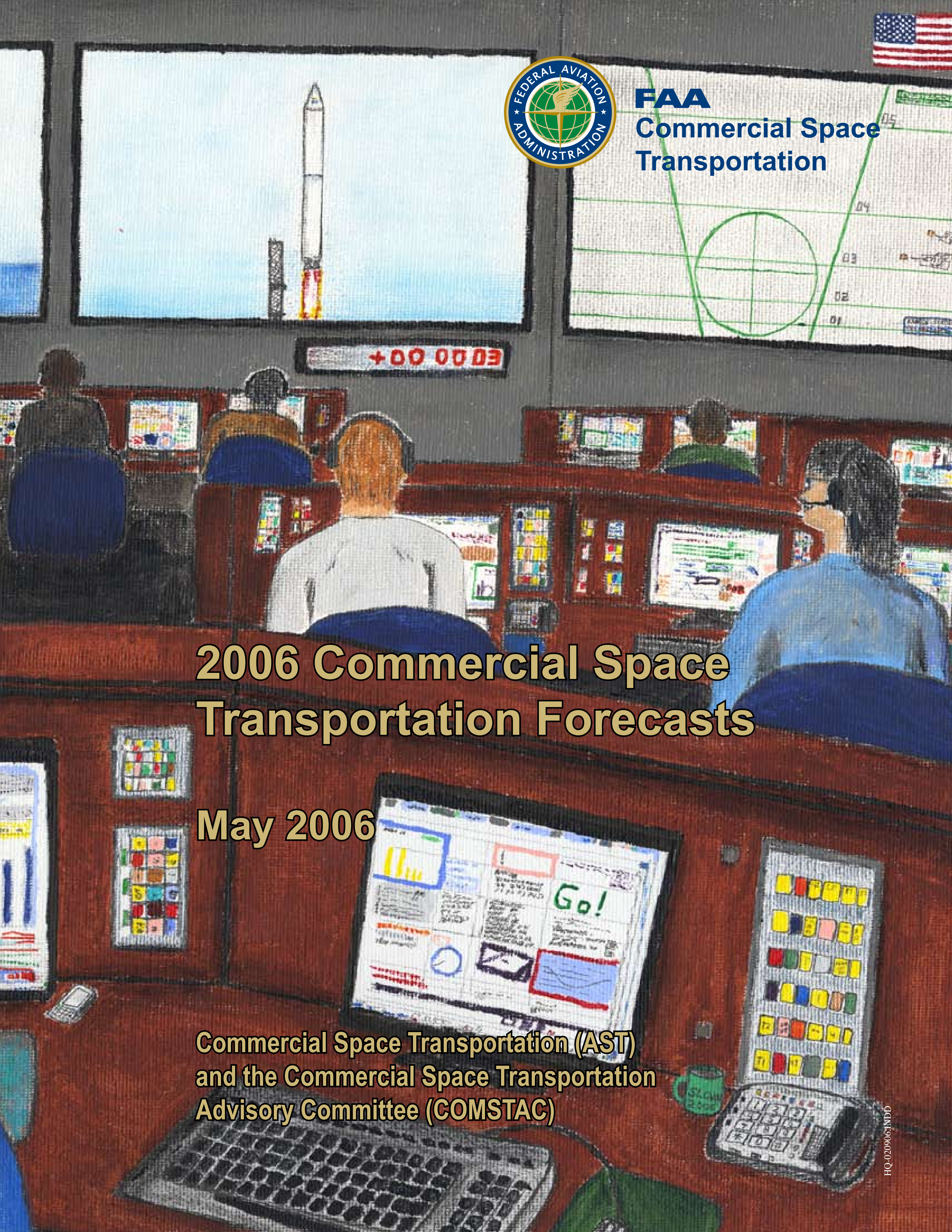


FAA
Commercial Space Transportation

2006 Commercial Space Transportation Forecasts

May 2006

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

HQ-020906INDD

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.

Cover: Art by John Sloan (2006)

Table of Contents

List of Figures

List of Tables

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 2006 to 2015.

The *2006 Commercial Space Transportation Forecasts* report includes:

- The *COMSTAC 2006 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; and

- The *FAA's 2006 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 Earth.

Together, the COMSTAC and FAA forecasts project an average annual demand of 23.6 commercial orbital space launches worldwide from 2006 to 2015. The combined forecast is similar to last year's forecast of 22.8 launches per year as well as the 23.4 annual launches in the 2004 forecast. Eighteen commercial launches occurred worldwide in 2005, a 20 percent increase over 2004. Demand will continue to increase to 34 launches in 2007 before returning to lower levels.

In the GSO market, satellite demand averages 20.8 satellites per year, a slight increase from 20.5 satellites in the 2005 forecast. The resulting demand for launches per year remains virtually unchanged, from an average of 16.4 launches per year in the 2005 forecast to 16.7 per year in the current forecast. The forecast also projects continued growth in average satellite mass and average number of transponders per satellite, with a record mass (nearly 100,000 kilograms) of total satellites forecast for launch in 2006.

The NGSO market includes 160 satellites forecast for launch from 2006–2015, the third significant annual increase in the total number of NGSO satellites since the 1998 forecast. Although the total number of satellites has increased 11 percent, the total number of launches increased only eight percent, reflecting the continued trend of multimanifesting several satellites on a single launch. Demand for medium-to-heavy NGSO launches increased by an average of over one launch per year compared to the 2005 forecast, indicating increased use of these vehicles for international science and other payloads. While demand is high in 2006–2007, several satellite systems are relatively new to the market and could be subject to schedule delay.

COMSTAC and FAA project an average annual demand for:

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

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

- 3.3 launches of small vehicles to NGSO.

Introduction

Each year, the Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) and the Commercial Space Transportation Advisory Committee (COMSTAC) prepare forecasts of international demand for commercial space launch services. The jointly-published *2006 Commercial Space Transportation Forecasts* report covers the period from 2006 to 2015 and includes COMSTAC's launch demand assessment for geosynchronous orbit and the FAA's launch demand assessment for non-geosynchronous orbits.

Characteristics of the Commercial Space Transportation Market

Since the origins of the commercial launch industry in the 1980s, commercial launch activity has fluctuated based on demand from various customers. During the peak of commercial launch activity, from 1997 through 2001, commercial launches accounted for 42 percent of all worldwide launch activity. That share has decreased in recent years, though, due to changes in the market: 33 percent of the worldwide launches in 2005—18 of 55—were commercial.

Demand for commercial launch services, a competitive international business, is directly impacted by activity in the global satellite market ranging from customer demand and introduction of new applications to satellite lifespan and regional economic conditions. The GSO market continues to be defined by commercial telecommunications services with most satellites weighing over 2,200 kilograms. The NGSO market, however, is mostly comprised of satellites weighing less than 1,200 kilograms performing a variety of missions for commercial and government customers including science, commercial remote sensing, technology demonstrations, and telecommunications.

About the COMSTAC 2006 Commercial Geosynchronous Launch Demand Forecast

First compiled in 1993, the COMSTAC geosynchronous launch demand model is prepared using plans and projections supplied by U.S. and international commercial satellite and launch companies. Projected payload and launch demand is limited to those spacecraft and launches that are open to internationally-competed launch 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. COMSTAC is comprised of representatives from the U.S. launch and satellite industry.

About the FAA NGSO Commercial Space Transportation Forecast

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

2006 Combined Satellite and Launch Forecast

This year's COMSTAC GSO and FAA NGSO combined forecast contains 368 international satellites expected to seek commercial launch services between 2006 and 2015, as shown in Table 1 and Figures

1, 2, and 3. The amount is more than last year's forecast of 349 satellites during the period 2005–2014 primarily because of more satellites in the NGSO market.

After calculating the number of satellites that could be launched two or more at a time on a single launch vehicle, a total launch demand of 236 commercial launches to GSO and NGSO destinations is forecast through 2015, as shown in Table 1 and Figure 3. This translates to an average demand of 23.6 worldwide launches per year, a slight increase over the 2005 forecast of 22.8 launches per year.

The GSO launch market contains nearly 100 more launches over the next ten years than the NGSO market. The number of satellites in the GSO market is significantly greater than NGSO for the sixth year in a row. There are 208 GSO satellites in the ten-year forecast, compared with 160 in NGSO.

The GSO forecast contains an average of 20.8 satellites per year with a high of 24 and a low of 17. The average is slightly more than the 20.5 satellites in the 2005 forecast. Demand for up to 23 GSO satellites to launch is projected during 2006 (including some delayed from 2005). An applied realization factor of between 13 and 20 satellites during 2006 is also projected. Sixteen GSO satellites actually launched during 2005.

The report discusses a trend towards increased mass of GSO satellites as well as an increase in the average number of transponders per satellite. A record mass of nearly 100,000 kilograms of GSO satellites is forecast for launch in 2006.

In the NGSO market, satellite demand is up 11 percent to 160 satellites or 16.0 satellites per year compared to the 2005 forecast of 144 satellites or 14.4 satellites per year. The increase is spread across the telecommunications, commercial remote sensing, and international science and technology demonstration missions.

Some individual NGSO launches contain multiple satellites. The demand for NGSO launches increased by eight percent to 69 worldwide launches during the next ten years in comparison to last year's forecast of 64 launches from 2005–2014. Ten or more launches are forecast per year from 2006 through 2008. The 2006 forecast shows more demand for medium-to-heavy vehicles (an average of 3.6 launches per year) than small launches (3.3 launches per year), reflecting the increased use of larger vehicles for international science and remote sensing satellites. Figure 4 shows historical forecasts from 1998 to 2005.

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.

Table 1. Commercial Space Transportation Satellite and Launch Forecasts

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Average
Satellites												
GSO Forecast (COMSTAC)	23	24	17	18	19	20	22	22	23	20	208	20.8
NGSO Forecast (FAA)	27	29	25	23	9	8	9	11	10	9	160	16.0
Total Satellites	**50**	**53**	**42**	**41**	**28**	**28**	**31**	**33**	**33**	**29**	**368**	**36.8**
Launch Demand												
GSO Medium-to-Heavy	18	20	13	14	15	16	18	18	19	16	167	16.7
NGSO Medium-to-Heavy	8	8	5	3	2	1	2	2	3	2	36	3.6
NGSO Small	5	6	5	5	2	2	2	2	2	2	33	3.3
Total Launches	**31**	**34**	**23**	**22**	**19**	**19**	**22**	**22**	**24**	**20**	**236**	**23.6**

