2008 will have an effect on the 2008 forecast as written in this report, but the impact will depend on the timing of return-to-flight and satellite operators choosing to use other launch options.

COMPARISON TO INTERNATIONAL COMPREHENSIVE INPUTS

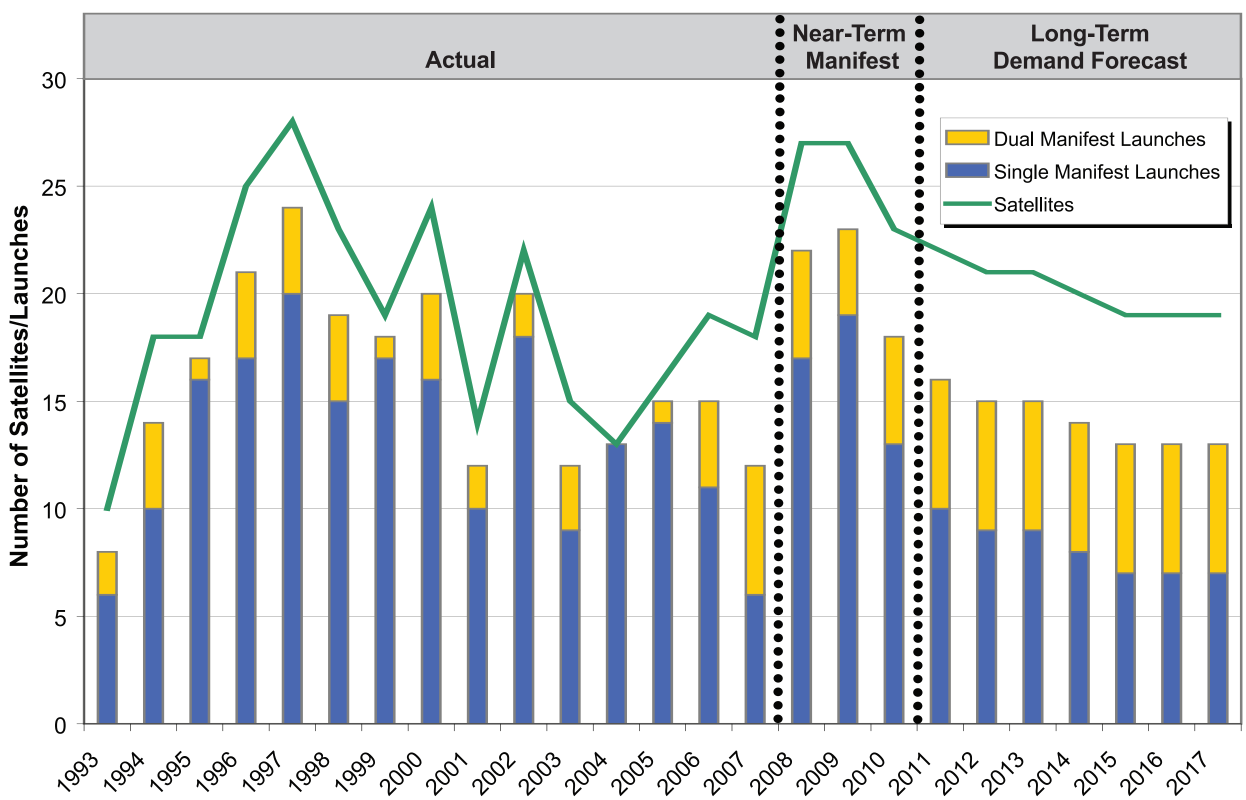
This year, the Working Group received comprehensive inputs from one major international launch service provider (Arianespace) and two major international satellite manufacturers (EADS Astrium and Thales Alenia). The combined average of these international inputs is higher than the combined 2008 demand forecast based on U.S. satellite and launch vehicle manufacturer inputs. The international input average annual demand for 2008 through 2017 is 26.1 satellites per year; the U.S.-based average annual demand forecast is 21.8 satellites per year. The distribution between mass classes is higher for the large mass class versus the intermediate mass class for international respondents, and effectively the same for the lower mass classes.

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 seven Ariane 5 launches 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 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

Figure 8. 2008 COMSTAC GSO Satellite and Launch Demand Forecast



for the 2011–2017 forecast period. The 2008–2010 near-term forecast includes dual-manifest launches consistent with the best current understanding of the mission set.

Figure 8 presents the 2008 satellite and launch demand forecast as well as actual values for 1993 through 2007.

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 hope to launch in a given year. This demand is typically larger than the number of satellites actually launched.

Some of the factors that 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. Increased satellite complexity has increased the likelihood of a delay due to technical challenges or immature planning. Delays in delivery of spacecraft to the launch site in turn impacts the planning and order of launches.

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 to all subsequent launches until the anomaly is identified to determine if there are fleet issues that need to be resolved.

Scheduling issues. Both satellite and launch issues lead to scheduling issues. One individual launch delay has a cascading impact on 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 is dependent on two satellites being delivered on time. Payload compatibility issues may also cause manifesting challenges.

Weather. Weather, including ground winds, flight winds, cloud cover, and currents, can cause multiple launch delays, though these typically are short-term (i.e. on the order of days) delays.

Planning. Failure to perform to plan will result in delays. Corporate reprioritization or changing strategies may delay or even cancel currently planned launches.

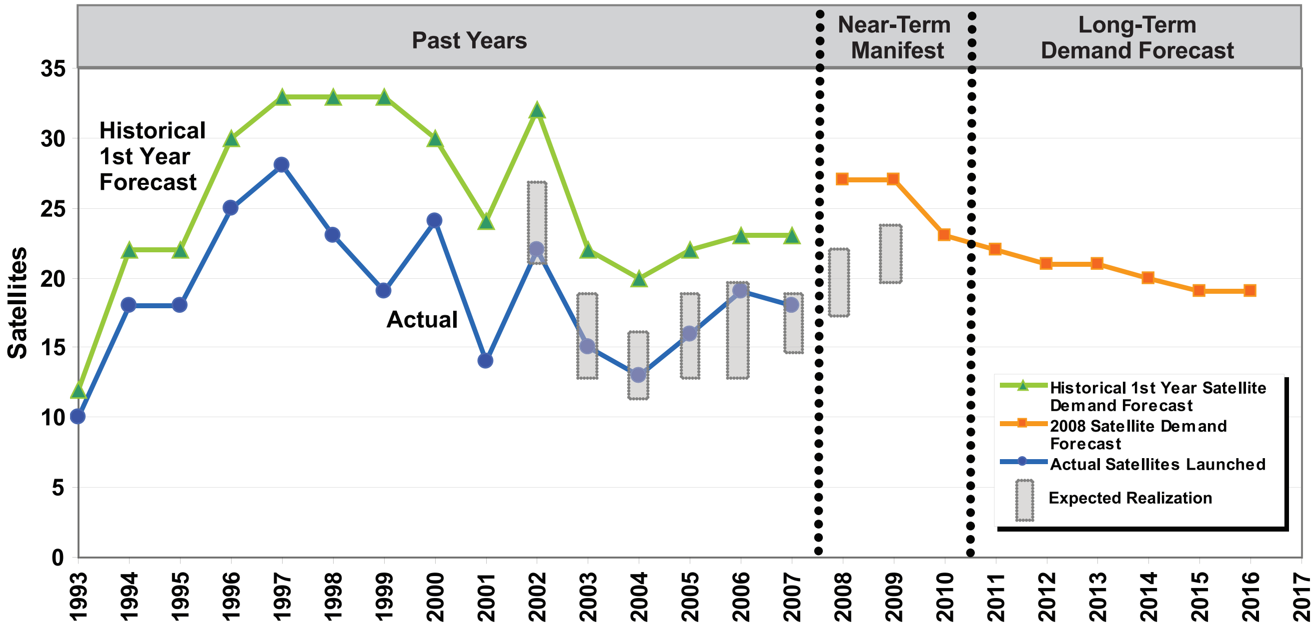
Funding. Satellite service providers may be unable to obtain the funding needed to carry out their planned satellite launch, or it may be delayed until alternate funding is found.

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. This has caused both delays and program cancellations.

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

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



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 27 percent while the average variance for the second year is 23 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 2008 forecast demand of 27 satellites yields a probable range of satellites that will actually be launched of 18 to 22. For the 2009 demand forecast of 27 satellites, a realized number of launches of between 20 and 23 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 the launch realization factor was added to the COMSTAC GSO Launch Demand Forecast in 2002, the actual number of satellites launched has indeed fallen within the discounted launch realization range.

FORECASTED SATELLITE DEMAND VERSUS ACTUAL SATELLITE LAUNCHES IN 2007

The 2007 COMSTAC Commercial GSO Demand Forecast listed 23 satellites for the 2007 near-term manifest. Eighteen satellites were actually launched in 2007. The difference between actual and manifested satellite launches were due to two reasons:

- Three satellites were delayed due to launch vehicle scheduling issues caused by the Sea Launch failure and recovery operations and Proton return-to-flight delays following launch failures

- Two satellites were delayed due to satellite issues

All five of the delayed satellites have subsequently been launched as of publication of this report (one of these launches, the Proton carrying AMC 14, 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 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.

Global economic conditions have changed dramatically in the past twelve months. In the U.S., economic conditions have deteriorated leading to a "credit crunch" and the "subprime crisis." This has affected the supply of capital for satellite programs as well as consumer demand for communications services. Financial institutions have suffered dramatic losses due to excess liquidity, low interest rates, high level of securitization, and leverage. These conditions have led to the tightening of the availability of capital and the willingness to invest in speculative projects. Globally, weakness in the U.S. dollar, while appearing to help U.S. exports, has devalued the buying power of those foreign entities holding large U.S. dollar reserves. The rising price of oil has affected both consumer spending and industrial production. In sum, the uncertainty and volatility has dampened enthusiasm on both the supply and demand sides of the market for telecommunications services. Nonetheless, given the long lead-time and lifecycle of commercial satellite assets, the fall-out on specific satellite programs has not been dramatic. The effect on new satellite orders (particularly for the established players) should be minimal barring additional significant declines. Pure consumer-oriented operators, like digital audio radio service (DARS) and mobile satellite services (MSS) operators, are at greatest risk of impact as their revenue generation is dependent on short-term rather than long-term consumer spending.

New commercial launch competitors will impact the launch market over the next few years with increased competition. Sea Launch is now marketing Land Launch vehicles to be launched from the Baikonur Cosmodrome and has recently successfully completed its maiden flight (after a year's delay). Land Launch uses a Zenit-3SLB vehicle, modified slightly from the Sea Launch Zenit-3SL. Its lift capability of 3,600 kilograms moves Sea Launch Company, L.L.C. into the medium launch market segment (2,500–4,000 kilograms), complementing the Sea Launch heavy-lift capability. Launch rate capacity is planned to be four launches per year. The debut of Arianespace's Soyuz launch from French Guiana (Kourou) has been delayed until 2009, with launch site construction starting in late March of this year. This modified Soyuz will provide medium-lift capability: the Soyuz 2-1-a can lift 2,700 kilograms to GTO, and the Soyuz 2-1-b will be capable of lifting 3,000 kilograms 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 just under 5,000 kilograms to GTO in the single core version and over 12,000 kilograms to GTO in the common booster core configuration. Its first launch is scheduled for late this year or early next year.

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 kilograms to GTO. However, it is still in the development phase, with two out of five of the GSLV launches having 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 kilograms to GTO. As China expands its satellite offerings, Long March will continue to be packaged in bids intended to preempt full international competition as with Venesat scheduled for launch in 2008. It is currently scheduled to launch one commercial GEO satellite in 2009, Palapa D. The H-IIA has a lift capacity of 4,100–5,000 kilograms to GTO. Japan has successfully performed 13 out of 14 launches of the H-IIA. The Japanese space agency, JAXA, plans to build an H-IIB vehicle with greater lift capability. Like China, the introduction of domestic satellites to the marketplace may result in higher usage of the H-IIA. As more countries grow their internal launch capability, the degree of open (commercial) competition for launches will decrease.

New market applications continue to drive demand for satellite services and new satellite systems. High-definition television (HDTV) and satellite broadband access services have firmly established commercial applications for Ka-band satellites. Continued growth of video services and HDTV is expected to underpin future satellite demand in general. Satellite broadband systems have demonstrated significant consumer demand in North America and new systems are in development for other regions. In the MSS segment, new systems from ICO, TerreStar, and MSV will be launched over the next two years using the Ancillary Terrestrial Component authorized by the FCC. ATC enables an integrated terrestrial/satellite network solution for MSS providers. If these systems are successful, similar systems could be developed worldwide. The U.S. market success of XM and Sirius Satellite Radio is also sparking interest in DARS and mobile video broadcast services in other regions.

U.S. Government regulatory environment continues to be an issue for domestic manufacturers as international competitors develop satellite and launch offerings that are not subject to U.S. export regulations for the commercial market.

Consolidation in recent years has reconfigured the satellite operator landscape, yielding global fleet operators SES and Intelsat and large regional and multi-regional operators such as Eutelsat, Telesat, and JSAT. While consolidation has not slowed new satellite orders to date and market growth has helped improve operator capacity utilization rates, some operators have said they plan to reduce their future replacement satellite requirements by reducing overall fleet size.

Hosted payloads are payloads who cannot afford the cost of a dedicated spacecraft, paired with a satellite service operator who wants to offset their commercial launch costs. There are a variety of potential hosted payloads including: experimental, scientific, weather, FAA, and military communications missions. Payload hosting offers many benefits to both parties. The cost of launch is shared, thereby reducing the primary payload's launch costs while providing affordable space access for the hosted payload. In addition, the hosted payload gains the efficiency of utilizing a commercial launch system that provides access to more orbital locations.

There are limitations to widespread acceptance and utilization of hosted payloads. The contractual relationships are more complex because there are three (or more) parties, rather than two, involved in the spacecraft purchase. In some cases, the commercial satellite service provider does not want to impact its program and requires firm deadlines for delivery of the hosted payload as well as clearly defined interfaces at the start of satellite construction. If the hosted payload fails to arrive on time, the client could be liable for covering any residual impacts to the satellite cost and schedule.

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 focus on factors that impact service providers' plans to purchase and launch satellites. A summary of the responses to this questionnaire is provided in Table 6. The last column is a comparison to the survey responses received for the 2007 COMSTAC report.

The following 18 satellite service providers responded to the supplementary questionnaires. The Working Group would like to offer special thanks for providing this additional input:

ARsat
Asia Satellite Telecommunications, Ltd. *
Hisdesat
Hispasat
Hughes Network Systems, LLC.
Intelsat, Ltd. *

Table 6. 2008 COMSTAC Survey Questionnaire Summary

	Significant Negative Impact	Some Negative Impact	No Effect	Some Positive Impact	Significant Positive Impact	Compared to 2007
Regional or global economic conditions	0%	33%	39%	28%	0%	↑
Demand for satellite services	6%	11%	28%	33%	22%	↑
Ability to compete with terrestrial services	6%	22%	61%	11%	0%	↓
Availability of financing	11%	17%	44%	22%	6%	↑
Availability of affordable insurance	0%	17%	56%	28%	0%	↑
Consolidation of service providers	0%	6%	94%	0%	0%	↑
Increasing satellite life times	0%	17%	72%	11%	0%	↑
Availability of satellite systems that meet your requirements	0%	6%	44%	39%	11%	↑
Reliability of satellite systems	0%	17%	44%	39%	0%	↑
Availability of launch vehicles that meet your requirements	0%	11%	50%	33%	6%	↑
Reliability of launch systems	0%	22%	39%	39%	0%	↑
Ability to obtain required export licenses	6%	17%	56%	22%	0%	↑
Ability to obtain required operating licenses	6%	22%	61%	11%	0%	↓

↑ More positive compared to 2007
↓ More negative compared to 2007

JSAT Corporation
Mobile Broadcasting Corporation (MBCO)
Measat Satellite Systems Sdn. Bhd.
Mobile Satellite Ventures (MSV)
ONDAS Media S. A.
Sirius Satellite Radio
Space Communications Corporation (SCC) *
Telenor ASA
Telesat *
Thuraya Satellite Telecommunications Company
Wildblue Communications, Inc.
XM Satellite Radio

* Indicates 2007 survey respondents

The 2008 survey reflects a generally positive perception of the industry and satellite market demand drivers, along with positive improvements in industry's ability to meet the needs of satellite service providers. The global economic conditions, ability to compete with terrestrial providers, and ability to acquire licensing, however, were cited as neutral to slightly negative. It should be noted that only four of the 18 respondents to the 2008 questionnaire submitted responses to the 2007 questionnaire, which could have some influence on the comparison of results.

The industry appears to have adjusted to the recent wave of satellite service provider consolidation, with 94 percent of the respondents seeing "no effect" this year compared with 36 percent of respondents indicating significant or some negative impact in 2007. Additionally, the reliability and availability of the satellite systems are identified as having a more positive impact according to the survey.

Launch vehicle reliability was cited as a negative factor by 22 percent of the respondents versus 50 percent of the respondents in 2007, despite the fact that there were two launch failures of commercial vehicles in 2007 (Sea Launch/NSS-8 and Proton M/JCSAT-11) compared to one launch failure (Proton M/Arabsat 4) in 2006. Seventy-six percent of the 2008 respondents indicated that launch vehicle reliability had either no effect or a positive effect on their plans. Launch vehicle availability was cited as a negative factor by 11 percent of the 2008 respondents compared to 59 percent of the 2007 respondents, which is a significant swing to the positive, considering the launch failures and the full near-term manifests of other commercial launch providers.

There were only two survey areas that experienced a downward trend from 2007 to 2008. Twenty-two percent of the 2008 respondents cited the perceived ability to compete with terrestrial services as a negative influence compared with only 17 percent of the 2007 respondents, and 22 percent of the 2008 respondents stated that they were negatively impacted by the ability to obtain the required operating licenses versus 8 percent of the respondents in 2007.

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 2007, with a projection for 2008 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 average number of transponders launched in recent years tends to trend up and down with respect to the numbers of each class of satellite launched with variances year over year. A five-year moving average reveals that despite the growth period in the number of transponders per satellite seen in the early part of this decade, the past several years have remained very stable. This corresponds with the stabilization of the move to heavier, higher-powered satellites. The average in 2008 is expected to drop slightly, but it will come back up in 2009. The average will continue

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

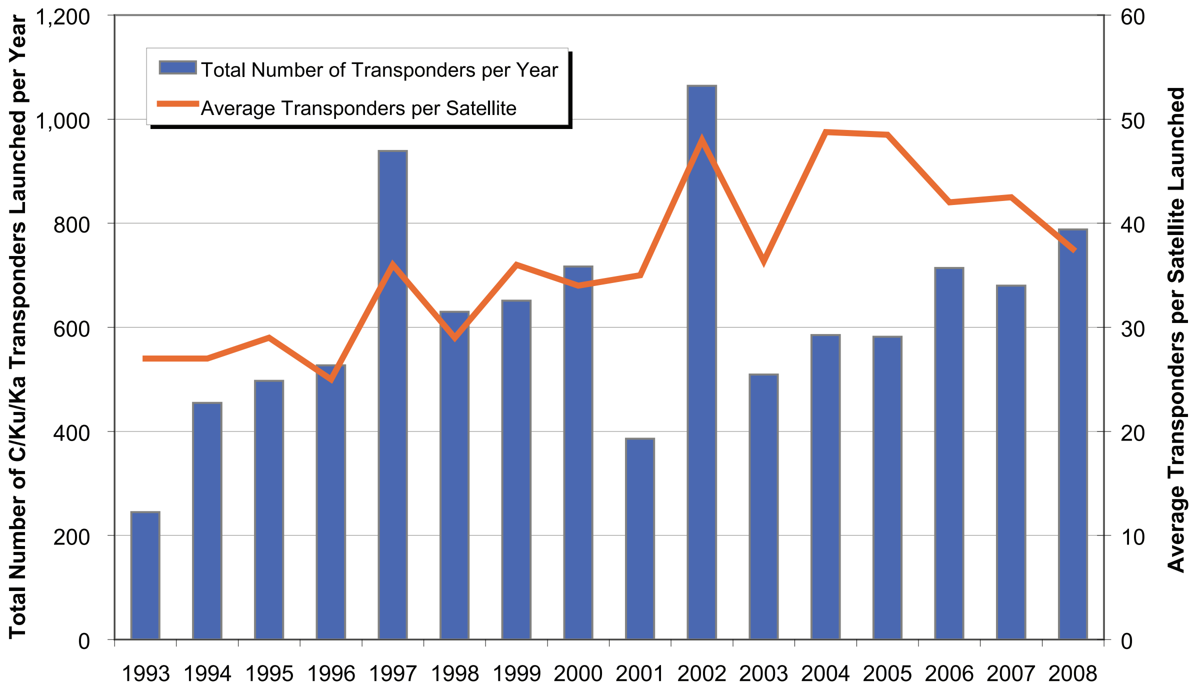


Table 7. Total C/Ku/Ka Transponders Launched per Year and Average Transponders per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total Number of Transponders per Year	245	455	497	527	939	630	651	717	386	1,064	509	585	582	714	680	788
Average Transponders per Satellite	27	27	29	25	36	29	36	34	35	48	36	49	49	42	43	38

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, and Ka-band transponders. Examples include the Inmarsat, Paradigm (Skynet 5), Thuraya, XTAR/Spainsat, ICO, XM and Sirius 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 four years have averaged a little over 4,000 kilograms and the expectation is that the next several years will be similar. This again correlates to the stabilization of the shift to heavier, higher-power satellites. The projected total mass to be launched in 2008 will be an all-time high, nearly 100,000 kilograms.

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

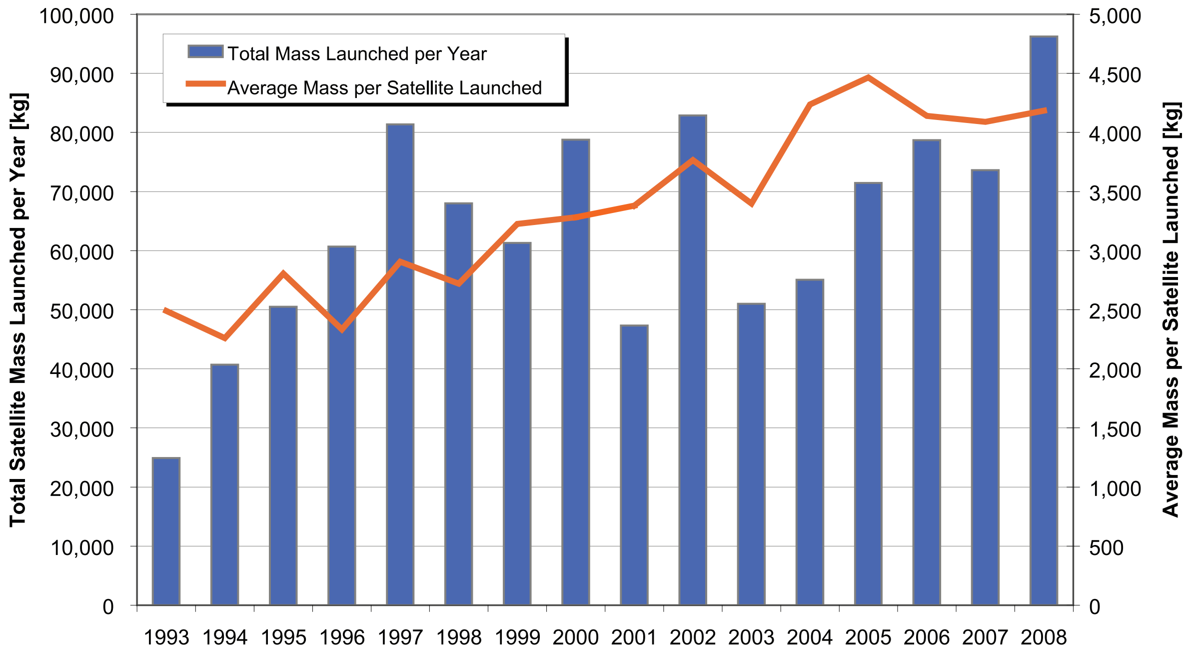


Table 8. Total Satellite Mass Launched per Year and Average Mass per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total Mass Launched per Year [in 1,000 kg]	24.9	40.7	50.5	60.7	81.4	68.0	61.3	78.8	47.3	82.9	51.0	55.1	71.5	78.7	73.6	96.3
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	4,090	4,185

Summary

The 2008 COMSTAC Commercial GSO Launch Demand Forecast projects an average annual demand of 21.8 satellites to be launched from 2008 through 2017, an increase of approximately one satellite when compared to the 2007 forecast of 21.0 and the 2006 forecast of 20.8 satellites per year. For the fifth year in a row however, the actual number of satellites launched has remained less than 20, with 18 launched in 2007.

The Working Group is forecasting 22 total launches (including 5 dual-manifest) in 2008, increasing to 23 total (including 4 dual-manifest) launches in 2009, with 18 (including 5 dual-manifest) launches expected in 2010. The long term forecast of average annual single-manifest launches over the ten-year period spanning 2008 through 2017 is 10.6 launches per year. The average annual dual-manifest launches during 2008 through 2017 are forecasted to be 5.6. Based upon these data and the satellite demand projection, the 2008 Commercial GSO Launch Demand Forecast averages 16.2 launches per year from 2008 through 2017—an increase of one launch from last year's forecast.

Though there has been steady growth in satellite mass since 1993, the trend looks to be stabilizing, after peaking in 2005 at 4,500 kilograms. The total mass launched will continue to hit highs with almost 100,000 kilograms forecast for 2008. 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 overall GSO spacecraft and launch demand within the space launch industry. Continued consumer acceptance of HDTV and growth in leased capacity is driving strength in the FSS and DTH markets. This is being supplemented by growth in segments such as MSS and regional operators, as well as the emergence of new entrants. Key factors affecting global satellite market demand at this time include the ability to economically secure financing for new satellite projects and operators, the overall affordability of the space segment, and timely and reliable access to space.

The launch vehicle industry is adding capacity with three new launch vehicle entrants capable of launching medium-class payloads in the immediate and mid-term periods: Land Launch, successfully launching its initial commercial satellite in April 2008; Falcon 9, planning to launch in late 2008 or early 2009; and Soyuz from Kourou, planning to conduct its initial launch sometime in 2009. Other U.S. launch vehicles in development, or those in existence from other emerging space nations, may provide additional capacity in the future.