Figure 1. GSO Satellite and Launch Demand

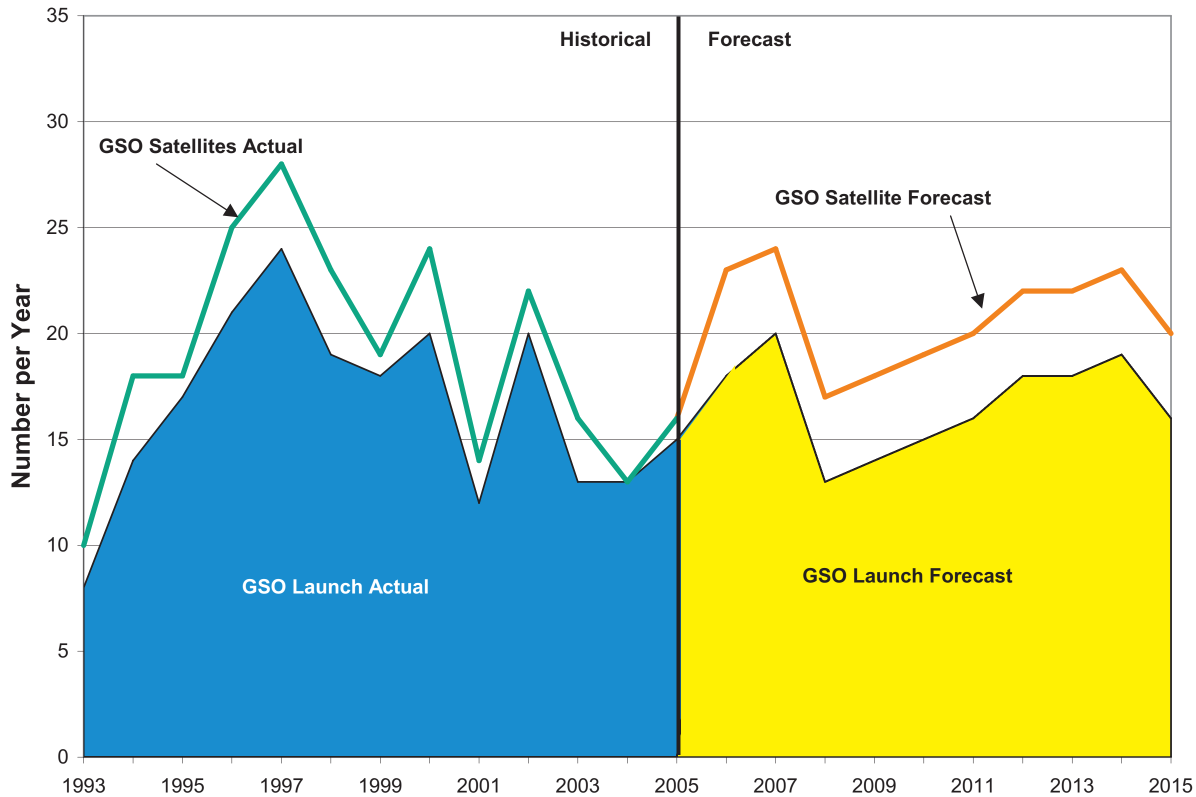


Figure 2. NGSO Satellite and Launch Demand

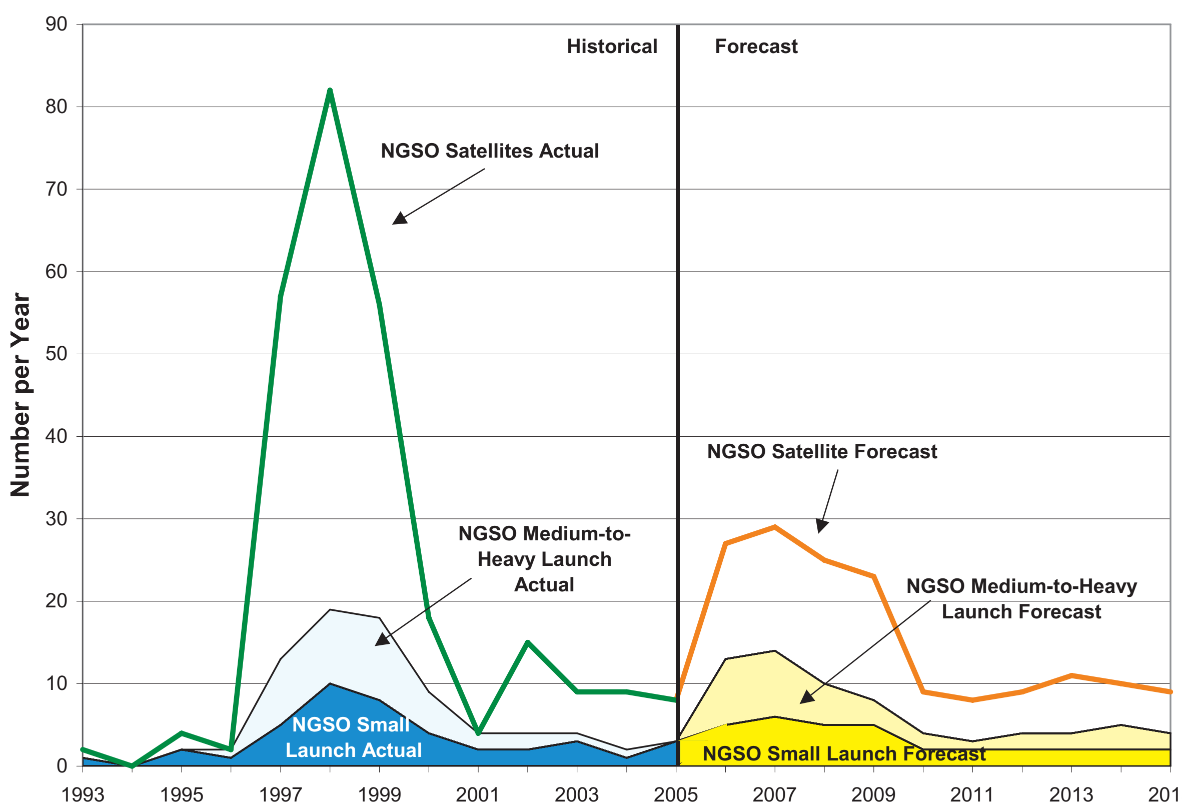


Figure 3. Combined GSO and NGSO Launch Forecasts

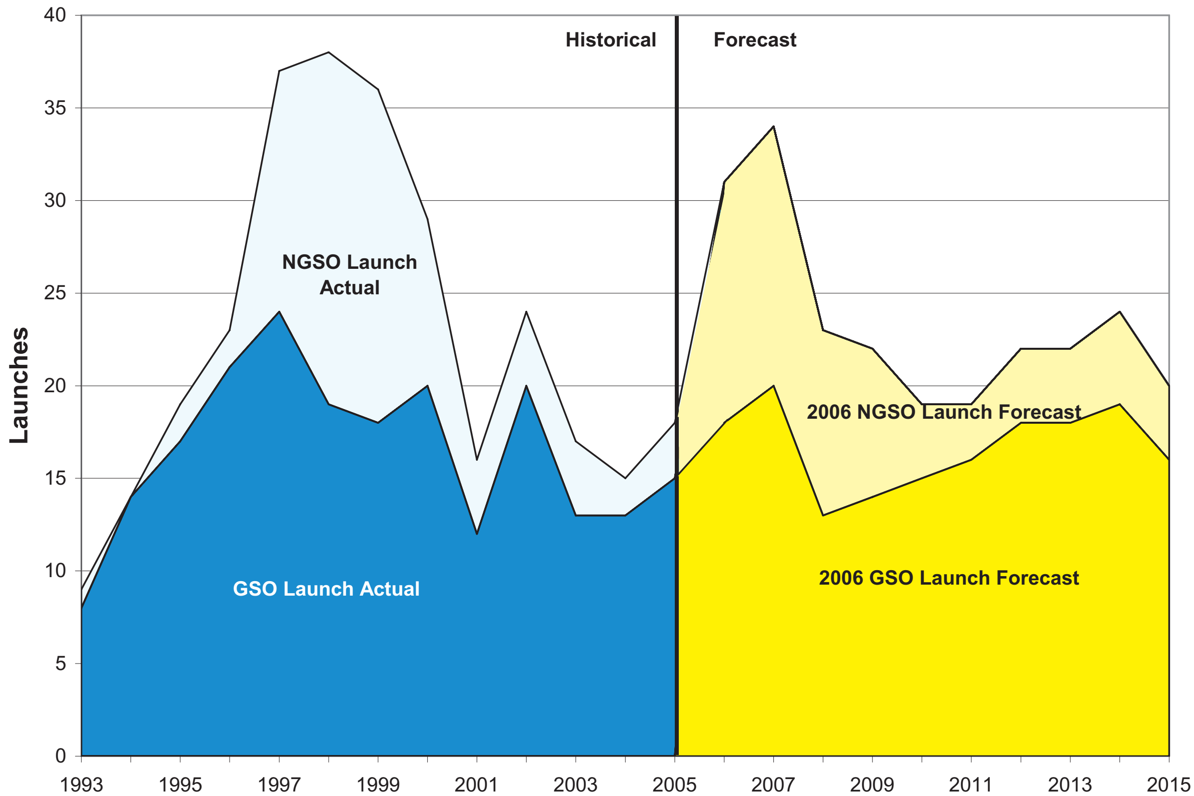
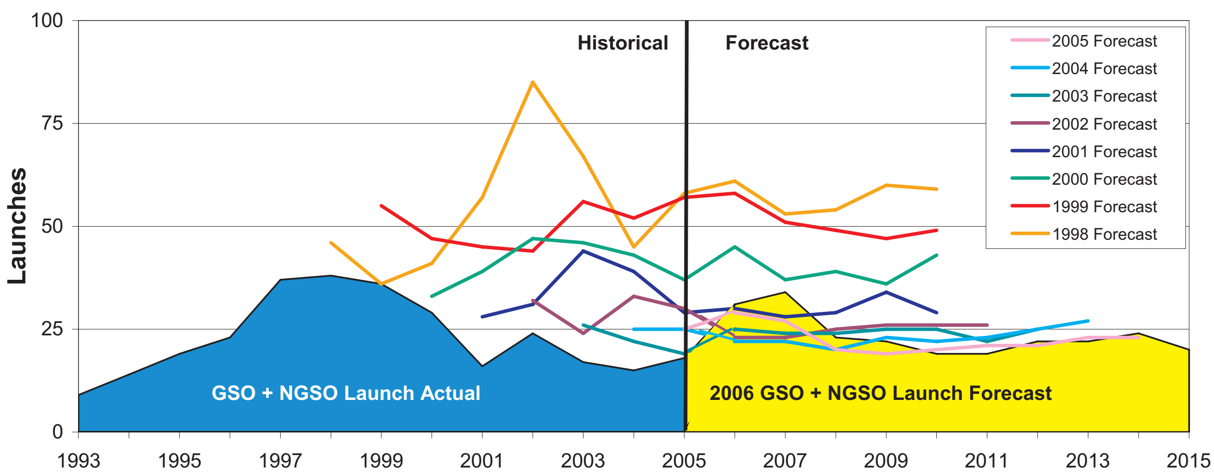


Figure 4. Historical Commercial Space Transportation Forecasts



COMSTAC 2006 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 *2006 Commercial Geosynchronous Orbit (GSO) Launch Demand Forecast* is the fourteenth annual forecast of the global demand for commercial GSO satellites and launches addressable to the U.S. commercial space launch industry. It is intended to assist FAA/AST in its efforts to foster a healthy commercial space launch capability in the United States.

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

The 2006 Commercial GSO Launch Demand Forecast for 2006 through 2015 is shown in Figure 5. Table 2 provides the corresponding values of forecasted satellites to be launched, the estimated number of dual-manifested launches, and the resulting number of projected launches for each year.

The 2006 forecast predicts an average demand for 20.8 satellites to be launched annually in the ten-year time frame from 2006 through 2015. An average demand of 16.7 launches per year is forecast over the same time frame. This year's average satellite launch demand of 20.8 per year is effectively the same as the previous two COMSTAC GSO forecasts (20.5 satellite launches per year were forecast in 2005 and 21.1 satellite launches per year were forecast in 2004). The near-term forecast, which is based on specific existing and anticipated satellite programs for 2006 through 2008, shows demand for 23 satellites to be launched in 2006, 24 in 2007, and 17 in 2008.

It is important to distinguish between forecasted demand and the actual number of satellites expected to be launched. Satellite projects, like many high-technology projects, are susceptible to delays, which tend to make the forecasted demand an upper limit of the number of satellites that might actually be launched. A "launch realization factor" has been devised based on historical data of actual satellites launched versus predicted satellite demand from previous commercial GSO forecasts. This factor has been applied to the near-term forecast in order to provide an idea of the actual number of satellites that may reasonably be expected to be launched. For example, while the demand forecast for satellites to be launched in 2006 is 23, the realization factor discounts this to a range of between 13 and 20.

Over the fourteen 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 2005, 16 commercial GSO satellites were launched, an increase of three from the 13 commercial satellites launched in 2004. Last year's forecast had projected a demand of 22 satellites to be launched in 2005, with a launch realization range of 13 to 19. Of the 16 satellites launched in 2005, 15 were correctly anticipated and one forecast for 2006 (AMC-23) launched early. The remaining seven satellites not launched in 2005 are expected to launch in 2006 and are included in this year's near-term satellite demand forecast.

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

An alternative view of satellite launch statistics is included in an assessment of the number of transponders launched and the mass of satellites launched over time. This data shows a growth trend in both average satellite mass and average number of transponders per satellite. Based on the forecasted satellite launch demand for 2006, a record mass (nearly 100,000 kg) of total satellites to be launched in 2006 is predicted.

Background

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

Figure 5. COMSTAC Commercial GSO Launch Demand Forecast

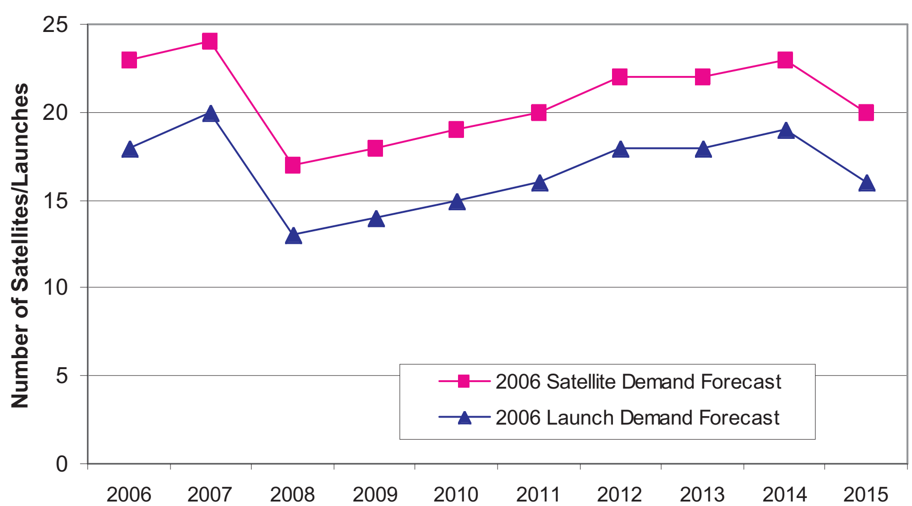


Table 2. Commercial GSO Launch Demand Forecast Data

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Average 2006 to 2015
Satellite Demand	23	24	17	18	19	20	22	22	23	20	208	20.8
Dual Launch Forecast	5	4	4	4	4	4	4	4	4	4	41	4.1
Launch Demand	18	20	13	14	15	16	18	18	19	16	167	16.7

obtain the commercial space launch industry's view of future space launch requirements.