Table 9. Historical Addressable Commercial GSO Satellites Launched (1993–2007)

		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	
2,500 - 4,200 kg (5,510 - 9,260 lbm)		6			9			14			14			21	
		Astra 1C	Ariane 42L		Astra 1D	Ariane 42P		Astra 1E	Ariane 42L	DM3	Arabsat 2A	Ariane 44L	DMN	Hot Bird 3	Ariane 44LP
	DM2	DBS 1	Ariane 44L		Intelsat 702	Ariane 44LP		DBS 3	Ariane 42P	DM4	Arabsat 2B	Ariane 44L		Intelsat 801	Ariane 44P
		Galaxy 4	Ariane 42P	DM2	PAS 2	Ariane 44L		Intelsat 706A	Ariane 44LP		EchoStar 2	Ariane 42P		Intelsat 802	Ariane 44P
		Intelsat 701	Ariane 44LP		$\boxed{\text{PAS 3}}$	Ariane 42P		N-Star a	Ariane 44P		Intelsat 707A	Ariane 44LP		Intelsat 803	Ariane 42L
	DMN	Solidaridad 1	Ariane 44LP	DM4	Solidaridad 2	Ariane 44L		PAS 4	Ariane 42L		Intelsat 709	Ariane 44P		Intelsat 804	Ariane 42L
		Telstar 401	Atlas IIAS		Telstar 402	Ariane 42L		Telstar 402R	Ariane 42L		MSAT 1	Ariane 42P		JCSat 5	Ariane 44P
					DBS 2	Atlas IIA		AMSC 1	Atlas IIA		N-Star b	Ariane 44P		PAS 6	Ariane 44P
					Intelsat 703	Atlas IIAS		Galaxy 3R	Atlas IIA	DM2	Palapa C2	Ariane 44L	DM4	Sirius 2	Ariane 44L
					Optus B3	Long March 2E		Intelsat 704	Atlas IIAS	DM1	PAS 3R	Ariane 44L	DM2	Thaicom 3	Ariane 44LP
								Intelsat 705	Atlas IIAS		AMC 1	Atlas IIA		AMC 3	Atlas IIAS
								JCSat 3	Atlas IIAS		Hot Bird 2	Atlas IIA		DirecTV 6	Atlas IIA
								$\boxed{\text{APStar 2}}$	Long March 2E		Palapa C1	Atlas IIAS		EchoStar 3	Atlas IIAS
								ASIASAT 2	Long March 2E		$\boxed{\text{Intelsat 708A}}$	Long March 3B		Galaxy 8i	Atlas IIAS
								EchoStar 1	Long March 2E		Astra 1F	Proton K/DM		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 2,500 kg (<5,510 lbm)		4			9			4			11			7	
	DM1	Insat 2B	Ariane 44L	DM3	Brazilsat B1	Ariane 44LP	DM1	Brazilsat B2	Ariane 44LP	DM2	Amos 1	Ariane 44L	DM1	AMC 2	Ariane 44L
	DM1	Hispasat 1B	Ariane 44L	DM2	BS-3N	Ariane 44L	DM1	Hot Bird 1	Ariane 44LP	DMN	Italsat 2	Ariane 44L	DM2	BSat 1A	Ariane 44LP
	DM2	Thaicom 1	Ariane 44L	DM1	$\boxed{\text{Eutelsat II F5}}$	Ariane 44LP	DMN	Insat 2C	Ariane 44L	DM1	Measat 1	Ariane 44L	DM4	Cakrawarta 1	Ariane 44L
		NATO 4B	Delta II	DM4	Thaicom 2	Ariane 44L		Koreasat 1	Delta II	DM4	Measat 2	Ariane 44L	DM3	Inmarsat 3F4	Ariane 44LP
				DM1	$\boxed{\text{TurkSat 1A}}$	Ariane 44LP				DM3	TurkSat 1C	Ariane 44L	DM3	Insat 2D	Ariane 44LP
				DM3	TurkSat 1B	Ariane 44LP					Inmarsat 3F1	Atlas IIA	DM1	Nahuel 1A	Ariane 44L
					Orion 1	Atlas IIA					Inmarsat 3F3	Atlas IIA		Thor II	Delta II
					Galaxy 1RS	Delta II					Galaxy 9	Delta II			
					APStar 1	Long March 3					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 (1993–2007) [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
2,500 - 4,200 kg (5,510 - 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 2,500 kg (<5,510 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 as they were retroactively determined not to have been competitively bid.

Table 9. Historical Addressable Commercial GSO Satellites Launched (1993–2007) [Continued]

	2003	2004	2005	2006	2007
Total Launches	12	13	15	15	12
Total Satellites	15	13	16	19	18

2003

Mass Class	Count	DM	Satellite	Launch Vehicle
Over 5,400 kg (>11,905 lbm)	0			
4,200 - 5,400 kg (9,260 - 11,905 lbm)	5		Intelsat 907	Ariane 44L
		DM2	Optus C1	Ariane 5G
			Rainbow 1	Atlas V 521
			EchoStar 9	Sea Launch
			Thuraya 2	Sea Launch
2,500 - 4,200 kg (5,510 - 9,260 lbm)	6	DM1	Insat 3A	Ariane 5G
		DM3	Insat 3E	Ariane 5G
			Asiasat 4	Atlas IIIB
			Hellas-sat	Atlas V 401
			AMC-9	Proton K/M
			Galaxy XIII	Sea Launch
Below 2,500 kg (<5,510 lbm)	4	DM2	Bsat 2C	Ariane 5G
		DM3	e-Bird 1	Ariane 5G
		DM1	Galaxy XII	Ariane 5G
			Amos 2	Soyuz

2004

Mass Class	Count	DM	Satellite	Launch Vehicle
Over 5,400 kg (>11,905 lbm)	3		Anik F2	Ariane 5G+
			Intelsat X	Proton M/M
			DirecTV 7S	Sea Launch
4,200 - 5,400 kg (9,260 - 11,905 lbm)	4		Eutelsat W3A	Proton M/M
			Amazonas	Proton M/M
			Estrela do Sul	Sea Launch
			APStar V	Sea Launch
2,500 - 4,200 kg (5,510 - 9,260 lbm)	4		Superbird 6	Atlas IIAS
			MBSat	Atlas IIIA
			AMC-16	Atlas V 521
			AMC-15	Proton M/M
Below 2,500 kg (<5,510 lbm)	2		AMC-10	Atlas IIAS
			AMC-11	Atlas IIAS

2005

Mass Class	Count	DM	Satellite	Launch Vehicle
Over 5,400 kg (>11,905 lbm)	6	DM1	Spaceway 2	Ariane 5ECA
			Thaicom 4	Ariane 5G+
			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)	4		AMC-12	Proton M/M
			Anik F1R	Proton M/M
			AMC-23	Proton M/M
			XM-3	Sea Launch
2,500 - 4,200 kg (5,510 - 9,260 lbm)	3	DMN	XTAR-EUR	Ariane 5ECA
			Insat 4A	Ariane 5G+
			DirecTV 8	Proton M/M
Below 2,500 kg (<5,510 lbm)	3	DM1	Telkom 2	Ariane 5ECA
		DMN	Galaxy 15	Ariane 5G+
			Galaxy 14	Soyuz

2006

Mass Class	Count	DM	Satellite	Launch Vehicle
Over 5,400 kg (>11,905 lbm)	2	DM2	Satmex 6	Ariane 5ECA
		DM3	DirecTV 9S	Ariane 5ECA
4,200 - 5,400 kg (9,260 - 11,905 lbm)	9	DM4	Wildblue 1	Ariane 5ECA
			Astra 1KR	Atlas V 411
			Hotbird 8	Proton M/M
			Measat 3	Proton M/M
			Echostar X	Sea Launch
			JCSat 9	Sea Launch
			Galaxy 16	Sea Launch
			Koreasat 5	Sea Launch
			XM-4	Sea Launch
2,500 - 4,200 kg (5,510 - 9,260 lbm)	6	DM1	$\boxed{\text{Hotbird 7A}}$	Ariane 5ECA
		DM1	Spainsat	Ariane 5ECA
		DM2	Thaicom 5	Ariane 5ECA
		DMN	JCSat 10	Ariane 5ECA
			Arabsat 4A	Proton M/M
			Arabsat 4B	Proton M/M
Below 2,500 kg (<5,510 lbm)	2	DM4	AMC-18	Ariane 5ECA
		DM3	Optus D1	Ariane 5ECA

2007

Mass Class	Count	DM	Satellite	Launch Vehicle
Over 5,400 kg (>11,905 lbm)	3	DM3	Spaceway 3	Ariane 5ECS
			DirecTV 10	Proton M/M
			$\boxed{\text{NSS-8}}$	Sea Launch
4,200 - 5,400 kg (9,260 - 11,905 lbm)	6	DM1	Skynet 5A	Ariane 5ECA
		DM2	Astra 1L	Ariane 5ECA
		DM5	Skynet 5B	Ariane 5ECA
			Nigcomsat	Long March 3B
			Anik F3	Proton M/M
			SES Sirius 4	Proton M/M
2,500 - 4,200 kg (5,510 - 9,260 lbm)	5	DM1	Insat 4B	Ariane 5ECA
		DM2	Galxy 17	Ariane 5ECA
		DM5	Star One C1	Ariane 5ECA
		DM6	RASCOM 1	Ariane 5G+
			$\boxed{\text{JCSat 11}}$	Proton M/M
Below 2,500 kg (<5,510 lbm)	4	DM3	Bsat 3A	Ariane 5ECA
		DM4	Intelsat 11	Ariane 5G+
		DM4	Optus D2	Ariane 5G+
		DM6	Horizons	Ariane 5G+

$\boxed{}$ = 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 (1993–2007)

	Total Launches	Total Spacecraft			
1993	3	3		Gorizont	Proton K/DM
				Gorizont 40	Proton K/DM
				Gorizont 41	Proton K/DM
1994	4	4		DFH 3-1	Long March 3A
				Express	Proton K/DM
				Gals-1	Proton K/DM
				Gorizont 42	Proton K/DM
1995	1	2	DMC	Telecom - 2C	Ariane 44L
				Gals 2	Proton K/DM
1996	4	5	DMC	Telecom 2D	Ariane 44L
				Chinasat 7	Long March 3A
				Express 2	Proton K/DM
				Gorizont 43	Proton K/DM
				Gorizont 44	Proton K/DM
1997	1	1		Chinasat 6	Long March 3A
1998	9	2		ChinaStar-1	Long March 3B
				Sinosat-1	Long March 3C
1999	8	3		Express A1	Proton K/DM
			DM1	Yamal 101	Proton K/DM
			DM1	Yamal 102	Proton K/DM
2000	15	4		Express A2	Proton K/DM
				Express A3	Proton K/DM
				Gorizont 45	Proton K/M
				SESAT	Proton K/DM
2001	7	1		Ekran M	Proton M/M
2002	6	1		Express A4	Proton K/DM
2003	3	4		Express AM-22	Proton K/DM
			DM1	Yamal 200 SC1^	Proton K/DM
			DM1	Yamal 200 SC2^	Proton K/DM
				Zhongxing 20	Long March 3A
2004	2	2		Express AM-11	Proton K/DM
				Express AM 1	Proton K/DM
2005	3	3		Express AM 2	Proton K/DM
				Express AM 3	Proton K/DM
				Apstar 6	Long March 3B
2006	2	2		Kazsat	Proton K/DM
				Sinosat 2	Long March 4B
2007	0	2		Sinosat 3	Long March 3B
				Chinasat 6B	Long March 3B

[box] = 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

2008 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits

Executive Summary

The Federal Aviation Administration's 2008 forecast projects a 38 percent increase in demand for worldwide commercial launches to non-geosynchronous orbits (NGSO) during 2008–2017 compared to last year's forecast. A total demand of 112 launches is forecast compared to 81 launches in the 2007 forecast. This increase is attributed to two factors: the inclusion of Iridium replacement launches in the forecast and the addition of a new category called orbital facility assembly and services as commercial companies today prepare to support the International Space Station (ISS). The forecast could be higher or lower in the future depending on the successful development of new vehicles attempting to meet this new orbital services market.

The *2008 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). The report assesses the worldwide market for satellites and other spacecraft expected to be available for competition between providers of commercial launch services, have commercial sponsors, or involve delivery of commercially operated services.

The 2008 forecast contains 276 satellites during the next ten years, an increase of 45 percent compared to the 2007 forecast of 191 satellites. Diversity continues to characterize the global NGSO market with combinations of private and government funding for missions ranging from science and commercial remote sensing to space station cargo and telecommunications.

2008 Launch Forecast: FAA/AST is forecasting an average demand of 11.2 worldwide launches per year during 2008–2017 with some sustained activity in the far-term, a change from recent forecasts that showed declining activity in the far term. During 2007 there were 12 actual commercial NGSO launches, the most since 1999.

Demand is divided into two vehicle size classes with an average of 8.1 medium-to-heavy launch vehicles per year and about 3.1 small vehicle launches per year during the forecast period. While the number of small launches is similar to last year's forecast, the number of medium-to-heavy launches increased by almost three launches per year.

The largest growth sector of the satellite (or payload) market is for telecommunications because of the addition of 72 satellites for Iridium's next-generation constellation. Telecommunications makes up half of the satellite market but only about 21.5 percent of the launch market because of multiple-manifesting; each launch for the second-generation Iridium, Globalstar, and ORBCOMM systems is expected to carry about six satellites per launch.

About 28 percent of the satellite market is comprised of international science and other satellites, such as technology demonstrations. This translates to 39 percent of the launch market. The new orbital facilities assembly and services category accounts for 25 percent of the launch market. A potential demand of 28 or more launches exists throughout the next ten years if companies are successful in developing new vehicles capable of launch, docking, and some for reentry. Commercial remote sensing satellites account for about 14 percent of the launch demand market.

Introduction

The 2008 non-geosynchronous orbits forecast shows changes again in the makeup of the market with addition of a new category called orbital facility assembly and services (OFAS) as well as the return to the forecast of the largest satellite constellation ever launched, Iridium.

This is the fourth 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.

To back up this trend, last year 12 actual NGSO commercial launches took place, more than the previous three years combined. There were as many NGSO launches as geosynchronous orbit (GSO) launches during 2007 (see Table 11). The GSO market was limited to 12 launches because of delays from launch failures and a new vehicle.

In last year's report, the FAA began use of a "realization" factor for the NGSO forecast because of a relatively high demand of 17 launches that appeared unlikely to occur in the first year (2007) of the ten-year forecast. The projected realization was for 10–13 launches during 2007. This year, the FAA realization is only 8–10 launches with a demand for 11 launches (see Table 16). Because the realization matches more closely with the demand forecast, this could be a sign of stabilization in the market. Four launches scheduled in 2007 carried over into 2008 compared to eight launches that shifted from 2006 into the 2007 forecast.