COMSTAC prepared the first commercial demand forecast in April 1993 as part of a report on commercial space launch systems requirements. It was developed by the major U.S. launch service providers and covered the period 1992–2010. The following year, the major U.S. satellite manufacturers and the satellite service providers began to contribute to the demand forecast. In 1995, the Technology and Innovation Working Group (the Working Group) was formally chartered by the FAA/AST to prepare the annual Commercial Payload Mission Model Update. Since 2001, the Commercial Launch Demand Forecast has covered a ten-year rolling forecast, with this year's report covering 2006 through 2015. This year the committee received 26 inputs from satellite service providers, satellite manufacturers, and launch service providers. COMSTAC would like to thank all of the participants in the 2006 Commercial GSO Launch Demand Forecast.

Forecast Methodology

Except for minor adjustments, the Working Group's launch demand forecast methodology has remained consistent throughout the history of the forecast. In brief, the Working Group, via the FAA Associate Administrator for Commercial Space Transportation, requests commercial GSO satellite forecasts from global satellite operators, satellite manufacturers, and launch service providers. Individual input is requested from satellite operators for a projection of their individual company requirements for the period 2006–2015; comprehensive input is requested of satellite manufacturers and launch service providers for the industry forecast of annual addressable commercial GSO satellite demand for the period 2006–2015.

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 2005, three commercial satellite launches (Express AM2 (Russia), Express AM3 (Russia), and Apstar 6 (China)) were excluded from the actual number of addressable commercial launches listed in this report because they were not internationally competed.

The commercial GSO satellite demand forecast is divided into four different mass classes based on the mass of the satellite at separation into geosynchronous transfer orbit (GTO). The mass categories are logical divisions based on standard satellite models offered by satellite manufacturers. The four classifications are: below 2,200 kilograms (<4,850 pounds); 2,200 to 4,200 kilograms (4,850 to 9,260 pounds); 4,200 to 5,400 kilograms (9,260 to 11,905 pounds); and above 5,400 kilograms (>11,905 pounds). A list of current satellite models associated with each mass category is shown in Table 3.

This year, the following 26 organizations (noted with the country in which their headquarters are located) responded with data used in the development of the 2006 report:

Table 3. Satellite Mass Classes

GTO Launch Mass Requirement	Satellite Bus Models
Below 2,200 kg (<4,850 lbm)	LM A2100A, Orbital Star 2
2,200 - 4,200 kg (4,850 - 9,260 lbm)	LM A2100, Boeing 601/601HP, Loral 1300, Astrium ES2000+, Alcatel SB 3000A/B/B2, Orbital Star 2
4,200 - 5,400 kg (9,260 - 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

- AirLaunch* (U.S.)
- Alcatel Alenia Space (France)
- Arianespace (France)
- Asia Satellite Telecommunications, Ltd. (China-Hong Kong)
- The Boeing Company* (U.S.)
- Broadcasting Satellite System Corp. (Japan)
- GD/Spectrum Astro (U.S.)
- Intelsat (U.S.)
- JSAT Corporation (Japan)
- Lockheed Martin Space Systems Co.* (U.S.)
- MEASAT (Malaysia)
- Mitsubishi Heavy Industries (Japan)
- Mobile Broadcasting Corp. (Japan)
- Mobile Satellite Ventures (U.S.)
- New Skies Satellites (Netherlands)
- Orbital Sciences Corp.* (U.S.)
- Protostar (U.S.)
- Sea Launch* (U.S.)
- SES Astra (Luxembourg)
- Sirius Satellite Radio (U.S.)
- Space Communications Corporation (Japan)
- Space Systems/Loral* (U.S.)
- Spacecom (Israel)
- Telesat Canada (Canada)
- Thuraya Telecommunications (U.A.E.)
- XM Satellite Radio (U.S.)

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

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

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

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

The combined comprehensive input from U.S. respondents was used for the long-term demand forecast 2009–2015. The near-term forecast, covering the first three years (2006–2008) of the ten-year forecast, was developed by the Working Group in conjunction with individual satellite operators' inputs. It is a compilation of launch vehicle providers' and satellite manufacturers' manifests, as well as an assessment of potential satellite systems to be launched.

In order to determine the demand for commercial GSO launches, the satellite demand forecast was adjusted by the projected number of dual-manifested launches per year (i.e., launch of two satellites at once). Based on the future plans and capability of Arianespace's Ariane 5, it is estimated that four 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.

2006 COMSTAC Commercial GSO Launch Demand Forecast Results

Near-Term Demand Model

The three-year near-term demand forecast is based on input from each U.S. satellite manufacturer and launch service provider, along with the inputs received from individual satellite operators. Development of the near-term forecast in this way results in a projection of the maximum identifiable demand for satellites to be launched each year. Identified demand for any particular year is defined as the number of satellites that customers wish to have launched, with no adjustment for potential launch schedule delays. Table 4 shows the near-term mission model for 2006 through 2008.

Table 4. Commercial GSO Near-term Manifest

	2006	2007	2008
Total	**23**	**24**	**17**
Below 2,200kg (<4,850 lbm)	**0**	**3**	**2**
		Amos 3: Land Launch BSAT-3A: Ariane 5 Thor 2R: Proton	KARI COMS: TBD Vinasat: TBD
2,2200 - 4,200 kg (4,850 - 9,260 lbm)	**7**	**8**	**6**
	Arabsat 4A*: Proton Arabsat 4B: Proton Hot Bird 7A: Ariane 5 Insat 4B: Ariane 5 Optus D1: Ariane 5 Spainsat*: Ariane 5 Thaicom 5: Ariane 5	AMC-18: Ariane 5 Galaxy 17: Ariane 5 Horizons 2: Land Launch Measat 1R: Land Launch Optus D2: Ariane 5 PAS 11: Land Launch StarOne C1: Ariane 5 StarOne C2: Ariane 5	AMC 21: TBD AsiaSat-5: Land Launch Eutelsat W2M: TBD Hot Bird 9: TBD Telstar 11N: TBD Turksat 3A: TBD
4,200 - 5,400 kg (9,260 - 11,905 lbm)	**14**	**6**	**6**
	AMC 14: Proton Anik F3: Proton Astra 1KR*: Atlas V DirecTV 9S: Ariane 5 Echostar X*: Sea Launch Galaxy 16: Sea Launch Hot Bird 8: Proton JCSat 9*: Sea Launch JCSat 10: Ariane 5 Koreasat 5: Sea Launch Measat 3*: Proton Skynet 5A: Ariane 5 Wildblue 1: Ariane 5 XM-4: Sea Launch	Astra 1L: Ariane 5 Galaxy 18: Sea Launch Intelsat Americas 9: Sea Launch Sirius-4 (NSAB): Proton Skynet 5B: Ariane 5 Thuraya D3: Sea Launch	Astra-1M: TBD Nimiq-4: Proton Quetzsat-1: TBD Sirius FM 5: Proton Skynet 5C: TBD Superbird 7: Ariane 5
Over 5,400kg (>11,905 lbm)	**2**	**7**	**3**
	NSS 8*: Sea Launch Satmex 6: Ariane 5	DirecTV 10: Sea Launch DirecTV 11: Proton Echostar 11: Sea Launch ICO-GEO 1: Atlas V Inmarsat 4F3: Atlas V Spaceway 3: Sea Launch TerreStar-1: TBD	Ciel 2: TBD Echostar XIII: TBD XM-5: TBD

* Indicates slip from COMSTAC 2005 GSO Forecast

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 2005, followed by the distribution projected in this year's demand forecast.

This year's forecast distribution between mass classes is similar to last year's forecast. The forecast calls for a continued average of 60% of satellites to be launched being in the two largest mass class categories (satellites with mass greater than 4,200 kg). The trend toward larger satellites has been demonstrated in the actual satellites launched over the last two years. In 2004, 62% of satellites launched had a mass of greater than 4,200 kg, three of which were greater than 5,400 kg. In 2005, 63% of satellites launched had a mass greater than 4,200 kg, with six satellites having a mass greater than 5,400 kg.

One item of note from this year's results shows a continuation of a trend noted in last year's report. The forecast shows a slight decline in the number of satellites in the less than 2,200 kg mass category (2.2 per year compared to 2.7 per year in last year's forecast). The decrease in the number of small satellites is proportional to an increase in the number of the largest satellites (4.4 per year compared to 3.9 per year in last year's forecast). The decline in the small mass category is most likely due to the changes in satellite manufacturers' product lines. Orbital Science's Star bus has incorporated design changes that bring

Figure 6. Trends in GSO Satellite Mass Distribution

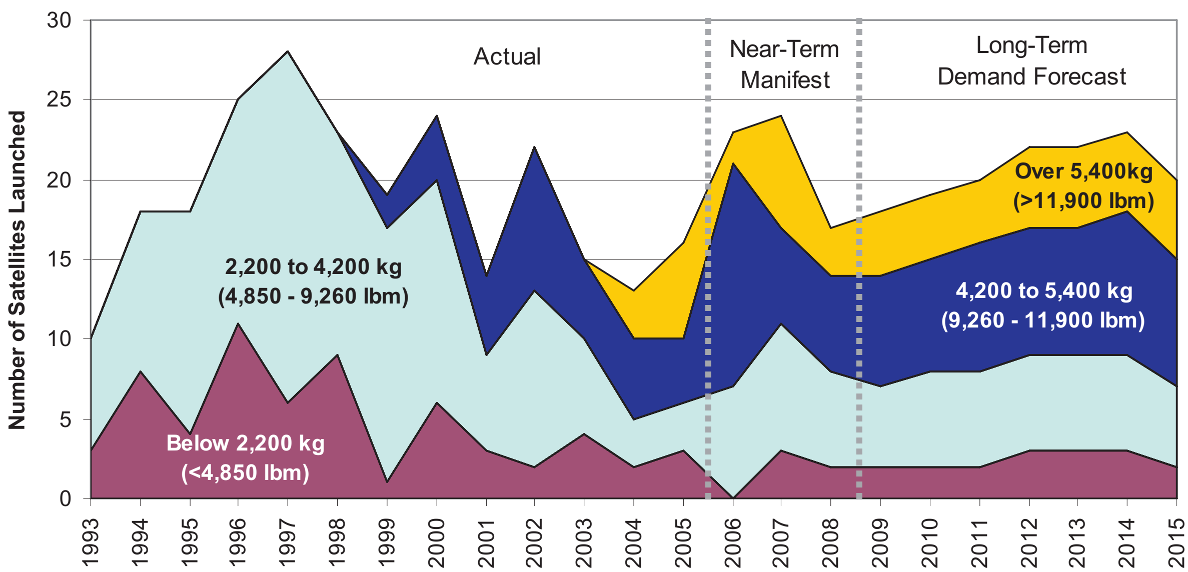
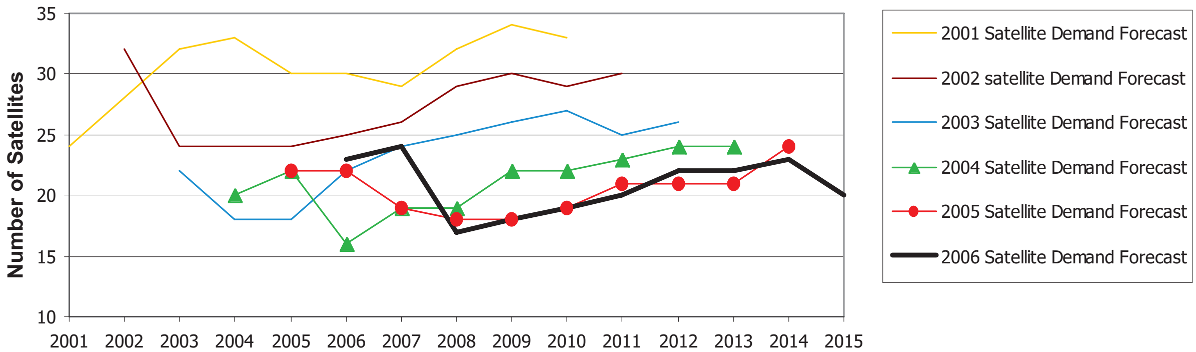


Table 5: Trends in GSO Satellite Mass Distribution

	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Total 2006 to 2015	Avg 2006 to 2015	% of Total
Below 2,200 kg (<4,850 lbm)	3	8	4	11	6	9	1	6	3	2	4	2	3	0	3	2	2	2	2	3	3	3	2	22	2.2	11%
2,200 to 4,200 kg (4,850 - 9,260 lbm)	7	10	14	14	22	14	16	14	6	11	6	3	3	7	8	6	5	6	6	6	6	6	5	61	6.1	29%
4,200 to 5,400 kg (9,260 - 11,900 lbm)	0	0	0	0	0	0	2	4	5	9	5	5	4	14	6	6	7	7	8	8	8	9	8	81	8.1	39%
Over 5,400 kg (>11,900 lbm)	0	0	0	0	0	0	0	0	0	0	0	3	6	2	7	3	4	4	4	5	5	5	5	44	4.4	21%
Total	**10**	**18**	**18**	**25**	**28**	**23**	**19**	**24**	**14**	**22**	**15**	**13**	**16**	**23**	**24**	**17**	**18**	**19**	**20**	**22**	**22**	**23**	**20**	**208**	**20.8**	**100%**

Figure 7. 2001 Through 2005 Versus 2006 Commercial GSO Satellite Demand Forecast



its mass close to the 2,500-kg range, just over the small mass class cutoff of 2,200 kg. Boeing no longer offers the small 376 bus model, and is concentrating on its large 702 model.