The near-term NGSO manifest shows a steady rate of NGSO launch demand with 11 in the forecast for 2008, 12 in 2009, 11 in 2010, and 10 in 2011. Unlike previous forecasts since 2003, the out-years also have a steady amount of activity comparable with the near-term because of the deployment of Iridium's next generation system of 72 satellites and projected consistent rate of commercial launches for resupply of the ISS.

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	12	12	**24**
2008 est.	11	22	**33**

However, the OFAS market is new and although demand is healthy and funding appears to be available both in the private sector and from government, forecasting the successful technical development by industry of new vehicles needed to meet the demand is uncertain. These vehicles include launch vehicles and automated rendezvous vehicles as well as spacecraft capable of carrying people. In addition, the competition for bids to provide services to NASA for ISS has not been completed. Furthermore, if a vehicle capable of carrying people is available, the market could grow quickly. Bigelow Aerospace could buy launch and rendezvous services for its planned habitat modules, some of which are under construction today.

Instead of excluding the ISS market or setting high and low rates of activity, the FAA is forecasting a launch rate necessary for two launch providers to meet commercial ISS supply upmass needs based on NASA's 2010–2015 model published in an April 2008 Request for Proposals. The forecast at this time does not include placeholders for Bigelow Aerospace modules or a projection of supply activity. It is entirely possible that flight rates and schedules to support both ISS and Bigelow Aerospace could change based on demand and when space transportation vehicles under development emerge.

Extensive private investment is being made by Bigelow Aerospace, SpaceX, and Orbital Sciences. For the latter two, the investment in new launch and rendezvous vehicles is supported by NASA funding from the Commercial Orbital Transportation Services (COTS) program.

Today's NGSO launch market is characterized by:

- An increase in activity by telecommunications satellites;
- A steady demand by international science;
- The new and promising sector of orbital facility assembly and services; and
- A small number of commercial remote sensing satellites.

With replacement plans for second generation systems for Globalstar, ORBCOMM, and Iridium all included in the forecast, telecommunications comprises the largest sector of the market. Fifty-three percent of all satellites seeking commercial launch services in during the next 10 years are in the telecommunications sector. However, no new telecommunications systems are forecast to compete with these existing systems. This may be an indicator that NGSO demand may be satisfied and companies and investors eager to enter the business have shifted to GSO systems.

The second largest satellite market segment is international science or "other" satellites (such as technology demonstrations) at 28 percent. After accounting for multiple-manifesting where more than one satellite can ride aboard per launch, the science market accounts for 39 percent of the launch demand market. The future science market continues to be difficult to assess beyond the near-term because of limited budgets and uncertainty on multiple- or single-manifesting. Historically, the science and other sector is the most dependable sector of activity. Because of the transfer of COTS launches from the "other" sector into the new OFAS category, science/other is the only sector to show a decline from the 2007 launch forecast.

The emerging OFAS market contains 10 percent of total spacecraft in the forecast but accounts for 25 percent of the launch market demand, all on medium-to-heavy launch vehicles. The commercial remote sensing sector encompasses only nine percent of the satellite market and 14 percent of the launch demand market with up and down demand cycles for both new programs and replacements of existing satellites.

The financial situation for existing NGSO operators, as with the entire satellite business sector, has been positive in recent years because of favorable lending terms, driven by the overall increase in global private equity investment programs and a healthy economy. Although there are signs of a slow down in the U.S. economy (including the housing subprime mortgage crisis and credit crunch) and rising fuel and food prices worldwide during 2008, it is unclear when and to what extent the satellite sector will be affected.

Unlike the 1990s when primary investors were the companies building the NGSO satellites, major backers today include private equity investors and global banking interests. Many private equity investors, however, may be looking to exit the overall satellite market through public offerings or other mechanisms.

After bankruptcies of the first generation of NGSO mobile constellations, new owners of the fully-deployed orbital systems started with a clean balance sheet. ORBCOMM and Iridium have prospered with new subscribers. ORBCOMM's stock has performed well and it signed a second-generation satellite construction contract in May 2008. Iridium posted record revenue during the first quarter of 2008 and plans to award a satellite construction contract in 2009 with the possibility of gaining further investment from hosting small guest payloads aboard its satellites. With its existing first generation in good shape, Iridium has time and momentum to build up more financing. Globalstar finds itself in the opposite situation after initially gaining subscribers following restructuring from bankruptcy. With the voice capabilities of its first-generation system degrading from S-band antenna problems, Globalstar faces some urgency to start launching its second-generation replacement satellites as soon as it can. After completing two launches of remaining first-generation spare satellites in 2007, second-generation satellite launches are scheduled to start in 2009. However, revenue and stock price declined in 2007 compared to 2006 and the company needs to raise additional financing.

In the U.S. commercial remote sensing sector there is broader optimism. GeoEye, which is publicly traded, saw its stock price increase almost 74 percent in 2007. Both GeoEye and its competitor DigitalGlobe (privately held, with Morgan Stanley as a key investor) have benefited from National Geospatial-Intelligence Agency (NGA) contracts and regular commercial customers. With near-term launches of new satellites funded, U.S. commercial remote sensing could have long-term financial stability.

Launch market share in the near-term NGSO market continues to be led by vehicles built by Russia and Ukraine. Of the 29 commercial NGSO launches from 2008–2010 that have known launch contracts, Russia/Ukraine is launching 18, followed by 10 for the U.S. and one launch by India.

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 is important to note 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 throughout the entire forecast. The forecast also does not evaluate if operators will 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 majority of satellites in the forecast are (or were) open for international launch services procurement or sponsored by commercial entities for commercial launch. In an addition to past methodology, U.S. commercially-competed launches for ISS resupply missions were included in this forecast.

The following sections review each market segment and describe the results of the 2008 forecast.

NGSO Satellite Systems

INTERNATIONAL SCIENCE AND OTHER PAYLOADS

Government programs, technology development missions, and satellite radio are significant customers of commercial launch services to NGSO. These are the primary constituents of the international science and other payload market category. Though most government missions do not use commercially-procured or commercially-licensed launches, there are select missions that do, particularly by governments that do not have domestic launch capabilities. For technology demonstration missions, most 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 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.

International science satellites can be classified into three groups. The first group is 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 are used for government purposes. 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 2008 on a Falcon 1. The Disaster Monitoring Constellation (DMC) is a remote sensing system that provides multispectral imaging in support of disaster relief operations. The system currently consists of five spacecraft built by Surrey Satellite Technology Ltd. (SSTL) for Algeria, China, Nigeria, Turkey, and the U.K. individually. Two next-generation DMC satellites are currently under development for Spain and the U.K., DEIMOS-1 and UK DMC-2. These satellites are planned to be launched together, along with two Aprize satellites and the primary payload Dubaisat-1, by a Dnepr vehicle in late 2008. Dubaisat-1, weighing in around 200 kilograms (440 pounds), is another remote sensing satellite within the international science market. The 2.5-meter (8.2-foot) resolution imaging satellite will serve civil infrastructure development and environmental monitoring purposes through the Emirates Institution for Advanced Science and Technology (EIAST), a Dubai government organization.

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.

The third class of satellites feature spacecraft designed to perform technology demonstrations. An example is the Cascade, Smallsat, and Ionospheric Polar Explorer (CASSIOPE) spacecraft. A prime objective of the CASSIOPE mission is to space qualify high-performance payload components that will be utilized in the CASCADE mission currently under development at MacDonald, Dettwiler and Associates (MDA). The CASCADE mission will enable a service business that will offer users in remote areas the ability to move potentially thousands of gigabits on a daily basis to and from anywhere on earth. MDA expects to launch the first constellation of four CASCADE satellites in 2010. The Swedish Space Corporation is also constructing a technology demonstration mission, named Prisma. This mission consists of two satellites demonstrating formation flying and rendezvous activities. The satellites will launch in June 2009 on a Dnepr.

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 digital audio radio services (DARS) providers, commonly referred to as satellite radio, have solidified their position in the U.S. consumer market, while new providers are looking to the European consumer market in the near future. In the United States, XM and Sirius Satellite Radio are continuing to boost their customer base, but are also planning to consolidate their operations and await a final determination from the Federal Communications Commisssion

(FCC). The U.S. Department of Justice gave its go-ahead to the XM-Sirius merger in early 2008. These merger plans add some uncertainty to the number and timing of future NGSO DARS satellites in the United States. Sirius currently has plans for one NGSO satellite launch and both companies have additional GSO launches booked, but a merger could affect these deployments.

In Europe, Ondas Media is making the strongest movement towards an NGSO DARS system. They have signed an authorization to proceed with Space Systems/Loral for the design and development of their system, which would include three ELI satellites launched around 2012. Ondas is currently in the financing phase. Ondas faces possible market competition from Europa Max, which reportedly plans a similar HEO system to Ondas, and GSO DARS players WorldSpace and an SES-Eutelsat partnership. This forecast assumes that there is a market for one European NGSO DARS system, based on the Ondas satellite and timeframe plans.

Military

Commercial launches are sometimes procured by governments for military satellites. These are minority cases, but two European systems currently use this commercial method: Italy's Cosmo-Skymed and Germany's SAR-Lupe. A third European country, Sweden, might also have future government missions launched under commercial contract.

The Italian Cosmo-Skymed constellation is a grouping of four synthetic aperture radar imaging satellites procured by the Italian Space Agency (ASI) for Italian government use. The spacecraft have a mass of 1,700 kilograms (3,745 pounds) and will orbit at an altitude of around 619 kilometers (385 miles). ASI contracted with Boeing Launch Services for the first three Cosmo-Skymed launches. The first two satellites were launched individually by Delta II vehicles in 2007. The third is planned for a Delta II in 2008, while the fourth is planned for a yet-to-be-determined vehicle in 2009.

SAR-Lupe is a constellation of five radar imagery satellites for use by the German Armed Forces. The 770-kilogram (1,968-pound) satellites are being 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$480-million) contract with the German Defense Ministry that began in 2002. The German government 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 were launched in 2007, and the final two will be launched in 2008.

Market Demand

FAA/AST projects that 76 satellites of the international science or other categories will be launched during the forecast period. These payloads will be deployed on 44 launches, including 19 medium-to-heavy and 25 small vehicles. Comparing market categories, this is the second largest number of satellites to be launched and the highest amount of total launch demand in the forecast.

COMMERCIAL REMOTE SENSING SATELLITES

Remote sensing has become a strong worldwide market with the advent of advanced and widely-distributed geographic information systems (GIS). Commercial remote sensing satellites are one set of systems that provide imagery and data for GIS applications, along with high-resolution government satellites and aerial systems. One sign of competition within the market is investment in vertical markets by major players, such as combining aerial and satellite assets together while offering additional value-added GIS services. There is sufficient demand for imagery and data from both government and commercial customers, though, to support several new and existing commercial satellites.

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 2011	EROS A and B are operational. EROS C planned as EROS A replacement at end of life.
IKONOS	GeoEye	Lockheed Martin	IKONOS 1 IKONOS	816 (1,800) 816 (1,800)	1 0.82	1999 1999	IKONOS 1 lost due to launch vehicle malfunction. IKONOS continues to operate.
OrbView	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-1 and -3 are 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	QuickBird continues to operate. EarlyBird failed in orbit shortly after launch. First QuickBird launch failed in 2000.
RADARSAT	MacDonald, Dettwiler and Associates (Telesat Canada)	MacDonald, Dettwiler and Associates	RADARSAT-1 RADARSAT-2 RCM	2,750 (6,050) 2,195 (4,840) 1,200 (2,645)	8 0.8 TBD	1995 2007 2014	RADARSAT-1 and -2 are operational. RCM is the future three-satellite RADARSAT Constellation Mission.
TerraSAR	Infoterra Group	Astrium	TerraSAR-X TanDEM-X TerraSAR-X2 TerraSAR-L	1,023 (2,255) 1,023 (2,255) 2,060 (4,540) TBD	3 3 5 TBD	2007 2009 2012 TBD	TerraSAR-X is currently operational. TanDEM-X will fly in formation with TerraSAR-X. TerraSAR-X2 is an end of life replacement for TerraSAR-X. TerraSAR-L implementation decision pending.
WorldView	DigitalGlobe	Ball Aerospace	WorldView 1 WorldView 2	2,500 (5,510) 2,800 (6,175)	0.5 0.5	2007 2009	WorldView 1 is operational. WorldView 2 will operate in a higher orbit than WorldView 1 and take imagery in additional spectral bands.
Under Development							
GeoEye	GeoEye	General Dynamics Advanced Info. Systems	GeoEye-1 GeoEye-2	907 (2,000) TBD	0.41 TBD	2008 2011	GeoEye-1 and -2 will provide very high-resolution imaging, upgrading GeoEye's current on-orbit fleet.
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.

The U.S. Government continues to be an important driver of the commercial remote sensing satellite market. The NGA partially funded the development of the current generation of GeoEye and DigitalGlobe satellites (although DigitalGlobe's WorldView 2 was not funded through an NGA contract). This satellite funding is provided by NextView contracts. The NGA also purchases imagery through ClearView contracts. The future of NGA contracts with commercial operators, which has yet to be announced, will be a significant determining factor on future satellite plans. Civil governments are also commercial imagery users. The U.S. Geological Survey announced in May 2008 new multi-year imagery acquisition contracts with GeoEye, DigitalGlobe, and SPOT Image Corporation for civil uses. Public-private partnerships in Europe have also spurred system development. For example, Germany and Infoterra partnered for the development of the TerraSAR system.

The National Oceanic and Atmospheric Administration (NOAA) is the U.S. agency with authority to license commercial remote sensing systems. There have been 28 licenses issued to date since 1993. Twelve of these licenses were granted to GeoEye and DigitalGlobe, or their predecessor companies. Fourteen other companies have received licenses, however, eight of these companies have retired their licenses. A listing of NOAA licenses is presented in Table 13. On June 29, 2007, NOAA lifted its 24-hour hold rule on satellite imagery of better than .82-meter ground resolution. This change allows the sale of imagery with a resolution no better than .5 meters ground sample distance resolution without a waiting period. This "no better than .5 meter ground sample distance resolution" is also the limit on commercially-sold imagery.

As has been the case in recent forecasts, the overall commercial remote sensing sector exhibits low, but steady, commercial launch demand. Though the GIS market is growing, it is not generating a significant amount of new commercial satellite and launch opportunities.

The major companies operating or actively developing remote sensing satellites across the globe are profiled below. A summary of the commercial remote sensing systems is provided in Table 12.

DigitalGlobe

DigitalGlobe is a U.S. commercial remote sensing data provider, based in Longmont, Colorado. The company was established in 1993 and is privately held. In April 2008, DigitalGlobe filed a registration statement with the SEC relating to a proposed initial public offering of its common stock, though, signaling a possible move towards public ownership. The company is currently expanding its on-orbit capability while also expanding its aerial assets and value-added capabilities.

DigitalGlobe has two remote sensing satellites on orbit within its Quickbird and WorldView systems. Quickbird, its first operational satellite, was launched by a Boeing Delta II on October 18, 2001 and continues to operate with a current projected operational lifetime lasting until around 2010. A previous Quickbird satellite was lost due to a Cosmos launch vehicle failure in November 2000. A higher-capability generation of satellites, beginning with WorldView 1, is also now operational. WorldView 1 was launched onboard a Boeing Delta II on September 18, 2007. The satellite has an average revisit time of 1.7 days and a swath width of 16 kilometers (10 miles). It is capable of collecting up to 500,000 square kilometers (200,000 square miles) per day of half-meter imagery.

DigitalGlobe also has a second WorldView satellite in development, with another Boeing contract announced for a Delta II launch in the mid-2009 timeframe. WorldView 2, also with half-meter resolution, will operate in an 800-kilometer (500-mile) orbit designed to reduce revisit times and has an estimated lifetime of at least seven years.

Both government and commercial customers have driven demand for DigitalGlobe's satellite imagery. The NGA awarded the company NextView and ClearView contracts beginning in 2003, which partially funded WorldView 1 and provided a sustained customer for imagery. Commercial imagery demand has grown since the early 2000s to significantly supplement government demand. The strong market is evidenced by the development of WorldView 2 without a significant NGA funding vehicle like NextView.

GeoEye

GeoEye, Inc., based in Dulles, Virginia, is a publicly-traded U.S. commercial remote sensing data provider. The company was formed by the acquisition of Space Imaging by ORBIMAGE in January 2006. GeoEye is nearing the launch of its next-generation satellite system, which will add higher-resolution satellite capability to its two currently-operational satellites, two imaging aircraft, network of ground stations, and geospatial information products and services.

GeoEye currently operates the IKONOS and OrbView-2 imaging satellites. IKONOS was launched on September 24, 1999, by an Athena II vehicle. The satellite operates in a 680-kilometer (423-mile) polar orbit with a ground resolution of 0.82 meters (2.7 feet). IKONOS is expected to remain operational for the foreseeable future, possibly into the next decade. The OrbView-2 satellite, launched by a Pegasus XL booster on August 1, 1997, continues to provide images of up to 1.1 kilometers (0.71 miles) much past its projected operational lifetime. Imagery from this satellite is primarily used by the commercial fishing industry and for scientific research. GeoEye's OrbView-3 satellite provided imagery until April 2007, when it experienced an imaging malfunction and was declared no longer operational.

The company's high-resolution next-generation satellite, GeoEye-1, is currently planned for launch aboard a Boeing Delta II from Vandenberg Air Force Base in August 2008. The satellite will operate in a sun-synchronous polar orbit at an altitude of 684 kilometers (425 miles) and 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. The satellite has a planned operational lifetime of seven years or longer

GeoEye has also begun the development of its next satellite, GeoEye-2. The company announced a contract with ITT in October 2007 for the commencement of work on the new satellite's imaging system. The satellite's ground resolution could possibly be as good as 0.25 meters (9.75 inches). Current development timelines place the launch of this third-generation satellite around 2011.

The U.S. government continues to be GeoEye's largest customer, though commercial customers also provide significant demand. The NGA had around $100 million of purchases from GeoEye in 2007. These purchases amounted to about 55 percent of company revenues, meaning that other government and commercial customer purchases were also significant drivers of demand.

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	License transfer from Space Imaging to ORBIMAGE.
ORBIMAGE (d/b/a GeoEye)	1/10/2006	License transfer from Space Imaging to ORBIMAGE.
ORBIMAGE (d/b/a GeoEye)	1/10/2006	License transfer from Space Imaging to ORBIMAGE.
Echostar	3/6/2007	GSO satellite with television camera for low-resolution images.

Note: Please see www.licensing.noaa.gov/licenses for public summaries for these systems.

ImageSat International NV

ImageSat, founded as West Indian Space in 1997, is a Netherlands Antilles company that provides commercial high-resolution imagery from its Earth Remote Observation Satellite (EROS) family of satellites. The EROS satellite contracting team includes Israel Aerospace Industries Ltd. as the satellite bus manufacturer and ELBIT-Electro Optics Industries as builder of the imaging system. Like the U.S. companies, ImageSat has seen recent growth in commercial customer revenue, though their customer base is still based on a few large government customers.

ImageSat currently operates two satellites, EROS A and EROS B. The EROS A and EROS B spacecraft were both placed into orbit by START 1 vehicles. EROS A was launched from Svobodny, Russia in December 2000, and is expected to operate until 2012 or later. In April 2006, the second ImageSat 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 lighting conditions; the satellite is projected to operate until 2018 or longer. ImageSat plans to develop and launch a third satellite, EROS C, though the company has not finalized mission requirements for this satellite. EROS C is projected to launch around 2011 or 2012 as a replacement for EROS A.

Infoterra Group

Infoterra GmbH is a part of the Infoterra Group and is a subsidiary of EADS Astrium GmbH. Through a public-private partnership with the German Aerospace Center (DLR), Infoterra provides radar imagery from the TerraSAR-X satellite. Infoterra is involved with commercial imagery, while DLR is responsible for science missions using the satellite. Additional satellites from this German partnership are planned to accompany TerraSAR-X on orbit in the upcoming years, adding to their imagery and data capability. Infoterra's customer profile fits the industry trend of a slight majority core of defense and security customers with other public and private customer demand showing growth.

TerraSAR-X is the first of a pair of X-band synthetic aperture radar satellites that will be launched and operated for Infoterra commercial use. The operational satellite, built by EADS Astrium with a projected operational lifetime of five or more years, was launched on June 15, 2007 by a Russian Dnepr vehicle. The second satellite of the pair is TanDEM-X, which will fly in close formation with TerraSAR-X. Adding this second satellite will allow Infoterra to create high-resolution digital elevation models. The satellite is currently under development at EADS Astrium and will also have a five-year or longer expected lifetime. The satellite is scheduled to launch on a Dnepr in 2009.

Two future satellite missions are under consideration to continue Infoterra's mission. TerraSAR-X2 would be the successor to TerraSAR-X around the time of its expected end of life in approximately 2012. The funding for this satellite is currently planned to come solely from monies earned through Infoterra's commercial activity, rather than from a public-private partnership like the first two satellites. There is also a proposal for an L-band radar satellite, TerraSAR-L, but a decision to proceed with this mission is pending and details regarding its implementation are not finalized.

MacDonald, Dettwiler and Associates

MacDonald, Dettwiler and Associates Ltd. (MDA) is a commercial provider of radar satellite remote sensing data coming from the Canadian RADARSAT series of satellites. The company distributes data from two operational satellites, RADARSAT-1 and RADARSAT-2. RADARSAT-1 was a Canadian Space Agency government-led program, while RADARSAT-2 is owned and operated by MDA under a public private partnership with the Government of Canada.

Alliant Techsystems (ATK), based in the United States, announced on January 8, 2008 that it planned to acquire the MDA Information

Systems and Geospatial Information Services business units, which would include the RADARSAT activities. This acquisition has since been blocked by the Canadian government, keeping the company and its activities at the status quo. If allowed to proceed, however, this acquisition would likely have an effect on future RADARSAT plans.

The first RADARSAT satellite was launched in November 1995 aboard a Delta II, while the second was launched on December 14, 2007 using a Starsem Soyuz vehicle from the Baikonur Cosmodrome. RADARSAT-1 provides data with resolutions between 8 and 100 meters (26 and 328 feet) and has a repeat cycle of 24 days. RADARSAT-2 includes improvements that allow for greater imaging flexibility, dual polarization and full polarimetric imaging options, and 3-meter (10-foot) resolution.

To provide continuation of the radar data missions, the Government of Canada and the Canadian Space Agency have proposed a three-satellite RADARSAT Constellation as a follow-on to RADARSAT-2. There has been C$200 million (US$198 million) committed for the first phase of the constellation program. The RADARSAT Constellation Mission will serve surveillance and monitoring purposes. These satellites, projected to weigh approximately 1,200 kilograms (2,600 pounds) each, are currently planned for launch between 2014 and 2017.

RapidEye AG

RapidEye, a German company providing satellite-based geo-information services, has developed a five-satellite remote sensing constellation designed to provide data for customers interested in agricultural and cartographic applications, among other possible markets. RapidEye expects their revenues to come from both commercial and government clients within these markets.

In May 2004 a supply agreement was signed for MDA to provide a satellite constellation, launch arrangements, and ground infrastructure for the RapidEye system. SSTL built the satellite platforms and the German company Jena-Optronik GmbH provided the optical payload.

The launch of the five RapidEye satellites is planned for mid-2008 on a Dnepr vehicle. 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 satellites, each providing resolution of up to 6.5 meters (21 feet), have an expected operational lifetime of seven years. RapidEye currently intends to maintain a satellite system beyond the lifetime of these five first-generation satellites, but detailed planning for a next generation has yet to be determined.

Market Demand

FAA/AST projects that the commercial satellite remote sensing sector will yield about 24 payloads throughout the forecast period, with a peak of 7 in 2015 due to the projected launch of future generation satellites for system continuity. The commercial remote sensing satellites will be deployed on 16 launches, including 14 on medium-to-heavy vehicles.

NGSO TELECOMMUNICATIONS SYSTEMS

The NGSO telecommunications satellite market is based on large constellations of small-to-medium-sized satellites that provide worldwide or near-worldwide communications coverage. The constellations fall into two categories, Little LEO and Big LEO, derived from the frequencies that satellites use: Little LEO systems operate at frequencies below 1 GHz and 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. There is one Little LEO system, ORBCOMM, and two Big LEO systems, Globalstar and Iridium, currently on-orbit and operational. All three of these systems are in the planning or development stage of their new generation of satellites. A second Little LEO system, AprizeStar, also has a small number of satellites in orbit. Little LEO systems are summarized in Table 14 and Big LEO systems in Table 15.

Other telecommunications systems have been proposed in the past, including Broadband LEO systems that would provide high-speed data services at Ka- and Ku-band frequencies. There are proposals to develop similar systems, using a mix of NGSO and GSO satellites, but these have not advanced beyond the planning stages. Other smaller systems have been developed, but have not played a significant role in the market. Details about the three major operational constellations, and other NGSO telecommunications operations, are provided below.

Globalstar

Globalstar, Inc. is a publicly-traded Big LEO system operator primarily serving the global satellite voice and data markets. Their full service offering began in the first quarter of 2000. In February 2002 the company filed for Chapter 11 bankruptcy. The company emerged from bankruptcy in 2004 when its assets were acquired by affiliates of Thermo Capital Partners. It subsequently conducted an IPO in November 2006, and is currently designing and constructing 48 replacement satellites for its on-orbit satellite constellation that is degrading as it ages.

For Globalstar's first-generation satellite constellation, a total of 52 satellites—48 operational satellites plus four on-orbit spares—were placed into orbit using Boeing Delta II boosters and Starsem Soyuz boosters between February 1998 and February 2000. The company suffered one launch failure of 12 satellites on a Zenit 2 in September 1998. The company announced in February 2007 that these operational satellites are continuing to experience S-band amplifier problems, a problem that started to a lesser extent in 2001. The amplifier degradation affected the company's voice and two-way data services. The simplex one-way L-band data services provided by the satellites are not affected by these problems.

Globalstar reported decreased revenues in 2007 largely as a result of its reduced voice service quality. The company reported $98.4 million in revenue in 2007, compared to $136.7 million in 2006. Service revenue fell by 13 percent while subscriber equipment sales dropped over 50 percent. The company reported a net loss of $27.9 million in 2007, compared to net income of $23.6 million in 2006. Globalstar reported having approximately 284,000 subscribers (defined by the number of devices under agreement for Globalstar services) at the end of 2007, a modest increase over the 262,802 reported at the end of 2006.

Table 14. 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.	35/29 (in orbit/ operational)	43 (95)	LEO	1995	System operational with 35 satellites on orbit; FCC licensed, October 1994. Emerged from bankruptcy protection in March 2002. 2008 FCC authorization for replacement satellite plan; launches scheduled to begin in mid-2008.
Under Development							
AprizeStar (LatinSat)	Aprize Satellite	SpaceQuest	4/2 (in orbit/ operational)	10 (22)	LEO	2002	Planned 48-satellite system, with intermittent launches planned in the near-term. First two satellites licensed by Argentine CNC in 1995.