Comparison with Previous COMSTAC Demand Forecasts

The 2006 forecast for commercial GSO satellites launched is compared to the 2001 through 2005 forecasts in Figure 7. The ten-year demand forecast had been dropping by 10–15% annually from 2001 to 2004. Since 2004, the ten-year forecast has remained fairly consistent, thus establishing the floor of the demand forecast. Comparing this year's forecast to the previous two years' forecasts, the "traveling bow wave" is evident. This "bow wave" effect occurs due to the difference between demand and realized launches, where the demand is typically greater than the actual number of launches due to launch delays. All three forecasts predicted a low point in the third year of the near-term manifest, when satellites are being planned, but have not been named publicly. Similar to last year's forecast, a demand recovery to greater than 20 satellite launches per year is forecast for the beginning of the next decade.

Comparison to International Comprehensive Inputs

This year, the Working Group received comprehensive inputs from two major international launch service providers (Arianespace and Mitsubishi Heavy Industries) and one major international satellite manufacturer (Alcatel Alenia Space). The combined average of these international inputs is effectively the same as the combined 2006 demand forecast based on U.S. satellite and launch vehicle manufacturer inputs. The international input average annual demand for 2006 through 2015 is 20.4 satellites per year; the U.S.-based average annual demand forecast is 20.8 satellites per year. However, the distribution between mass classes is quite different between U.S. and international respondents. As shown in the 2006 forecast, 60% of the total ten-year U.S.-based commercial GSO satellite demand is comprised of the two largest mass categories, while the international respondents predicted that less than 50% of the total demand would be in the two largest mass categories.

Launch Vehicle Demand

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

Given the history of dual-manifest realization and the unlikely expectation that new dual-manifest capabilities will emerge during the forecast period, the Working Group has based its projection of dual-manifest launches on Arianespace's projected manifest. Arianespace has indicated a launch expectation of approximately six Ariane 5 vehicles per year, with most, if not all, commercial missions expected to be dual-manifested. Based on Arianespace's launch history, we project that of the six missions, one 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 four dual-manifested missions can be expected each year for the 2009–2015 forecast period. The 2006–2008 near-term forecast includes dual-manifest launches consistent with the best current understanding of the mission set.

Figure 8 presents the 2006 satellite and launch demand forecast as well as actual values for 1993 through 2005.

COMSTAC Demand Projection vs. Actual Launches Realized

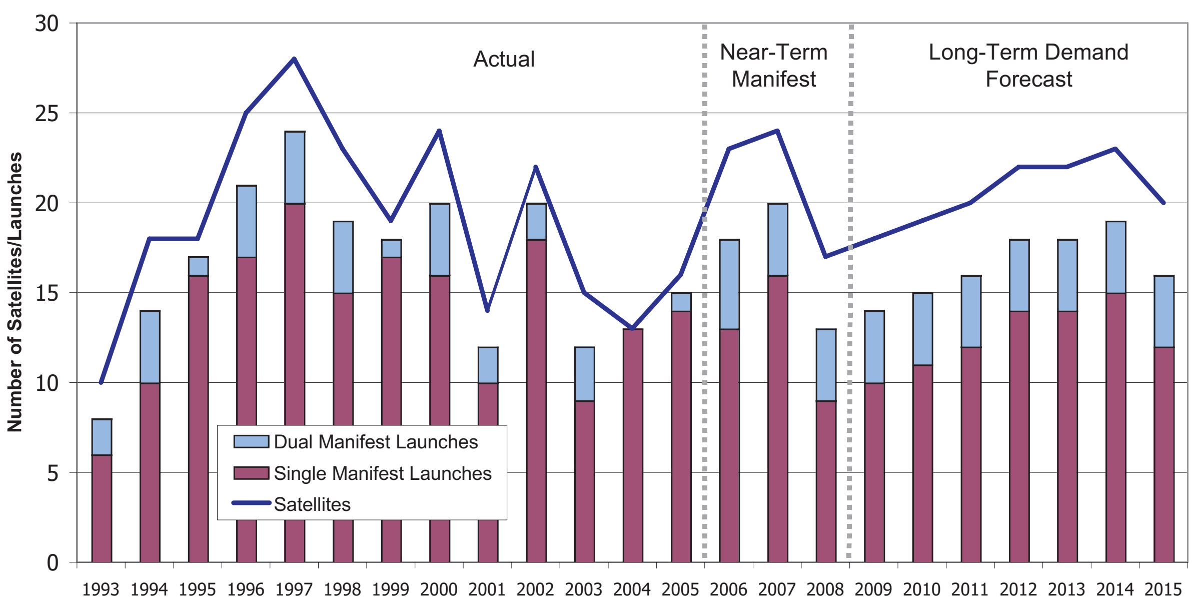
Factors That Affect Satellite Launch Realization

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

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

- **Satellite issues**. Satellite manufacturers may have factory, supplier, or component issues that can delay the delivery of a spacecraft to the launch site or halt a launch of the vehicle that is already on the pad. Increased satellite complexity increases the likelihood of a delay due to technical challenges or immature planning.
- **Launch vehicle issues**. Launch vehicle manufacturers may have factory, supplier, or component issues that can delay the availability of the launch vehicle or cause a delay at the launch pad. A launch failure or component problem can cause a stand-down to all subsequent launches until the proper anomaly resolution has been identified.

Figure 8. 2006 COMSTAC GSO Satellite and Launch Demand Forecast



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

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

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

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

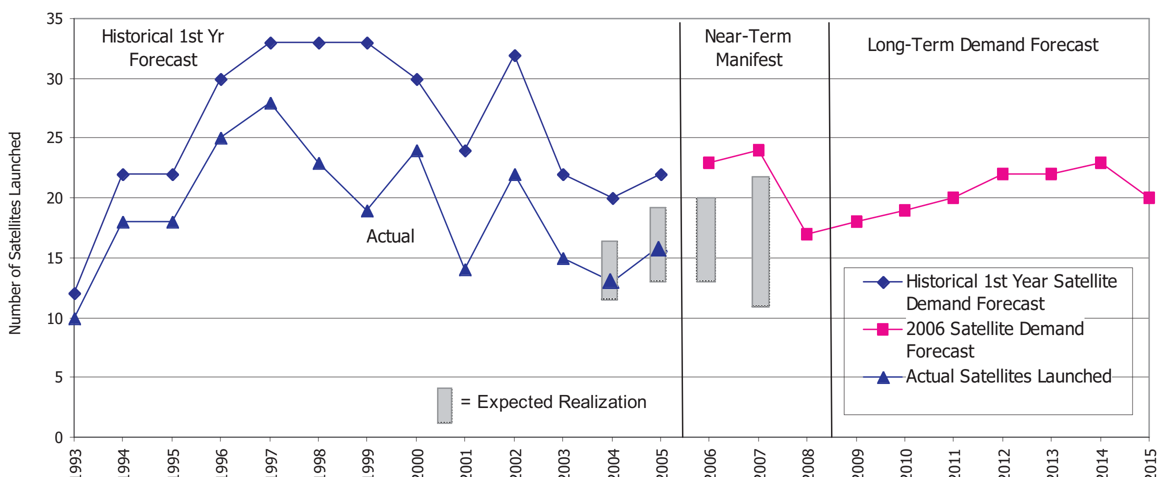
- **Funding**. Satellite service providers may be unable to obtain the funding needed to carry out their planned satellite launch, or it may be delayed until alternate funding is found.

- **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 cancellations of programs.

Projecting Actual Satellites Launched Using a Realization Factor

The Working Group acknowledges that over the history of this report, the forecasted demand in terms of both satellites and launches has almost always exceeded the actual number of satellites and launches 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." A historical variance was calculated using data since 1996 of fore-

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



casted demand and the actual number of satellites launched for the first two forecast years. The average variance for the first year is 27% while the average variance for the second year is 29%.

The range of expected actual satellites launched is calculated by multiplying the near-term demand forecast for the first and second years by the historical highest and lowest variance for the first and second years. Applying the calculated realization band to the 2006 forecast demand of 23 satellites yields a probable range of satellites that will actually be launched of 13 to 20. For the 2007 demand forecast of 24 satellites, a realized number of launches of between 11 and 22 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 2004 through 2007.

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

Forecasted Satellite Demand Versus Actual Satellite Launches in 2005

The 2005 COMSTAC Commercial GSO Demand Forecast listed 22 satellites for the 2005 near-term manifest. The execution of that manifest was impacted primarily by satellite production delays. Sixteen satellites were actually launched in 2005, one satellite launched earlier than forecasted (AMC-23 had been forecast to launch in 2006), five satellites were delayed due to satellite issues, one was delayed due to launch vehicle issues, and one was delayed due to both satellite and launch vehicle issues. All of the seven delayed satellites are expected to launch in 2006, with five of the satellites already having been launched as of publication of this report.

Launch Assurance Agreements

As discussed earlier in the report, launches are sometimes delayed by satellite or launch vehicle issues, or external factors beyond the control of either the launch provider or the satellite manufacturer such as regulatory delays or any other acts of governments. Occasionally, such delays will result in a launch service provider being unable to meet the customer's schedule requirements. In the majority of these situations, the customer has the right to terminate the contract with their original launch service provider and enter into an agreement with a new launch provider that can launch sooner. Customers are sometimes able to find alternative providers that can meet their schedule due to the available, although dwindling, capacity in the launch industry. However, in the last five years, launch service providers have also developed schedule assurance offerings that provide for "backup" arrangements on a different vehicle if schedule or technical issues are encountered on the primary launcher.

International Launch Services offers integrated schedule assurance with the Atlas and Proton vehicles, and the Launch Services Alliance (LSA), formed by Arianespace, Boeing Launch Services, and Mitsubishi Heavy Industries, offers dual or triple integration among the Ariane 5, Zenit 3SL, and H-IIA launch systems.

Factors That May Affect Future Demand

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

- **Economic conditions** have been improving. Low interest rates have increased access to low-cost capital.

However, many global fixed satellite services (FSS) operators are highly leveraged with debt levels more than six times earnings before interest, taxes, depreciation, and amortization (EBITDA). This high level of debt combined with continuing excess satellite transponder capacity in some regions may impede short-term demand for satellites.

- **New commercial competitors** will impact the launch market over the next few years. Sea Launch is now offering Land Launch vehicles to be launched from the Baikonur Cosmodrome. Land Launch uses a Zenit 3SLB vehicle, modified slightly from the Sea Launch Zenit 3SL. Its lift capability of 3,600 kg moves Sea Launch Company, LLC into the medium launch market segment (2,200–4,000 kg), complementing the Sea Launch heavy-lift capability. Launch rate capacity will be 4–5 launches per year. There are currently four Land Launch launches manifested in 2007. Arianespace will begin offering Soyuz launch services from French Guiana (Kourou) in 2008. This modified Soyuz will provide medium-lift capability: the Soyuz 2-1-a can lift 2,700 kg to GTO, and the Soyuz 2-1-b will be capable of lifting 3,000 kg to GTO. The near-equatorial launch location increases the capacity of the upgraded Soyuz by almost a factor of two over the launch capacity from Baikonur. This will add another new competitor in the medium launch market segment. Other launch vehicles in development include the SpaceX Falcon vehicles, the Indian GSLV Mark III, and the Russian Angara III.

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

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

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

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

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

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

Supplementary Questionnaire Results

As part of the COMSTAC request for inputs from industry participants for the 2006 Commercial GSO Launch Demand Forecast, a supplemental questionnaire was provided to satellite service providers. The questions were focused on determining how certain factors have impacted satellite service providers' recent plans to purchase and launch satellites. A summary of the results of this questionnaire is provided in Table 6.

Inputs were received from the following 16 satellite service providers. The Working Group would like to offer special thanks to these organizations for providing this additional input:

- Asiasat
- Broadcasting Satellite System Corp.
- Intelsat
- JSAT Corp
- MEASAT
- Mobile Broadcasting Corp.
- Mobile Satellite Ventures
- New Skies Satellites
- Protostar
- SES Astra
- Sirius Satellite Radio
- Spacecom
- Space Communications Corp.
- Telesat Canada
- Thuraya Telecommunications
- XM Satellite Radio

The 2006 survey reflects mixed trends in the global environment and satellite market demand drivers, along with positive improvements in industry's ability to meet the needs of satellite service providers.

Global economic conditions have improved, although some regions are still experiencing difficulty. Access to financing has also improved, but the availability of affordable insurance remains problematic. Difficulties in obtaining export and operating licenses have restrained demand. In particular, 25% of respondents cited difficulties in obtaining operating licenses as a negative factor, up from 13% in 2005.

Near-term demand for new satellite orders remains soft in many regions due to continuing excess transponder capacity. The impact of the consolidation of service providers on satellite demand is more negative this year, with 25% of respondents indicating some negative impact compared to 13% in 2005. However, recent problems associated with satellite on-orbit reliability have required some additional satellite purchases.

Table 6. 2006 COMSTAC Survey Questionnaire Summary

	Significant Negative Impact	Some Negative Impact	No Effect	Some Positive Impact	Significant Positive Impact	Compared to 2005 ⬆ = more pos ⬇ = more neg
Regional or global economic conditions	6%	13%	56%	19%	6%	↑
Demand for satellite services	6%	19%	19%	44%	13%	↑
Ability to compete with terrestrial services	6%	25%	38%	25%	6%	↑
Availability of financing	0%	13%	56%	13%	19%	↑
Availability of affordable insurance	19%	25%	44%	13%	0%	↑
Consolidation of service providers	0%	25%	56%	19%	0%	↓
Increasing satellite life times	0%	25%	56%	13%	6%	↑
Availability of satellite systems that meet your requirements	0%	6%	50%	31%	13%	↑
Reliability of satellite systems	6%	13%	63%	6%	13%	-
Availability of launch vehicles that meet your requirements	0%	6%	63%	25%	6%	↑
Reliability of launch systems	0%	6%	50%	44%	0%	↑
Ability to obtain required export licenses	6%	31%	56%	6%	0%	-
Ability to obtain required operating licenses	0%	25%	69%	6%	0%	↓

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

On the positive side, industry has improved its ability to meet the needs of satellite service providers. The availability of satellite systems to meet requirements was reported as a positive impact on demand by 44% of respondents, while only 13% expressed this view in 2005. The availability of launch systems to meet requirements was cited as a positive impact on demand by 31% of respondents, versus 7% in 2005. Improvements in launch vehicle reliability were cited as a positive factor by 44% of respondents, versus 13% in 2005.

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 2005, with a projection for 2006 based on the near-term manifest shown in Table 4. Peaks in total number of transponders launched correspond to peaks in number of satellites launched for a given year. The total number of transponders launched in 2003, 2004, and 2005 were low compared to previous history. However, a 50% increase over 2005 is predicted for 2006, which corresponds to the plan to launch the seven delayed satellites from 2005 in 2006. There is a growing trend over time in the average number of transponders per satellite. This corresponds with the move to heavier, higher-powered satellites.

For the purpose of this analysis, a small number of satellites were excluded because their application is substantially different

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

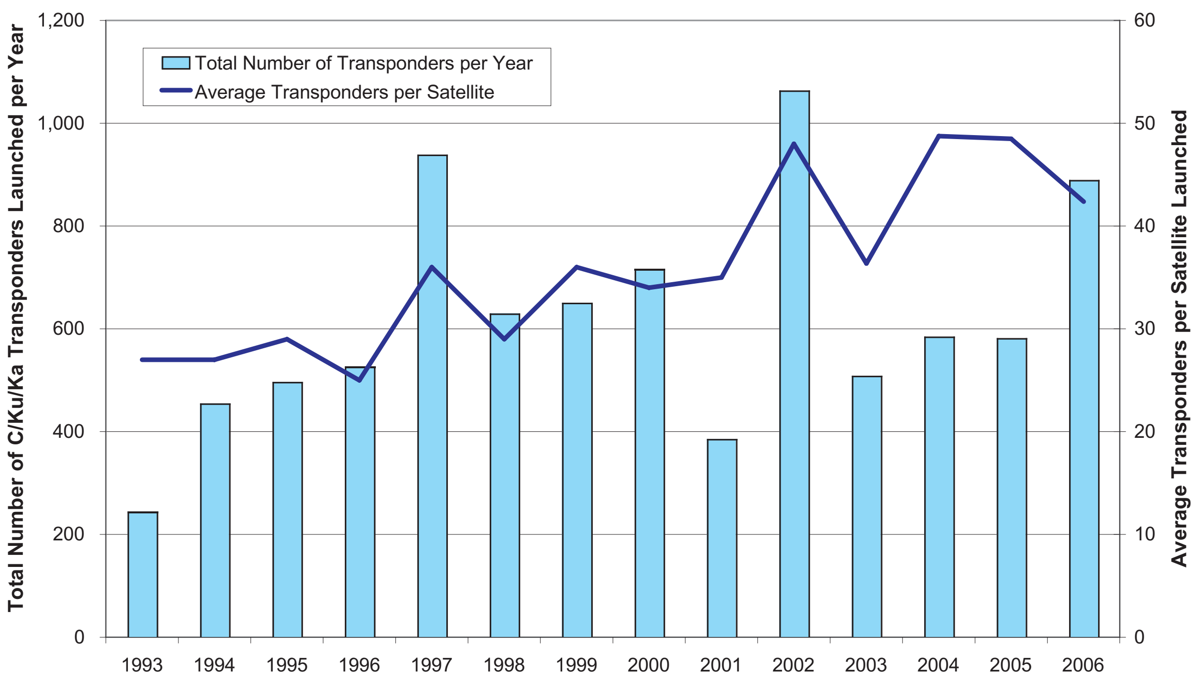


Table 7. Total C/Ku/Ka Transponders Launched Per Year and Average Transponders per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total Number of Transponders per Year	245	455	497	527	939	630	651	717	386	1,064	509	585	582	890
Average Transponders per Satellite	27	27	29	25	36	29	36	34	35	48	36	49	49	42

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, Skynet, Thuraya, and XM satellites, which have X-band, L-band, and/or S-band transponders.

Trends in Average Satellite Mass

Figure 11 and Table 8 show the total mass launched per year and the average mass per satellite launched. The total mass launched per year correlates with the number of satellites launched per year, as does the total number of transponders. Even though the total number of transponders launched in 2005 remained as low as the previous two years, the total mass launched in 2005 increased significantly from 2004, indicative of the continued increase in average satellite mass, which peaked in 2005. This again correlates to the trend toward heavier, higher-power satellites. The projected total mass to be launched in 2006 will be an all-time high, nearly 100,000 kg, due to the delay in launching seven satellites from 2005 to 2006.

Summary

The 2006 COMSTAC Commercial GSO Launch Demand Forecast predicts an average annual demand of 20.8 satellites to be launched from 2006 through 2015, effectively the same as the 2005 forecast of 20.5 and the 2004 forecast of 21.1 satellites per year. For the third year in a row, the actual number of satellites launched has remained less than 20, with 16

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

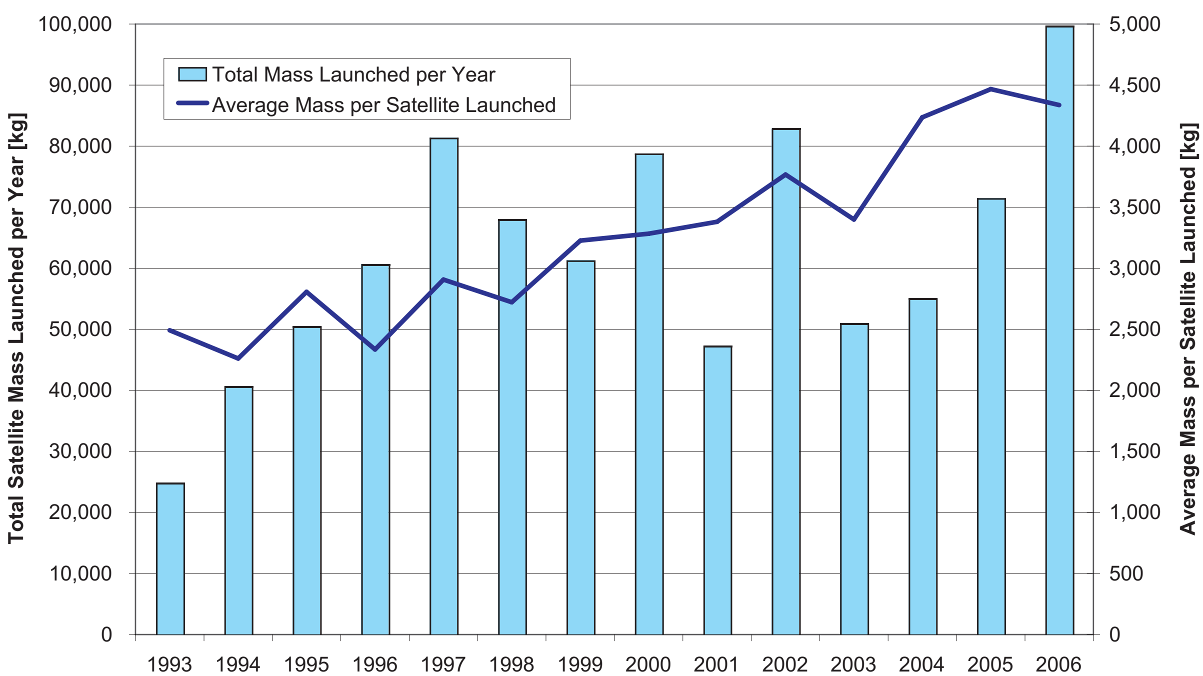


Table 8. Total Satellite Mass Launched per Year and Average Mass per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total Mass Launched per Year [kg]	24,910	40,689	50,502	60,695	81,373	68,015	61,295	78,784	47,329	82,880	50,990	55,070	71,456	99,726
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	4,336

launched in 2005. Beyond the immediate "bow wave" effect, or backlog, of satellites to be launched in 2006 and 2007, the number of satellites to be launched does not grow to greater than 20 until early next decade.

There has been a decrease in the actual number of dual-manifest launches in recent years (2004 and 2005) due to the transition from the Ariane 4 to the Ariane 5, and due to the Ariane 5 ECA failure in 2002. However, the Working Group predicts a recovery in 2006, with five dual-manifest launches forecast in 2006, and a long-term forecast of four dual-manifest launches per year. Based on this dual-manifest forecast and the satellite demand projection, the 2006 Commercial GSO Launch Demand Forecast averages 16.7 launches per year from 2006 through 2015. This is effectively the same as last year's forecast of 16.4 launches per year.

The trend in satellite mass growth continues, with the average mass per satellite launched in 2005 at 4,500 kg, and a peak total satellite mass to be launched of 100,000 kg forecast for 2006. At the same time, the trend in increasing average number of transponders per satellite continues, although the peak number of over 1000 transponders launched in 2002 has not been topped.

The Working Group has identified market events that have the potential of impacting the space launch industry. Although the Atlas V, Delta IV, and next generation Ariane 5 vehicles all have had successful launches, these vehicles remain in the early stages of their flight experience. These vehicles represent a significant increase in the industry's capacity to launch heavy and extra-heavy payloads. Two new launch vehicle entrants, Land Launch and Soyuz from Kourou, will begin to launch medium-class payloads in the near future, and other launch vehicles in development may provide additional capacity. On the satellite industry side, continued consolidation and unfavorable U.S. regulatory conditions may impact the health of U.S. satellite manufacturers. Key factors affecting global satellite market demand at this time include the economic atmosphere, availability of financing, and the regulatory environment. New satellite service market applications, like HDTV, may create additional demand for new satellites, beyond the existing satellite replenishment market.