Table 15. Big LEO Systems

System	Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
			Number	Mass kg (lbm)			
Operational							
Globalstar	Globalstar Inc.	Alenia Spazio	60/48 (in orbit/ operational)	447 (985)	LEO	1998	Constellation on-orbit and operational, with some technical anomalies. Thermo Capital Partners acquired a majority interest in the company in December 2003. Eight replacement satellites launched in 2007. Next-generation system planned for launch starting in 2009.
Iridium	Iridium Satellite LLC	Motorola	95/75 (in orbit/ operational)	680 (1,500)	LEO	1997	Constellation on-orbit and operational. Assets acquired in December 2000 bankruptcy proceeding. Five spare satellites launched in February 2002, two additional spares launched June 2002. Next-generation system to be developed and launched.

As a mitigation measure against the S-band problems and to begin the process of updating its on-orbit constellation, Globalstar launched its final eight first-generation replacement satellites on two Soyuz vehicles in May and October 2007. These eight satellites are expected to form part of the replacement constellation. In addition to these two launches, the company plans to launch a second-generation system beginning in late 2009. In September 2007, Globalstar announced a contract with Arianespace for four Soyuz launches of six satellites each, with an option for four additional launches. The company expects to use the four launches during 2009 and 2012 to launch 24 of the satellites. The satellites are currently being constructed by Thales Alenia Space. Together with the eight replacement satellites launched in 2007, Globalstar will create a 32-satellite system as the initial deployment of its new constellation.

In addition to the FCC licenses granted for its satellite constellation, Globalstar has FAA acuthority to provide ancillary terrestrial component (ATC) service. The company was originally granted permission to use 11 MHz for an ATC system. In April 2008, the FCC granted it permission to use additional spectrum, 19.275 MHz in total, for ATC. Globalstar signed an agreement in late 2007 with Open Range Communications, permitting that company to use Globalstar's ATC spectrum to provide terrestrial WiMAX service, a technology to provide wireless data over long distances, in rural communities. Open Range Communications has yet to deploy that system, and has recently received a $267 million loan from the Department of Agriculture's Rural Utilities program. Globalstar said it plans to enter discussions with other companies that could use the ATC spectrum.

Iridium

Iridium Satellite LLC, a privately-held company, is the successor to the original Iridium Corporation that built and launched the 66-spacecraft Iridium satellite constellation in the late 1990s. Iridium Satellite purchased the assets of Iridium, including the satellite constellation, for approximately $25 million in December 2000 and restarted Big LEO commercial communications services using the satellite system a few months later. In addition to the 66 operational spacecraft, there are nine functioning spare satellites in orbit as of March 2008. Iridium is now taking the first steps to develop and launch a second-generation satellite constellation, named Iridium NEXT.

A total of 95 Iridium satellites have been launched as a part of the first-generation system, including seven spare satellites launched in 2002: five on a Delta II and two on a Rockot. These satellites comprise a fully-operational system that is expected to provide service until at least 2014. The company has no spare satellites remaining on the ground and has no plans to build any until it deploys Iridium NEXT.

Iridium has begun the process to implement its next-generation constellation. In March 2008, Iridium announced it had selected three companies as finalists for the contract to develop the Iridium NEXT satellites: Lockheed Martin, Space Systems/Loral, and Thales Alenia Space. The three companies will perform design studies for five months, after which Iridium will select two to proceed into the system development phase. Iridium will select a prime contractor by April 2009. Iridium is considering hosted payload options for its next-generation satellites in addition to the primary communications payload.

Iridium has made no formal plans for the launch of Iridium NEXT. The company's current notional launch plans call for launching 72 satellites on approximately 12 launches of 6 spacecraft each. Those launches would be spread over a three-year period, which could begin as soon as 2012. Iridium is considering a number of launch vehicle options.

As Iridium begins its Iridium NEXT plans, the company is experiencing continued growth of its current business. Iridium reported an EBITDA (earnings before interest, taxes, depreciation, and amortization) of $73.6 million in 2007, compared to $53.8 million in 2006. The company also reported increased revenues, totaling $260.4 million in 2007 versus $212.4 million in 2006. The company had 234,000 subscribers (defined as customers, not active devices) at the end of 2007, an increase of 59,000 from the end of 2006. The number of subscribers increased 37 percent from the end of the first quarter of 2007 to the end of the first quarter of 2008.

ORBCOMM

Between 1995 and 1999, ORBCOMM deployed a Little LEO constellation of 35 satellites, 29 of which are operational as of April 2008. It is the only company to have fully deployed a dedicated commercial system that provides low-bandwidth packet data services worldwide. ORBCOMM plans to launch a new generation of satellites early next decade, as well as six satellites in 2008, to continue their telecommunications services.

As plans are set for new satellite development, ORBCOMM reported improved financial statistics in 2007. A publicly-traded company, ORBCOMM earned revenues of $28 million in 2007, up 15 percent from $24.5 million in 2006. A strong increase in service revenues offset a decline in product sales. The company also recorded $1.5 million in 2007 from the sale of gateway earth station assets. For year end 2007, the company reported a net loss of $3.6 million, compared to a loss of $11.2 million for 2006.

ORBCOMM intends to launch six satellites on a Cosmos 3M in June 2008, as part of its plan to replenish its current 29-satellite constellation with 24 satellites. Five of the six satellites to be launched in June 2008 are the company's "QuickLaunch" spacecraft, originally scheduled to be launched in 2007 but delayed due to "electromagnetic compatibility testing" problems. The sixth satellite to be launched is a U.S. Coast Guard demonstration satellite with an Automatic Identification System (AIS) payload.

The remaining 18 new satellites will be "Generation 2" satellites. ORBCOMM chose MicroSat Systems to be the prime contractor for these 18 spacecraft in May 2008. The projected plans are to launch these satellites in 2010 and 2011, most likely with three launches of six spacecraft each. Generation 2 will likely create demand for small launch vehicles, as did the first generation and QuickLaunch missions. The new ORBCOMM constellation will operate in four orbital planes, each in 750-kilometer circular orbits at an inclination of 48.5°. ORBCOMM received FCC authorization for these new satellite and launch plans in March 2008.

Other Systems

A number of additional NGSO satellite telecommunications systems have been proposed, but have not been major drivers of launch demand. These systems run the gamut of Big LEO, Little LEO, and Broadband LEO satellites. Some potential providers of satellite telecommunications services struggled to gain necessary funding or failed to follow through on their business plans. Others have had slow deployment timelines or have delayed satellite plans.

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

ICO Global Communications—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 MEO at an altitude of 10,390 kilometers (6,450 miles). ICO did begin NGSO launches, but did not complete the deployment of its planned system. One ICO satellite was lost in a launch failure in March 2000. A second satellite was successfully launched in June 2001. ICO then changed its satellite plans to a GSO system. 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. The ICO G1 satellite, built by Space Systems/Loral, successfully launched to GSO on April 14, 2008. In May 2007, ICO stated intentions to pursue a European operating license and hoped to still launch its ten NGSO satellites that remain in storage, four of which are in various stages of assembly.

Two companies have made initial plans to develop broadband satellite systems using a combination of GSO and NGSO satellites. @Contact and Northrop Grumman have filed applications with the FCC for hybrid GSO/NGSO systems. Each company is planning to incorporate four GSO satellites plus three HEO satellites in their system. @Contact received a license from the FCC for its Ka-band system in April 2006; the license includes milestones that require the company to have its entire system certified as operational by April 2012. No launch contract for its system has been announced, however, the company entered into a non-contingent satellite manufacturing contract with Space Systems/Loral in April 2007 and filed a confirmation with the FCC that it completed a critical design review of the system in April 2008. Northrop Grumman updated the FCC application for its Global EHF Satellite Network, meant to operate at Ka- and V-band frequencies, as recently as February 2007, but no other visible activity has been undertaken to advance the development of the system.

Market Demand

FAA/AST projects that 28 Little LEO satellites will be launched during the coming decade and generate a demand for four launches of small vehicles. FAA/AST projects that 120 Big LEO satellites will be launched during the coming decade to cover the replenishment of two existing systems. These payloads will be deployed on 20 launches of medium-to-heavy vehicles.

ORBITAL FACILITY ASSEMBLY AND SERVICES

A new market has emerged for the commercial launch of cargo and people to orbital facilities. This market includes the International Space Station (ISS) and orbital habitats under development by Bigelow Aerospace. These commercially-provided launch services will carry supplies and eventually people to and from orbit. They will meet the needs of ISS as well as the emerging orbital space tourism market and possibly other exploration or science purposes such as microgravity experiments. Some vehicles will have pressurized and unpressurized cargo accomodations.

NASA is accepting bids for regular U.S. commercial cargo supply missions to support the ISS during the transition from the Space Shuttle to the Constellation vehicles. NASA's Commercial Orbital Transportation Services (COTS) program has sparked the necessary technology development for these missions.

This OFAS market category is new to the forecast, although orbital facility launches have historical precedence within the "other" market category, which previously included launches of Bigelow's Genesis habitat technology demonstration spacecraft.

Bigelow Aerospace Orbital Habitats

The first commercial orbital facilities are under development by Bigelow Aerospace. Bigelow's goal is to create crewed orbital facilities based on expandable habitats. Two initial demonstration spacecraft, Genesis I and Genesis II, were commercially launched by Dnepr rockets in 2006 and 2007, respectively. These spacecraft are successfully testing and validating systems critical for future Bigelow expandable habitats.

Bigelow Aerospace is currently constructing its first habitable spacecraft, the Sundancer. Sundancer will offer 175 cubic meters of habitable volume and be able to support up to three people. The Sundancer's ultimate launch date will be determined by the availability of the necessary transportation systems to support the transfer of crew and cargo. Shortly after Sundancer, Bigelow plans to launch a node and bus system that will be combined with Sundancer to add operational functionality as part of the first orbital complex. Bigelow then anticipates launching two of the larger full standard modules, which will each provide roughly 300 cubic meters of habitable volume, to join with Sundancer and the node/bus to complete its first orbital complex.

Bigelow business plans include selling four-week trips to its modules to astronauts from various national space agencies. The company will also offer full module lease opportunities. A critical consideration for Bigelow's plans is the availability of affordable commercial transportation to carry people and cargo to and from its orbital facilities. Once in orbit, the habitats will require a regular supply of both crew and cargo. The development of a new private sector crew capsule to affordably, reliably, and safely transfer Bigelow personnel and customers to and from its orbital complexes is needed. Because of the transportation uncertainty, at this time, the forecast does not include launch demand for Bigelow Aerospace.

NASA COTS

The COTS program at NASA is supporting the development of orbital cargo transportation capabilities within U.S. commercial industry. COTS includes two funded Space Act Agreements with SpaceX and Orbital Sciences, totaling approximately $500 million, as well as several unfunded Space Act Agreements with other companies. COTS is intended to promote systems that could provide cargo resupply to the ISS. There is an option for developing a COTS crew capability as well, but this option has not yet been exercised.

The funded Agreements require four FAA/AST-licensed demonstration launches during the next few years, three by SpaceX and one by Orbital Sciences. Both companies are developing new launch and orbital vehicles for COTS and must provide private financing in addition to the COTS funding. The SpaceX system uses the company's Falcon 9 launch vehicle and Dragon spacecraft. Their first two demonstration flights are planned for 2009, with the third flight in 2010. The Orbital Sciences system combines the Taurus II launch vehicle and the Cygnus spacecraft. One COTS demonstration launch is planned for Orbital Sciences, in late 2010.

Commercial ISS Resupply

Building on the projected success of the COTS program and other U.S. commercial space technology, NASA is beginning the process to acquire commercial cargo transportation services to resupply the ISS. These launches will be licensed by the FAA. Between the time when the Space Shuttle is retired and the new Constellation transportation systems are operational, the United States will face a shortfall in transportation capability to the ISS. Procuring U.S. commercial services is part of the solution for filling this transportation demand gap, which also includes the use of foreign orbital vehicles. NASA will depend on the cargo capability of the European ATV and Japanese HTV and rely on pre-positioned spares, delivered by the Shuttle before its retirement in 2010, until U.S. commercial cargo vehicles are operational.

NASA released a Request for Information in August 2007 and held a pre-proposal conference in March 2008 regarding the provision of these services. The agency has issued a final Request for Proposals (RFP) with a contract award date in late 2008. The projected NASA demand for commercial transportation services is spelled out in this RFP, with requirements for internal and external upmass, return downmass, and disposal downmass listed for calendar years 2010 to 2015.[1] Forecasted launch demand is projected to primarily fall within the 2011 to 2015 timeframe for commercial ISS resupply, though the number of launches per year remains uncertain. The ISS is a continuing market for cargo supply, though. Demand for commercial service could possibly continue after 2015, the last year under the RFP, depending on decisions regarding continued operations on the ISS and NASA transportation choices.

Market Demand

FAA/AST projects that 28 orbital facility assembly and service missions will launch during the ten-year forecast period. Each of these missions will require a medium-to-heavy launch vehicle, thus creating a demand for 28 launches in this vehicle category. This demand could increase if new commercial transportation services capable of carrying people become availalable for use by Bigelow Aerospace.

Future Markets

Demand for commercial launches to NGSO could be affected by new emerging markets and even by a series of prize competitions. The launch demand possibilities of future markets are evidenced by this year's inclusion of the OFAS market category in the forecast model.

The orbital public space travel market could potentially grow into a fruitful NGSO launch market. Connected to OFAS missions, private space travel would include paying customer missions to orbit either solely onboard a vehicle or on a trip to an orbital facility. A number of companies are developing suborbital vehicles to be used for public space travel—these are not considered in the forecast since they are not orbital missions—and other companies have proposed new commercial orbital vehicles. Though the suborbital industry is forming, the orbital industry has yet to concretely come together. There have been a number of individual space tourist missions onboard Russian Soyuz ISS missions, but because of the government nature of these missions, they do not constitute the beginnings of a market when considering commercial launch demand.