Appendix A. Letter from the Associate Administrator

Name
Title
Company
Address
City, Country

Dear ,

The Federal Aviation Administration (FAA) Office of Commercial Space Transportation (AST) commissions an annual update to the Commercial Geosynchronous Orbit Launch Demand Model for geosynchronous satellites. The demand model is developed by the Commercial Space Transportation Advisory Committee (COMSTAC), a chartered industry advisory body that provides recommendations to the FAA on issues that affect the U.S. commercial launch industry. The FAA and industry use the demand model to identify projected commercial space launch user requirements. It is also used to facilitate U.S. Government policy and planning for the commercial space transportation industry. The 2005 demand forecast can be viewed on-line at http://ast.faa.gov/rep_study/forcasts_and_reports.htm.

Your participation is important to the development of the 2006 model. Therefore, our office requests comprehensive input from your company based on your forecasts of global future spacecraft and launch needs. The COMSTAC Technology and Innovation Working Group will then develop the model based on your response and other industry input.

Your response is needed by February 8, 2006, to ensure that the demand model update is ready for publication in May 2006. Please forward this request to the department most appropriate within your organization (e.g., marketing, business development, or contracts). Enclosed is a table and instructions that will give you more detailed information on how and where to respond, as well as whom to contact. If you have any questions or comments, please contact Mr. John Sloan of my staff at (202) 267-7989 or john.sloan@faa.gov.

Thank you for your support of this activity.

Sincerely,

Patricia Grace Smith
Associate Administrator for Commercial Space Transportation

Enclosures: (1) 2006 Commercial GSO Launch Demand Model Instructions
(2) Satellite Demand Forecast by Payload Mass
(3) COMSTAC Launch Demand Model Report Feedback Form

2006 Commercial GSO Launch Demand Model Instructions

As with prior year efforts, the goal for the 2006 COMSTAC Geosynchronous Orbit Launch Demand Model is to forecast the demand for worldwide commercial space launch requirements. This demand is based on the projected sales of geosynchronous satellites and the size, in terms of mass, of those satellites. We are requesting your assistance in this effort by filling out the attached "Satellite Demand Forecast by Payload Mass" table.

Please provide us with your forecast of total worldwide demand for "addressable" commercial geosynchronous satellite launches between 2006 and 2015. Addressable payloads in this context are those payloads that are open for internationally competitive launch service procurement. Please do not include in your forecast those payloads that are captive to national flag launch service providers (i.e., U.S., European, Russian, Japanese, or Chinese government payloads that are captive to their own national launch providers). In addition, if your forecast has changed significantly from the forecast that you submitted last year, please provide a brief explanation of the changes.

A projection of the addressable payloads in the low and medium Earth orbit market (i.e., non-geosynchronous orbits) will be completed by the FAA separately and a combined projection will be published by the FAA.

Your input, along with those of other satellite manufacturers and launch vehicle suppliers will be combined to form a composite view of the demand for launch services through 2015. We ask that you submit a comprehensive world market demand model, with projections for all four of the identified mass ranges. Data from this type of input are essential to assuring a complete and comprehensive forecast of the future commercial satellite and launch needs. This information will be used by corporations in their planning processes and governments in the administration of international space launch policy and decisions. As such, an accurate and realistic projection is vitally important. The third enclosure provides a forum for your feedback on the usefulness of this report.

We are looking forward to receiving your response by **February 8, 2006**, in order to support our GSO Forecast schedule. Your responses should be sent directly to Ms. Lisa Hague at the following address:

Ms. Lisa Hague
Boeing Launch Services, Inc.
5301 Bolsa Ave MC H014-C443
Huntington Beach, CA 92647-2099

Phone: 714-896-5603
Fax: 714-372-2855
Email: lisa.m.hague@boeing.com

If you have any questions, please contact Ms. Hague directly.

COMSTAC Launch Demand Model Report Feedback Form

In May of each year, COMSTAC and the FAA release the annual COMSTAC Commercial Geosynchronous Orbit Launch Demand Model, as part of the Commercial Space Transportation Forecasts document. COMSTAC and the FAA are very interested in receiving detailed comments on the usefulness of the GSO Launch Demand Model Report published each year. This form requests responses from your company to a few brief questions, and provides additional space for any more extensive comments that your organization might have.

What information in the report is most useful to your company?

Are the payload mass category breakdowns appropriate? Would a different set of payload mass categories be more useful? If so, please provide an alternate breakdown and provide rationale for your suggested change.

The Commercial GSO Launch Demand Forecast projects demand for “addressable” commercial satellites, where addressable is defined as those payloads that are open for internationally competitive launch service procurement. Excluded are those payloads that are captive to national flag launch service providers.

> Which GSO forecast would be more useful to your company: the addressable commercial launch demand forecast or a total worldwide commercial launch demand forecast? Why?

How can we make the COMSTAC Commercial Geosynchronous Orbit Launch Demand Model report more useful for your company?

Appendix B. Historical Launches

A list of historical addressable commercial satellites launched from 1993 through 2005 is presented in Table 9. The table also notes which missions were flown on a dual-manifested launch and the resulting total number of launches in each year. Please note that the satellites are separated into mass categories as defined in the current COMSTAC report. This may result in slight differences in the categorization of satellites compared to earlier COMSTAC publications.

Table 9. Historical Addressable Commercial GSO Satellites Launched (1993-2005)

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

☐ = Launch Failure (boxed entries shown in bold)

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 (1993-2005) [Continued]

1998 — Total Launches: 19; Total Satellites: 23

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)	0			
2,200 - 4,200 kg (4,850 - 9,260 lbm)	14	DM4	Afristar	Ariane 44L
		DM3	Eutelsat W2	Ariane 44L
			Hot Bird 4	Ariane 42P
			PAS 6B	Ariane 42L
			PAS 7	Ariane 44LP
			Satmex 5	Ariane 42L
			ST-1	Ariane 44P
			Hot Bird 5	Atlas IIA
			Intelsat 805A	Atlas IIAS
			Intelsat 806A	Atlas IIAS
			Galaxy 10	Delta III
			Astra 2A	Proton K/DM
			EchoStar 4	Proton K/DM
			PAS 8	Proton K/DM
Below 2,200 kg (<4,850 lbm)	9	DM4	AMC 5	Ariane 44L
		DM1	Brazilsat B3	Ariane 44LP
		DM2	BSat 1B	Ariane 44P
		DM1	Inmarsat 3F5	Ariane 44LP
		DM2	NileSat 101	Ariane 44P
		DM3	Sirius 3	Ariane 44L
			Bonum-1	Delta II
			Skynet 4D	Delta II
			Thor III	Delta II

1999 — Total Launches: 18; Total Satellites: 19

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)	2		Galaxy 11	Ariane 44L
			Orion 3	Delta III
2,200 - 4,200 kg (4,850 - 9,260 lbm)	16		AMC 4	Ariane 44L
		DM1	Arabsat 3A	Ariane 44L
			Insat 2E	Ariane 42P
			Koreasat 3	Ariane 42P
			Orion 2	Ariane 44LP
			Telkom	Ariane 42P
			Telstar 7	Ariane 44LP
			Echostar V	Atlas IIAS
			Eutelsat W3	Atlas IIAS
			JCSat 6	Atlas IIAS
			Asiasat 3S	Proton K/DM
			Astra 1H	Proton K/DM
			LMI 1	Proton K/DM
			Nimiq	Proton K/DM
			Telstar 6	Proton K/DM
			DirecTV 1R	Sea Launch
Below 2,200 kg (<4,850 lbm)	1	DM1	Skynet 4E	Ariane 44L

2000 — Total Launches: 20; Total Satellites: 24

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)	4		Anik F1	Ariane 44L
			PAS 1R	Ariane 5G
			Garuda 1	Proton K/DM
			Thuraya 1	Sea Launch
2,200 - 4,200 kg (4,850 - 9,260 lbm)	14	DM1	Asiastar 1	Ariane 5G
		DM3	Astra 2B	Ariane 5G
			Europe*Star 1	Ariane 44LP
			Eutelsat W1R	Ariane 44P
			Galaxy 10R	Ariane 42L
			Galaxy IVR	Ariane 42L
			N-Sat-110	Ariane 42L
			Superbird 4	Ariane 44LP
			Echostar VI	Atlas IIAS
			Eutelsat W4	Atlas IIIA
			Hispasat 1C	Atlas IIAS
			AAP 1	Proton K/DM
			AMC 6	Proton K/DM
			PAS 9	Sea Launch
Below 2,200 kg (<4,850 lbm)	6	DM3	AMC 7	Ariane 5G
		DM4	AMC 8	Ariane 5G
		DM4	Astra 2D	Ariane 5G
		DM2	Brazilsat B4	Ariane 44LP
		DM1	Insat 3B	Ariane 5G
		DM2	Nilesat 102	Ariane 44LP

2001 — Total Launches: 12; Total Satellites: 14

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		DirecTV 4S	Ariane 44LP
			Intelsat 901	Ariane 44L
			Intelsat 902	Ariane 44L
			XM Rock	Sea Launch
			XM Roll	Sea Launch
2,200 - 4,200 kg (4,850 - 9,260 lbm)	6	DM2	**Artemis**	Ariane 5G
			Atlantic Bird 2	Ariane 44P
		DM1	Eurobird	Ariane 5G
			Turksat 2A	Ariane 44P
			Astra 2C	Proton K/DM
			PAS 10	Proton K/DM
Below 2,200 kg (<4,850 lbm)	3	DM1	BSat 2A	Ariane 5G
		DM2	**BSat 2B**	Ariane 5G
		DMN	Skynet 4F	Ariane 44L

2002 — Total Launches: 20; Total Satellites: 22

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)	9		Intelsat 904	Ariane 44L
			Intelsat 905	Ariane 44L
			Intelsat 906	Ariane 44L
			NSS-6	Ariane 44L
			NSS-7	Ariane 44L
			Astra 1K	Proton K/DM
			Echostar 8	Proton K/DM
			Intelsat 903	Proton K/DM
			Galaxy IIIC	Sea Launch
2,200 - 4,200 kg (4,850 - 9,260 lbm)	11	DMN	Atlantic Bird 1	Ariane 5G
		DMN	**Hotbird 7**	Ariane 5ECA
			Insat 3C	Ariane 42L
		DM1	JCSat 8	Ariane 44L
		DM2	Stellat 5	Ariane 5G
			Echostar 7	Atlas IIIB
			Hispasat 1D	Atlas IIAS
			Hotbird 6	Atlas V 401
			Eutelsat W5	Delta IV M+ (4,2)
			DirecTV 5	Proton K/DM
			Nimiq 2	Proton M/M
Below 2,200 kg (<4,850 lbm)	2	DM1	Astra 3A	Ariane 44L
		DM2	N-Star c	Ariane 5G

▭ = 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 (1993-2005) [Continued]

	2003			2004		2005			2006	2007
Total Launches		**12**		**13**			**15**			
Total Satellites		**15**		**13**			**16**		**0**	**0**
Over 5,400 kg (>11,905 lbm)		**0**		**3**			**6**		**0**	**0**
				Anik F2	Ariane 5		IA-8	Sea Launch		
				DirecTV 7S	Sea Launch		Inmarsat 4F1	Atlas V		
				Intelsat X	Proton		Inmarsat 4F2	Sea Launch		
							Thaicom 4	Ariane 5		
							Spaceway 1	Sea Launch		
						DM1	Spaceway 2	Ariane 5		
4,200 - 5,400 kg (9,260 - 11,905 lbm)		**5**		**5**			**4**		**0**	**0**
		EchoStar 9	Sea Launch	Eutelsat W3A	Proton		AMC-12	Proton		
		Intelsat 907	Ariane 44L	Estrela do Sul	Sea Launch		Anik F1R	Proton		
	DM2	Optus C1	Ariane 5	APStar V	Sea Launch		XM-3	Sea Launch		
		Rainbow 1	Atlas V	Amazonas	Proton		AMC-23	Proton		
		Thuraya 2	Sea Launch	AMC-16	Atlas V					
2,200 - 4,200 kg (4,850 - 9,260 lbm)		**6**		**3**			**3**		**0**	**0**
		AMC-9	Proton	Superbird 6	Atlas IIAS		DirecTV 8	Proton		
		Asiasat 4	Atlas III	MBSat	Atlas III		Insat 4A	Ariane 5		
		Galaxy XIII	Sea Launch	AMC-15	Proton		XTAR-EUR	Ariane 5		
		Hellas-sat	Atlas V							
	DM1	Insat 3A	Ariane 5							
	DM3	Insat 3E	Ariane 5							
Below 2,200 kg (<4,850 lbm)		**4**		**2**			**3**		**0**	**0**
		Amos 2	Ariane 5	AMC-10	Atlas IIAS		Galaxy 14	Soyuz		
	DM2	Bsat 2C	Ariane 5	AMC-11	Atlas IIAS		Galaxy 15	Ariane 5		
	DM3	e-Bird 1	Ariane 5			DM1	Telkom 2	Ariane 5		
	DM1	Galaxy XII	Ariane 5							

☐ = 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

2006 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits

Executive Summary

The *2006 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits* is an annual report prepared by the Federal Aviation Administration's Office of Commercial Space Transportation (AST) that assesses the worldwide market for satellites and other spacecraft that are expected to be available for competition between providers of commercial launch services or are otherwise sponsored by commercial companies.

The FAA's 2006 forecast projects a demand for 69 commercial launches to non-geosynchronous orbits (NGSO) worldwide from 2006–2015, an increase of eight percent compared to last year's forecast. The increase is attributed to a few more international science and technology demonstration satellites seeking launch services.

The 2006 forecast contains 160 satellites during the next ten years, an increase of 11 percent compared to the ten-year projection in the 2005 forecast of 144 satellites.

This year's report again shows a diversity of global payloads scheduled in the near term ranging from government radar satellites to privately-funded demonstrations of habitable spacecraft as well as traditional science, commercial remote sensing, and telecommunications satellites.

2006 Launch Forecast: FAA/AST is forecasting an average demand of 6.9 worldwide launches per year during 2006–2015 with more activity in the near term including demand for 13 launches in 2006, 14 in 2007, and 10 in 2008. However, many of these customers are developing new spacecraft that could delay launch schedules. This near-term forecast contrasts with sluggish activity of three actual NGSO launches in 2005, two in 2004, and four per year from 2001–2003.

Demand is divided into two vehicle size classes with an average of 3.6 medium-to-heavy launch vehicles per year and about 3.3 small vehicle launches per year of the forecast period. While the number of small launches declined slightly from last year's forecast of 39, the number of medium-to-heavy launches increased by about one launch per year compared to last year. Overall there are five more launches in the 2006 forecast compared to 2005.

A little over 60 percent of the 160 satellites in the market are international science or other satellites such as technology demonstrations. Twenty-seven percent of the market is made up of telecommunications satellites and the remaining 12.5 percent of the market is commercial remote sensing satellites, many of which are replacements or augmentations to existing orbiting satellites. This relative allocation of satellites is nearly the same as last year.

Slightly more than half of the satellites assigned to launch vehicles in the near term weigh less than 200 kilograms. The overall ratio of satellites to launch vehicles is about 2.3 to one, indicating that many individual launches have a multiple satellite manifest.

Introduction

Although recent history of actual launches to NGSO shows a depressed market at an average of about 3.5 launches per year, the 2006 forecast projects a high rate of near-term launch activity with up to 37 launches from 2006–2008 if schedules live up to actual launch rates.

This build up of near-term launches reflects several trends unique to the NGSO market: an increase in countries, companies, and international non-profit organizations interested in deploying diverse satellites; the availability of low-cost launch vehicles to fit increasingly capable small mass satellites; delays in funding or technical development that has caused manifests to back up; and the confluence of planned replacements for commercial remote sensing and telecommunications satellites.

The 2006 forecast is also the third consecutive forecast to contain an overall increase in the number of satellites in each ten-year projection, indicating a healthier market compared to 2001–2003.

The space industry's international flavor continues to be a theme in today's NGSO market compared to the late 1990s. In the next four years, only two of 27 assigned launches have a satellite owner/operator that will fly on a launch vehicle built by its home country. This is mostly because of the continued oversupply of Russian/ Ukrainian vehicles that has attracted international customers with agreeable prices.

As the technology and cost barriers to enter space with small satellites have fallen, the number of participating organizations and countries has risen. Competition and independent national use of space have also contributed to an expansion of customers for low Earth orbit (LEO) launch providers.

Table 10. Commercially Competed Launches

	NGSO	GSO	**Total**
1996	2	21	**23**
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 est.	13	18	**31**

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

While not generating high commercial revenues like the geosynchronous orbit (GSO) market, the NGSO market maintains a small but steady demand of diverse customers for science, commercial remote sensing, telecommunications, education, digital audio radio, and demonstration of advanced technologies. An overall question remains for observers of the NGSO market: when will new or improved applications emerge to consistently increase launch demand?

Although the pioneers of the NGSO mobile telecommunications services are actively planning next-generation systems, they are not expected to launch at rates experienced during 1997–1999 when there was a business race to orbit (see Table 10). Follow-on replacement launches are likely to be stretched out over multiple years as funding becomes available and as on-orbit lifespan runs out. While ORBCOMM plans in the next few years to replace its data messaging system, it is still too early to forecast second generation launches for Iridium and Globalstar, both of which expect to be operating their first generation past 2010.

The utility of mobile satellite communications was demonstrated after Hurricane Katrina struck areas of the U.S. Gulf Coast in August 2005. Traditional land-based communications systems were shut down for days or weeks, creating an opening for mobile satellite telephony providers to prove their independent capabilities and increase awareness of satellite communications options for state and local governments. Iridium and Globalstar activated an estimated 20,000 handheld satellite phones in the area soon after Katrina hit in an attempt to meet high demand. “If we learned anything from Hurricane Katrina, it is that we cannot rely solely on terrestrial communications,” said Federal Communications Commission Chairman Kevin Martin during testimony before Congress in September 2005.

To date it is unclear if the vulnerability of cellular and other land-based communications will translate into significant increased business for Iridium and Globalstar as primary or backup communications for emergency services and other disaster response users. The impact of potential activity is not just in the Gulf of Mexico region but nationwide, as the federal and state and local governments establish plans related to homeland security and natural disasters, including voice communications and tracking mobile assets. In the meantime, Iridium, Globalstar, and ORBCOMM have been successful in garnering new investors and rolling out new services.

Although several new suborbital launch vehicles capable of carrying passengers are expected to enter the commercial space business with regular service in the 2008–2009 timeframe and these companies have an eye towards expanding into orbital markets, it is too early to forecast when new orbital passenger launches will occur. This forecast only contains demand for orbital launches.

FAA/AST 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 LEO, medium Earth orbit (MEO), elliptical orbit (ELI), and external orbit (EXT) such as to the Moon, Mars, and beyond.

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. The forecast also does not evaluate how many systems 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 satellites in the forecast are (or were) open for international launch services procurement or were sponsored by commercial entities for commercial launch.

The following sections review each market segment and describe the results of the 2006 forecast.

NGSO Satellite Systems

International Science and Other Payloads

The growth of satellite development efforts in countries without indigenous launch capabilities has generated steady demand for commercial launch services that has outpaced demand from other markets, including telecommunications and commercial remote sensing, over the last several years. Most of these missions involve small satellites on modest budgets, so the demand leans toward low-cost, small launch vehicles. The continued availability of inexpensive launches on refurbished Russian and Ukrainian ballistic missiles, some capable of carrying multiple satellites, promises to support increased demand for such launch services over the next several years. 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, Nigeria, Saudi Arabia, Taiwan, Turkey, and the United Kingdom. The U.S. Space Transportation Policy, enacted in December 2004, generally restricts U.S. government payloads from launching on non-U.S.-built vehicles, so demand for these payloads is not included in this report.

International science satellites can be classified into three groups. The first are remote sensing satellites that are operated non-commercially, typically by government agencies, but are often built by commercial firms in other countries. The imagery products generated from these satellites are usually offered for free or at cost. EgyptSat, built by Ukrainian manufacturer KB Yuzhnoye for Egypt's National Authority for Remote Sensing and Space Sciences, is a remote sensing satellite scheduled for launch in 2006 on a Dnepr. The Thai Earth Optical System (THEOS) is a remote sensing satellite being manufactured by EADS Astrium for Thailand's Geo-Informatics and Space Technology Development Agency (GISTDA). The satellite will be launched in 2007 on a Rockot.

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 of such missions is ESA's Gravity Field and Steady-State Ocean Circulation Mission (GOCE), a mission to generate high-resolution maps of the Earth's gravity field; it is scheduled for launch on a Rockot in 2007. A similar example is AGILE, a gamma-ray astronomy satellite funded by the Italian Space Agency, which is scheduled to launch on an Indian Polar Satellite Launch Vehicle (PSLV) in 2006. The launch is believed to be the first commercial competition won by India for the launch of a primary payload.

The third class of satellites feature spacecraft designed to perform technology demonstrations. AKS 1 and 2, a pair of satellites built by Russian company Aerospace Systems Ltd., are designed to test solar sail deployment technologies. The two satellites are scheduled for launch on a Dnepr in 2006. The Cascade, Smallsat, and Ionospheric Polar Explorer (CASSIOPE) spacecraft, built by MacDonald, Dettwiler and Associates Ltd. for the Canadian Space Agency, has a dual mission: carry a suite of experiments to study the ionosphere and demonstrate small satellite and communications technologies for use on future missions. The spacecraft will be launched on a Falcon 9 in 2008.

Small, one-kilogram satellites measuring about 10 centimeters square 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. Six CubeSats, built by five universities and one commercial venture, were launched on a non-commercial Rockot mission in June 2003; three others were launched as secondary payloads on a commercial Cosmos launch in October 2005. Launch costs per CubeSat can be as low as $40,000. Two Dnepr launches in 2006, including one non-commercial mission, are scheduled to launch 22 CubeSats as secondary payloads. Because of the small size of the satellites and their developers' limited budgets, these payloads do not stimulate commercial launch demand on their own.

Digital Audio Radio Services

Satellite radio is already among the fastest adopted consumer electronics products in U.S. history. Sirius Satellite Radio announced in March 2006 that it had more than four million subscribers, while rival XM Satellite Radio announced in April 2006 that it had in excess of 6.5 million subscribers. Neither company is currently profitable, primarily because of increased marketing and programming costs, although both anticipate reaching cash-flow breakeven as early as the end of 2006.

Sirius launched three satellites into highly-elliptical orbit in 2000 and rolled out service in 2002. In a March 2006 regulatory filing, the company announced that it planned to augment or replace its satellite constellation by 2010, using either its existing spare satellite on the ground and/or new satellites yet to be ordered. One replacement satellite is tentatively planned for launch to ELI in 2008; future satellites, however, could be launched to GSO. XM currently has three satellites in GSO and two additional GSO satellites on order.

While the DARS market has been limited to North America to date, there is growing interest in satellite radio systems elsewhere, principally in Europe. WorldSpace, which currently operates two GSO satellites with listeners in Europe, Africa, Asia, and the Middle East, is planning to launch a third GSO satellite to serve Europe. Ondas Media, a Spanish company, and Europa Max, based in Luxembourg, are each planning NGSO DARS systems modeled on Sirius, with three satellites in ELI. Both ventures are in the process of raising funding and have yet to announce satellite and launch contracts for their systems. Given the uncertainty these systems face at this time, neither system has been included in the 2006 forecast.

Military

On rare occasions governments will procure commercial launches for military satellites. One example is SAR-Lupe, a constellation of five satellites that will provide high-resolution radar imagery for the German Armed Forces and potentially other European militaries. The 770-kilogram (1,968-pound) satellites will be placed into three 500-kilometer (311-mile) orbital planes, from which they will be able to observe the Earth's surface between 80 degrees north and south latitude. The satellites are being built by a team led by German satellite manufacturer OHB-System under a 15-year, 300-million-euro (US$385-million) contract with the German Defense Ministry that began in 2002. The German government has contracted with Rosoboronexport, the Russian state corporation that handles the import and export of military systems, to launch the satellites on several Cosmos 3M boosters, starting in 2006; Dnepr vehicles will be used as a backup if necessary.

Market Demand Scenarios

FAA/AST projects that approximately 97 satellites of the international science or other category will be launched during the forecast period. These payloads will be deployed on 48 launches, including 22 medium-to-heavy vehicles. This is the largest single market sector of the satellite and launch demand forecast.

Commercial Remote Sensing Satellites

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

The commercial market for satellite-based high-resolution imagery has grown more slowly than expected several years ago, limiting the anticipated demand for new commercial remote sensing satellites. Growth has been hampered by competition from imagery generated by aircraft and by the limited number of trained GIS professionals who can process, analyze, and produce imagery-based products for widespread applications. As a result, remote sensing satellite companies have become increasingly dependent on government business to maintain their competitive edge. Although commercial remote sensing faces competition from civil, military, and intelligence imaging systems, the ever-increasing worldwide government demand for high-resolution imagery has opened a major market for remote sensing companies.

Consistent with the 2003 U.S. commercial remote sensing policy promoting government use of commercial imagery, the National Geospatial-Intelligence Agency (NGA) awarded multiple ClearView contracts to American companies to purchase high-resolution satellite imagery. NGA also awarded two NextView contracts to DigitalGlobe and ORBIMAGE (now GeoEye) to enable the development and launch of next-generation commercial remote sensing satellites. U.S. imagery providers are expected to rely heavily on these government contracts to fund their next-generation systems. The U.S. satellite-based commercial remote sensing industry consolidation during the past year demonstrated companies' reliance on government contracts. Space Imaging was not issued an NGA NextView contract, depriving it of the support necessary to build its next-generation system. ORBIMAGE acquired the company's assets, creating GeoEye, and leaving DigitalGlobe as the only other major U.S. satellite remote sensing company. The funding available for these NGA contracts will influence the pace of growth for this industry over the next several years.