Prize competitions are also driving possible new commercial launch demand. The Google Lunar X PRIZE, announced in September 2007, is an international competition to promote the private exploration of the Moon, with a total available prize purse of $30 million. The contest rules require private launch arrangements with incentives for landing on the surface with a robotic

[1] Up-to-date information can be found on NASA's ISS Commercial Resupply Services webpage: http://procurement.jsc.nasa.gov/issresupply/default.asp

rover by 2012. It is too early to include a projection of launch demand in the forecast for this prize. Bigelow Aerospace is also offering a prize competition, America's Space Prize, to promote orbital transfer vehicle development for the future servicing of its habitats. Successful flight of a docking and return vehicle must be repeated within 60 days to win the $50 million prize. The prize offer expires in January 2010.

NASA's "Centennial Challenges" prize competition program, within the Innovative Partnerships Program, 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. 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. The largest competition to date, the Northrop Grumman Lunar Lander Challenge, features $2 million in prizes for vehicles that can simulate the liftoff and landing of a lunar spacecraft; the same technology could be used for the development of future commercial suborbital and orbital spacecraft. No prize money was awarded for the competition in 2006 or 2007, but the competition will be held again in 2008.

Risk Factors That Affect Satellite and Launch Demand

Several factors could negatively or positively impact the NGSO forecast:

- **U.S. national and global economy**—Strong overall economic conditions have historically fostered growth and expansion in satellite markets. Similarly, relatively weaker currency exchange rates in one nation generally create favorable circumstances for exporters and buyers in a given marketplace. Global satellite manufacturers and purchasers have shown strong interest in taking advantage of the highly attractive values offered by the historically low U.S. dollar exchange rates. However, it is difficult to project if this trend will be sustained given the very mixed picture created by the overall economic data. The troubled credit markets have eroded investor confidence broadly and soaring prices for basic necessities such as food and fuel typically foreshadow significant contractions of all consumer based markets particularly in the short term.

- **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 emphasis 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

Table 16. Near-Term Identified NGSO Satellite Manifest

Service Type	2008	2009	2010	2011
Commercial Remote Sensing	GeoEye-1* - Delta II	TanDEM X - Dnepr		GeoEye-2 - TBA
	RapidEye 1-5 - Dnepr	WorldView 2 - Delta II		EROS C - TBA
International Science	THEOS* - Dnepr	CASSIOPE - Falcon 9	Kompsat 5 - Dnepr	Microscope - TBA
	RazakSAT* - Falcon 1	Cryosat 2 - Rockot	MoonLite - PSLV	EnMap - TBA
	DubaiSat 1 - Dnepr DEIMOS UK DMC 2 AprizeStar 3-4	SERVIS 2 - Rockot	SWARM 1-3 - TBA	
		Kompsat 3 - TBA		
	GOCE - Rockot			
	SMOS - Rockot			
Telecommunications	ORBCOMM (5)* - Cosmos	Globalstar (6) - Soyuz 2	Globalstar (6) - Soyuz 2	Globalstar (6) - Soyuz 2
	ORBCOMM CDS 3*	Globalstar (6) - Soyuz 2	Globalstar (6) - Soyuz 2	Globalstar (6) - Soyuz 2
			ORBCOMM (6) - TBA	ORBCOMM (6) - TBA
			ORBCOMM (6) - TBA	
Orbital Facility Assembly and Services		Dragon COTS Demo 1- Falcon 9	Dragon COTS Demo 3- Falcon 9	ISS Re-supply - TBA
		Dragon COTS Demo 2- Falcon 9	Cygnus COTS Demo - Taurus II	ISS Re-supply - TBA
Other	SAR Lupe 4 - Cosmos	Cosmo-Skymed 4 - TBA	Cascade 1-4 - Falcon 1	SSC TBA - Falcon 1
	SAR Lupe 5 - Cosmos	PRISMA 1 and 2 - Dnepr	Sirius FM-6 - Proton M	
	Cosmo-Skymed 3 - Delta II			
Total Payloads	24	23	36	25
Total Launches	11	12	11	10
FAA Realization Launches	8-10			

* Carryover from 2007
Note: Chart includes only those payloads announced as of May 2, 2008
Does not include secondary payloads that do not generate launch demand

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. The forecast includes a "realization factor" that provides an estimate of the number of launches that will take place in 2008, based on historical trends in past forecasts and an assessment of current activity.

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 2008.

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 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 160-2,400 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.

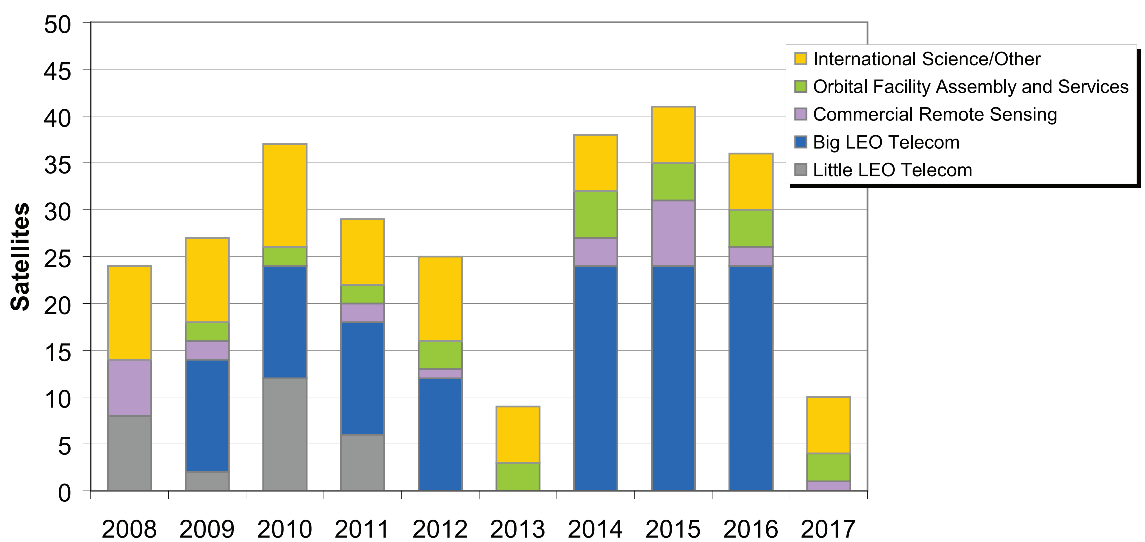
Satellite and Launch Forecast

In this forecast, 276 satellites are seeking future commercial launch, creating demand for 112 launches after multi-manifesting. These numbers are significantly greater than those in the 2007 forecast, which predicted 191 satellites to be launched on 81 vehicles in the 2007–2016 timeframe. This increase is the most significant overall forecast change experienced in the past few years. The inclusion of an additional full Big LEO replacement constellation and the addition of several OFAS missions are the primary causes of the increase in satellites and launches from last year's forecast. Table 17 and Figures 12 and 13 show the satellites and launches forecasted between 2008 and 2017.

Table 17. Satellite and Launch Demand Forecast

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TOTAL	Avg
Satellites												
Little LEO Telecom	8	2	12	6	0	0	0	0	0	0	28	2.8
Big LEO Telecom	0	12	12	12	12	0	24	24	24	0	120	12.0
Commercial Remote Sensing	6	2	0	2	1	0	3	7	2	1	24	2.4
Orbital Facility Assembly and Services	0	2	2	2	3	3	5	4	4	3	28	2.8
International Science/Other	10	9	11	7	9	6	6	6	6	6	76	7.6
Total Satellites	**24**	**27**	**37**	**29**	**25**	**9**	**38**	**41**	**36**	**10**	**276**	**27.6**
Launch Demand												
Medium-to-Heavy Vehicles	5	10	6	6	10	4	13	12	11	4	81	8.1
Small Vehicles	6	2	5	5	2	2	2	2	2	3	31	3.1
Total Launches	**11**	**12**	**11**	**11**	**12**	**6**	**15**	**14**	**13**	**7**	**112**	**11.2**

Figure 12. Satellite Forecast



The forecast anticipates the following satellite market characteristics from 2008–2017:

- Telecommunications satellites account for about 53 percent of the market with 148 satellites, an increase from the 81 satellites in last year's forecast because of new plans regarding the deployment of next-generation Big LEO and Little LEO systems.

- International science and other satellites (such as military spacecraft and technology demonstrations) will comprise about 28 percent of the NGSO satellite market with 76 satellites, a significant drop from the 48 percent share from 91 satellites in the 2007 forecast.

- Orbital facility assembly and service satellites account for 10 percent of the 2008 forecast with 28 spacecraft. This is a new market category that has not been counted in previous forecasts.

- Commercial remote sensing satellites encompass 9 percent of the 2008 forecast with 24 satellites, a slight increase in number of satellites from the 2007 forecast because of one future system replacement plan.

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

	2008	2009	2010	2011	Total	Percent of Total
< 200 kg (< 441 lbm)	16	2	12	6	**36**	**33%**
200-600 kg (441-1323 lbm)	2	1	7	3	**13**	**12%**
601-1200 kg (1324-2646 lbm)	4	16	14	13	**47**	**44%**
> 1200 kg (> 2646 lbm)	2	4	3	3	**12**	**11%**
Total	24	23	36	25	**108**	**100%**

Table 18 shows the mass distributions of known manifested satellites over the next four years. Large spacecraft, those with a mass higher than 600 kilograms (1,324 pounds), make up 55 percent of those manifested from 2008 to 2011. This trend has increased from 49 percent in the 2007 forecast and 31 percent in the 2006 forecast.

The launch forecast of 112 launches is composed of 31 small vehicle and 81 medium-to-heavy vehicle launches. This demand breaks down to an average of just over three launches annually on small launch vehicles and about eight launches annually on medium-to-heavy launch vehicles. The total number of launches is 38 percent greater than the 2007 forecast, with

Figure 13. Launch Demand Forecast

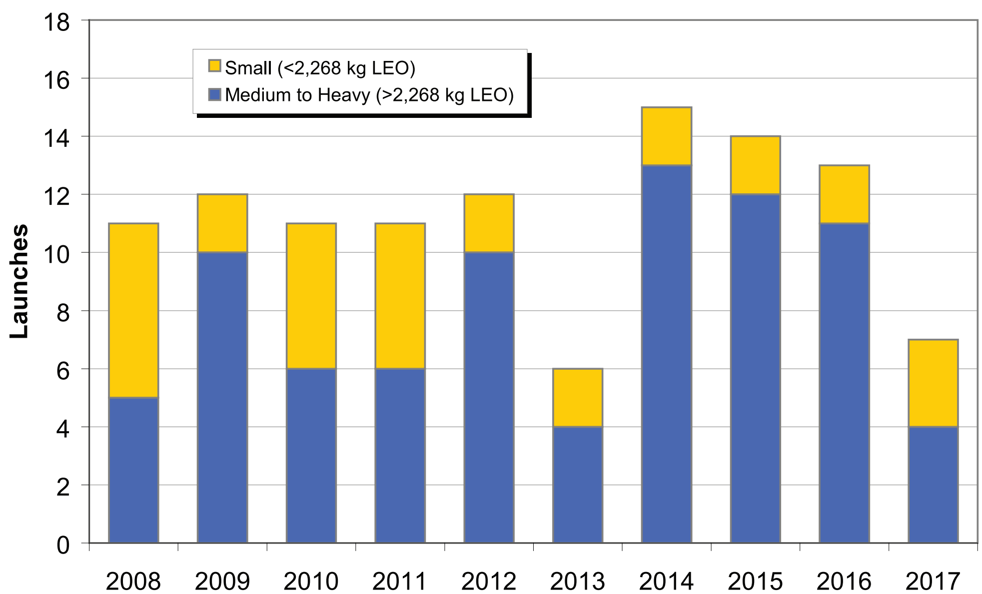


Table 19. Distribution of Launches Among Market Sectors

	Satellites	Launch Demand: Small	Launch Demand: Medium to Heavy	Launch Demand: Total
Telecommunications	148	4	20	24
International Science/Other	76	25	19	44
Commercial Remote Sensing	24	2	14	16
Orbital Facility Assembly and Services	28	0	28	28
Total	**276**	**31**	**81**	**112**

the increase solely in launches of medium-to-heavy vehicles. This increase is primarily attributable to higher demand in the Big LEO and OFAS market categories in 2008. The amount of small vehicles decreased by one launch between the 2007 and 2008 forecasts.

The forecast starts with a total of 24 satellites demanding 11 launches in 2008. Because of launch vehicle and satellite schedule delays, as described in the Methodology section, a realization factor was applied to the number of launches planned for 2008. Therefore, the FAA expects 8 to 10 launches to occur in 2008. The highest amount of forecasted launch demand falls in 2014 and 2015, with 15 and 14 launches, respectively. The forecast shows steady launch demand around 11 to 12 launches per year between 2008 and 2012, but then experiences an increase in demand and some overall demand fluctuation until the end of the forecast in 2017.

Though the telecommunications market, led by Big LEO systems, dominates the forecasted satellite market, the international science plus other and the OFAS market categories lead the forecasted launch market. As shown in Table 19, 44 of the 112 launches in the current forecast will carry international science and other payloads, while 28 will carry OFAS spacecraft. The international science and other launches are split between small and medium-to-heavy vehicles, with slightly more small vehicles forecasted. The OFAS market uses all medium-to-heavy vehicles. Twenty-four launches are forecasted for telecommunications, with all Big LEO missions using medium-to-heavy vehicles and all Little LEO missions using small vehicles. Sixteen launches are forecast to carry commercial remote sensing satellites, the majority of which will use medium-to-heavy vehicles.

Historical NGSO Market Assessments

The 2008 FAA/AST forecast of commercial NGSO launches and payloads for 2008–2017 shows new overall trends from recent forecasts. The 2004 through 2007 forecasts both began with the maximum number of forecasted launches in the first few years of the forecast period, generally decreasing to the end of the period. The 2008 forecast, though, begins with five years steadily near the ten-year average number of launches and then increases for the second half of the forecast. The second half of the forecast, 2013 through 2017, experiences both the maximum and minimum number of launch demand.

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, a decrease from 1999 to 2001, and now an increase from 2007 to 2008. Figure 14 provides a historical comparison of FAA/AST forecasts from 2002 to the present, with actual launches to date included. After the high rate of demand 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, while the change from the 2007 to the 2008 forecast shows a greater growth rate with 276 payloads projected to launch on 112 vehicles from 2008 to 2017. This represents an increase of 85 spacecraft from last year's forecast, the sixth consecutive year of increased payload projections. The 112 launches

Table 20. Historical Commercial NGSO Activity*

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
Satellites																
Big LEO	0	0	0	0	46	60	42	5	1	7	0	0	0	0	8	169
Little LEO	1	0	3	0	8	18	7	0	0	2	0	2	0	0	0	41
International Science/Other	1	0	0	2	1	4	5	11	1	6	1	7	8	4	14	65
Commercial Remote Sensing	0	0	1	0	2	0	2	2	2	0	8	0	0	1	3	21
Total Satellites	**2**	**0**	**4**	**2**	**57**	**82**	**56**	**18**	**4**	**15**	**9**	**9**	**8**	**5**	**25**	**296**
Launches																
Medium-to-Heavy Vehicles	0	0	0	1	8	9	11	6	2	2	1	1	0	2	10	53
Small Vehicles	1	0	2	1	5	10	7	3	2	2	3	1	3	3	2	45
Total Launches	**1**	**0**	**2**	**2**	**13**	**19**	**18**	**9**	**4**	**4**	**4**	**2**	**3**	**5**	**12**	**98**

* 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.

is a 31-launch increase from the 2007 forecast, which is the third year in a row that has seen an increased forecast of total launches. Figure 15 illustrates the launch 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.

Examining historical commercial NGSO satellite launch activity, the telecommunications market put large constellations of satellites into orbit within a few years, creating a short spurt of intense launch activity. This was the case in 1997 to 1999 when the three major systems, Globalstar, Iridium, and ORBCOMM, were launched. The 2008 forecast shows a slightly more spread-out schedule of launches as each of these systems is being replaced with new satellites. The future next-generation deployment schedules do not fully overlap as they did in the late 1990s.

The international science and commercial remote sensing satellite markets create steady and less-intense launch demand according to historical figures. Since 1996, there has always been at least one international science or other satellite launched, with a maximum amount of 11 satellites launched in one year (2000). The commercial remote sensing market has low launch demand that is more sporadic than international science and other; since 1993 there have been eight years with at least one satellite launched, while there have been seven years with none from this market. Next year, historical data for the OFAS market will begin to be tabulated.

Table 20 lists the number of payloads launched by market sector and total commercial launches that were internationally competed or commercially sponsored from 1993–2007. Small vehicles performed 45 launches during this period, while medium-to-heavy vehicles conducted 53 launches. In 2007, the historical number of launches between vehicle classes was equal, 43 launches for both small and medium-to-heavy vehicles. The 2008 forecast estimates that the larger vehicle class will continue to conduct the most launches.

Historical satellite and launch data from 1993–2007 are shown in Table 21. Secondary and piggyback payloads on launches with larger primary payloads were not included in the payload and launch tabulations.

Figure 14. Comparison of Past Baseline Launch Demand Forecasts

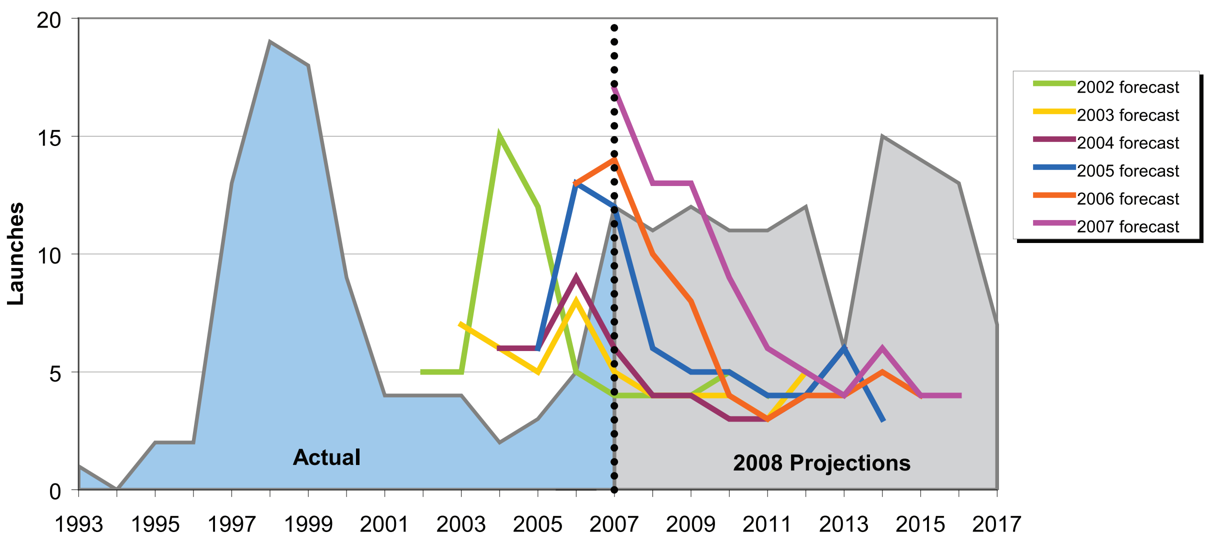


Figure 15. Average and Maximum Launches per Year from NGSO Forecasts 1998–2008

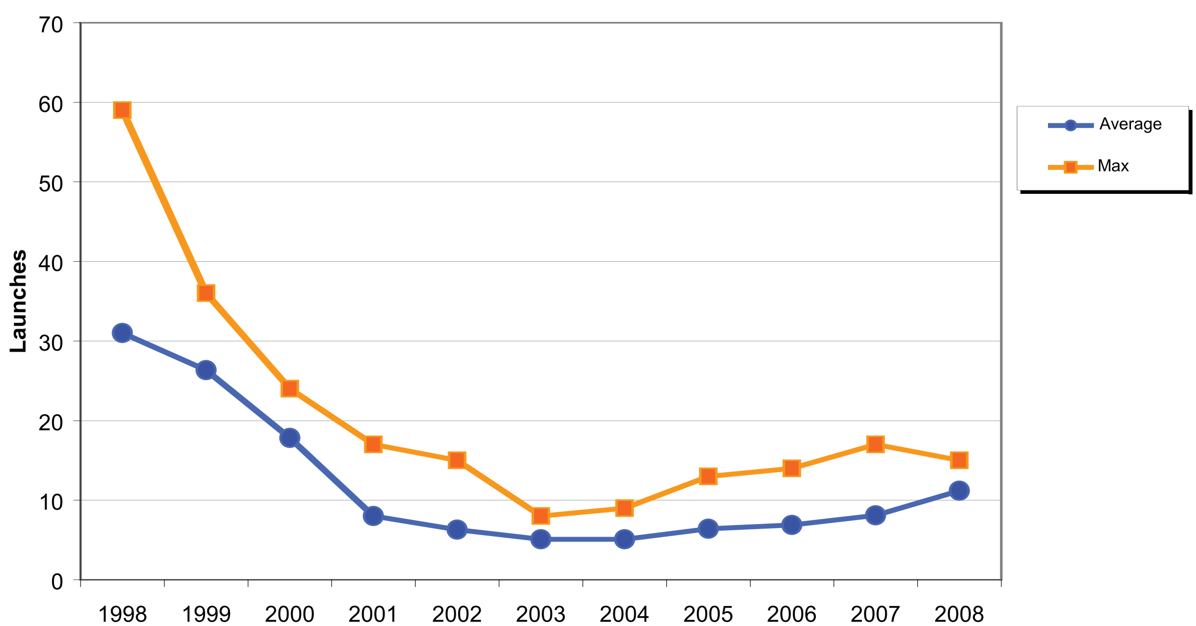


Table 21. Historical NGSO Satellite and Launch Activities (1993–2007)†

Summary	Market Segment	Date	Satellite	Launch Vehicle	
2007					
25 Satellites	**Big LEO**	5/30/07	Globalstar Replacement 1-4	Soyuz	Medium-to-Heavy
8 Big LEO Telecom		10/21/07	Globalstar Replacement 5-8	Soyuz	Medium-to-Heavy
3 Remote Sensing					
9 Int'l Science	**Remote Sensing**	6/15/07	TerraSAR-X	Dnepr	Medium-to-Heavy
5 Other		9/18/07	WorldView 1	Delta II	Medium-to-Heavy
		12/14/07	RADARSAT 2	Soyuz	Medium-to-Heavy
	International Science	4/17/07	Egyptsat	Dnepr	Medium-to-Heavy
			SaudiComsat 3-7		
			Saudisat 3		
		4/23/07	AGILE	PSLV	Medium-to-Heavy
			AAM		
	Other	6/7/07	Cosmo-Skymed 1	Delta II	Medium-to-Heavy
		6/28/07	Genesis II	Dnepr	Medium-to-Heavy
12 Launches		7/2/07	SAR Lupe 2	Cosmos 3M	Small
10 Medium-to-Heavy		11/1/07	SAR Lupe 3	Cosmos 3M	Small
2 Small		12/8/07	Cosmo-Skymed 2	Delta II	Medium-to-Heavy
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 Telecom					
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		

† 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 (1993–2007) [Continued]

Summary	Market Segment	Date	Satellite	Launch Vehicle	
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 II	Medium-to-Heavy
7 Big LEO Telecom		6/20/02	Iridium (2 sats)	Rockot	Small
2 Little LEO Telecom					
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		
2001					
4 Satellites	**Big LEO**	6/19/01	ICO F-2	Atlas 2AS	Medium-to-Heavy
1 Big LEO Telecom					
2 Remote Sensing	**Remote Sensing**	9/21/01	OrbView 4	Taurus[F]	Small
1 Int'l. Science		10/18/01	QuickBird 2	Delta II	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 II	Medium-to-Heavy
5 Big LEO Telecom		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

Table 21. Historical NGSO Satellite and Launch Activities (1993–2007) [Continued]

Summary	Market Segment	Date	Satellite	Launch Vehicle	
1999					
56 Satellites	**Big LEO**	2/9/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
42 Big LEO Telecom		3/15/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
7 Little LEO Telecom		4/15/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
2 Remote Sensing		6/10/99	Globalstar (4 sats)	Delta II	Medium-to-Heavy
5 Int'l. Science		6/11/99	Iridium (2 sats)	LM-2C	Small
		7/10/99	Globalstar (4 sats)	Delta II	Medium-to-Heavy
		7/25/99	Globalstar (4 sats)	Delta II	Medium-to-Heavy
		8/17/99	Globalstar (4 sats)	Delta II	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
1998					
82 Satellites	**Broadband LEO**	2/25/98	Teledesic T1 (BATSAT)	Pegasus	Small
1 Broadband LEO					
60 Big LEO Telecom	**Big LEO**	2/14/98	Globalstar (4 sats)	Delta II	Medium-to-Heavy
18 Little LEO Telecom		2/18/98	Iridium (5 sats)	Delta II	Medium-to-Heavy
3 Int'l. Science		3/25/98	Iridium (2 sats)	LM-2C	Small
		3/29/98	Iridium (5 sats)	Delta II	Medium-to-Heavy
		4/7/98	Iridium (7 sats)	Proton	Medium-to-Heavy
		4/24/98	Globalstar (4 sats)	Delta II	Medium-to-Heavy
		5/2/98	Iridium (2 sats)	LM-2C	Small
		5/17/98	Iridium (5 sats)	Delta II	Medium-to-Heavy
		8/20/98	Iridium (2 sats)	LM-2C	Small
		9/8/98	Iridium (5 sats)	Delta II	Medium-to-Heavy
		9/10/98	Globalstar (12 sats)	Zenit 2[F]	Medium-to-Heavy
		11/6/98	Iridium (5 sats)	Delta II	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 II	Medium-to-Heavy
46 Big LEO Telecom		6/18/97	Iridium (7 sats)	Proton	Medium-to-Heavy
8 Little LEO Telecom		7/9/97	Iridium (5 sats)	Delta II	Medium-to-Heavy
2 Remote Sensing		8/20/97	Iridium (5 sats)	Delta II	Medium-to-Heavy
1 Int'l. Science		9/14/97	Iridium (7 sats)	Proton	Medium-to-Heavy
		9/26/97	Iridium (5 sats)	Delta II	Medium-to-Heavy
		11/8/97	Iridium (5 sats)	Delta II	Medium-to-Heavy
		12/8/97	Iridium (2 sats)	LM-2C	Small
		12/20/97	Iridium (5 sats)	Delta II	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

Table 21. Historical NGSO Satellite and Launch Activities (1993–2007) [Continued]

Summary	Market Segment	Date	Satellite	Launch Vehicle	
1996					
2 Satellites *2 Int'l. Science* ***2 Launches*** *1 Medium-to-Heavy* *1 Small*	**International Science**	4/30/96 11/4/96	SAX SAC B	Atlas 1 Pegasus	Medium-to-Heavy Small
1995					
4 Satellites *3 Little LEO Telecom* *1 Remote Sensing* ***2 Launches*** *2 Small*	**Little LEO** **International Science**	4/3/95 8/15/95 4/3/95	ORBCOMM (2 sats) GEMStar 1 OrbView 1 (Microlab)	Pegasus Athena 1[F] Pegasus	Small Small Small
1994					
0 Satellites ***0 Launches***					
1993					
2 Satellites *1 Little LEO Telecom* *1 Int'l. Science* ***1 Launch*** *1 Small*	**Little LEO** **International Science**	2/9/93 2/9/93	CDS 1 SCD 1	Pegasus Pegasus	Small Small