There are current and future applications that could provide increased demand for imagery beyond the high-resolution needs of the military and intelligence community, despite the market's historical slow growth. For example, low- and medium-resolution imagery is critical for civil and commercial activities in scientific studies (forestry, geology, coastal change), agriculture, disaster response, homeland security, and other applications.

The major companies operating remote sensing satellites in the U.S. and around the world are profiled below.

DigitalGlobe

DigitalGlobe was established in 1993 and was granted the first National Oceanic and Atmospheric Administration (NOAA) license (under the name WorldView Imaging Corporation) in the same year. The company contracted with Boeing for the launch of the QuickBird satellite aboard a Delta 2 on October 18, 2001. QuickBird is

Table 11. 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 A1 EROS B EROS C	280 (617) 350 (771) 350 (771)	1.5 0.7 0.7	2000 2006 2009	EROS A1 continues to operate.
IKONOS	GeoEye	Lockheed Martin	IKONOS 1 IKONOS	816 (1,800) 816 (1,800)	1 1	1999 1999	IKONOS 1 lost due to launch vehicle malfunction. IKONOS continues to operate.
OrbView	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	OrbViews 2 and 3 continue to operate. OrbView 4 lost due to launch vehicle failure.
QuickBird	DigitalGlobe	Ball Aerospace	EarlyBird QuickBird 1 QuickBird	310 (682) 815 (1,797) 909 (2,004)	3 1 0.6	1997 2000 2001	EarlyBird failed in orbit shortly after launch. First QuickBird launch failed in 2000. QuickBird started commercial operations in 2002.
Radarsat	MacDonald, Dettwiler and Associates (Radarsat International)	MacDonald, Dettwiler and Associates	Radarsat 1 Radarsat 2 Radarsat 3	2,750 (6,050) 2,195 (4,840) 1,200 (2,645)	8 3 TBD	1995 2006 2012	Radarsat 1 continues to operate. Radarsat 3 will be a three-satellite constellation.
Under Development							
GeoEye	GeoEye	General Dynamics C4 Systems	GeoEye 1	907 (2,000)	0.41	2007	Formerly known as OrbView 5.
RapidEye	RapidEye AG	Surrey Satellite Technology Ltd.	RapidEye 1-5	150 (330)	6.5	2007	String of five satellites provides high temporal frequency and redundancy.
TerraSAR	InfoTerra GmbH	Astrium	TerraSAR X TanDEM X TerraSAR L	1,023 (2,255) 1,023 (2,255) 2,060 (4,540)	3 3 5	2006 2009 TBD	TerraSAR X and TanDEM X will provide commercial imagery, TerraSAR L appears largely restricted to government applications.
TrailBlazer	TransOrbital	TransOrbital	TrailBlazer	420 (926)	1	2007-2008	TrailBlazer will conduct remote sensing of the Moon in 1-meter resolution, but requires NOAA license to image the Earth from a distance.
WorldView	DigitalGlobe	Ball Aerospace	WorldView 1 WorldView 2	2,500 (5,510) 2,800 (6,175)	0.5 0.5	2007 2008	WorldView 2 will operate in a higher orbit than WorldView 1 and take imagery in additional spectral bands.

capable of imaging objects 0.6 meters (2 feet) in size or greater, and became available for commercial service in early 2002. QuickBird is scheduled to remain in operation through at least 2009.

In January 2003, NGA awarded DigitalGlobe a firm, fixed-price, $96-million order and an indefinite-delivery, indefinite-quantity contract worth up to $500 million to provide space imagery as part of NGA's ClearView program. The contract enables NGA to use commercial satellite imagery across a broad spectrum of value-added applications. The original contract was for three years and is dependent on availability of funds. There have been multiple contract modifications allowing NGA to increase its acquisition of QuickBird imagery, with the latest occurrence adding $12 million to the ClearView contract in March 2006.

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

GeoEye

Formed as a result of the ORBIMAGE acquisition of Space Imaging, which was completed in January 2006, GeoEye is the largest commercial remote sensing company in the world. The newly combined company, with almost 300 employees, is based in Dulles, Virginia, with facilities in St. Louis, Missouri and Denver, Colorado. ORBIMAGE bought Space Imaging after the latter put itself up for sale in early 2005, primarily because it had lost its competitive position in the U.S. remote sensing industry when it was not awarded an important NGA NextView contract. ORBIMAGE, on the other hand, did receive the second NextView contract in September 2004. The contract is worth about $500 million and is for the development of a next-generation high-resolution remote sensing satellite now known as GeoEye 1.

GeoEye 1 (previously known as OrbView 5), scheduled to launch in early 2007 on a Delta 2 from Vandenberg Air Force Base, will operate in a sun-synchronous polar orbit at an altitude of 660 kilometers (410 miles). Its camera will have the ability to take panchromatic images with a ground resolution of 0.41 meters (1.3 feet) and multispectral images with a resolution of 1.65 meters (5.4 feet); the 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. A team that includes General Dynamics C4 Systems (formerly Spectrum Astro) and ITT are building the GeoEye 1 satellite.

GeoEye currently owns and operates a constellation of three Earth imaging satellites: OrbView 2, IKONOS, and OrbView 3. OrbView 2, launched by a Pegasus XL booster on August 1, 1997, continues to operate and provides low-resolution images of up to 1.1 kilometers (0.71 miles). On September 24, 1999, an Athena 2 rocket launched the IKONOS satellite into a 684-kilometer (423-mile) polar orbit. IKONOS is the world's first high-resolution commercial remote sensing satellite, with a ground resolution of 0.82 meters (2.7 feet). On June 26, 2003, a Pegasus XL successfully launched OrbView 3 into a 470-kilometer (292-mile) sun-synchronous orbit. The satellite is capable of providing one-meter resolution panchromatic and four-meter resolution multispectral imagery. GeoEye is also a U.S. distributor of worldwide imagery from India's remote sensing satellites.

The company sells time on the IKONOS and OrbView 3 satellites to investors around the globe. Ground station owners in almost every region of the world have direct access to the satellites and can market and sell imagery in those parts of the world.

The NGA is GeoEye's single biggest customer. While funding about half of the cost of the company's next-generation imaging system, the NGA is also buying imagery from the IKONOS and OrbView 3 satellites. Under the NGA ClearView program, NGA has committed almost $50 million to buy imagery and products from GeoEye during the 2006 calendar year.

ImageSat International

ImageSat, founded as West Indian Space Ltd. in 1997, provides commercial high-resolution imagery from its Earth Remote Observation Satellite (EROS) family of remote sensing satellites. It was the first non-U.S. company to successfully deploy a commercial high-resolution imaging satellite, EROS A. Based in Netherlands Antilles, ImageSat's strategic partners include Israel Aircraft Industries Ltd. and Electro Optics Industries, developers of the company's satellites and cameras, respectively.

ImageSat currently operates two satellites. EROS A was launched from Svobodny, Russia in December 2000 on a START vehicle. This satellite provides standard panchromatic resolution of 1.9 meters (6.2 feet) and sub-meter resolution using hyper-sampling techniques. EROS B, launched on April 25, 2006 by a START vehicle from Svobodny, is a very-high-resolution satellite with panchromatic resolution of 0.7 meters (2.3 feet). EROS B, like its predecessor, offers flexible imaging capabilities at various angles, azimuth, and light conditions, but features a larger camera and on-board recorder, better pointing accuracy, and a faster data link. In 2009, ImageSat plans to launch EROS C, which will provide images with a panchromatic resolution of 0.7 meters, as well as multispectral images at a resolution of 2.8 meters (9.2 feet), with a swath of 11 kilometers (6.8 miles) at nadir. Like the previous two spacecraft, EROS C is scheduled to launch on a START vehicle. All EROS satellites have a planned lifespan of ten years.

InfoTerra GmbH

Infoterra GmbH, a subsidiary of EADS Astrium GmbH and part of the InfoTerra Group, holds the exclusive commercial exploitation rights for the TerraSAR X one-meter resolution radar satellite. The German Aerospace Center (Deutsches Zentrum für Luft und Raumfahrt, DLR) selected EADS Astrium to jointly develop the TerraSAR X satellite, which is an X-band synthetic aperture radar (SAR) observation spacecraft. The spacecraft is currently being built in Friedrichshafen, Germany and is scheduled to be placed into polar orbit by a Dnepr vehicle in October 2006. Infoterra GmbH will be responsible for the commercial exploitation of TerraSAR X data, while DLR will oversee science operations.

A second satellite to complement TerraSAR X is being considered. This suggested TanDEM X mission, an enhancement of TerraSAR X through a second, similar spacecraft allowing the generation of a high-quality global Digital Elevation Model, is being reviewed by DLR. TanDEM X is tentatively projected to launch in early 2009. Furthermore, plans for a complementary L-band spacecraft, TerraSAR L, financed by ESA, have been developed with Infoterra Ltd. in the United Kingdom, another company in the InfoTerra Group. An implementation decision is still pending for TerraSAR L and a potential launch of the satellite is not envisioned before early next decade.

MDA Geospatial Services

MacDonald, Dettwiler and Associates' (MDA) Geospatial Services unit (formerly Radarsat International) is the worldwide distributor of Radarsat 1 data. Radarsat 1, launched in November 1995 aboard a Delta 2, has gathered SAR data over nearly the entire Earth's surface. The spacecraft provides data with resolutions between eight and 100 meters (26.2 and 328.1 feet) and has a repeat cycle of 24 days. Radarsat 2, planned for launch in late 2006 on a Soyuz rocket, will continue the mission of its predecessor while offering significant technical advancements, including improved resolutions of three meters (ten feet).

The Radarsat 2 program marks a transition from the government-led Radarsat 1 program to one now led by the private sector. MDA will own and operate the satellite and ground segment and will be responsible for satellite mission management operations and satellite programming, as well as international marketing and data distribution.

In 2004, the Canadian Space Agency (CSA) commissioned MDA to develop concepts for a follow-on to Radarsat 2. In February 2005, the CSA announced funding for a three-satellite SAR constellation to succeed Radarsat 2. The three satellites, projected to weigh approximately 1,200 kilograms (2,643 pounds) each, will be placed in the same orbital plane spaced apart by 120 degrees. The constellation is scheduled for deployment early next decade.

Northrop Grumman

Northrop Grumman was granted a NOAA commercial remote sensing license for a system called Continuum in February 2004. The spacecraft will be able to take still and video images at a resolution of 0.5 meters (1.6 feet), despite the high altitude of the two-satellite system in elliptical MEO orbits ranging from 1,340 to 6,188 kilometers (833 to 3,845 miles). This is feasible using technology developed for the James Webb Space Telescope that Northrop Grumman is building for NASA. Once work begins, Northrop is planning a four-to-five-year development plan for Continuum. The two spacecraft would be launched 18 months apart using EELV-class vehicles from Vandenberg Air Force Base, California. During the past year there has been no indication of funding for this system, as well as no indication that manufacturing has proceeded.

RapidEye AG

RapidEye, a German company providing satellite-based geo-information services, is pursuing a five-satellite system designed to provide data for customers interested in agricultural and cartographic applications, with other markets possible. The satellite constellation design provides high temporal frequency and redundancy. Each RapidEye satellite will be placed into the same orbital plane, and will be supported by an S-band command center and an X-band downlink ground component. The five satellites, each providing resolution of up to 6.5 meters (21.3 feet), will be launched together in the first half of 2007 on a single Dnepr vehicle.

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

TransOrbital

TransOrbital has a unique business plan that will make it the first company to obtain and sell lunar imagery by sending a commercial spacecraft to orbit the Moon. The company secured a NOAA license in 2002 to image Earth during its mission. With the successful launch of its TrailBlazer Structural Test Article in December 2002, TransOrbital is developing the operational spacecraft to carry out its imaging mission, TrailBlazer, which will provide live streaming video of the Moon's surface, pictures of Earth from lunar orbit, maps of the lunar surface, and a fast pass over lunar terrain as it heads toward impact with the surface at its mission's end. TrailBlazer's sensors will have a resolution of about one meter. TransOrbital is currently pursuing funding for the future launch of TrailBlazer, which is presently projected to occur around the 2007 to 2008 timeframe.

Market Demand Scenarios

FAA/AST projects that the commercial satellite remote sensing sector will yield about 20 payloads throughout the forecast period, with a peak in 2007 due to the launch of five RapidEye satellites. These satellites will be deployed on 14 launches, including 12 medium-to-heavy vehicles.

NGSO Telecommunications Systems

NGSO telecommunications systems today fall into two classes, Little LEO and Big LEO. The names derive from the frequencies used by these systems: Little LEO systems operate at frequencies below 1 GHz while Big LEO systems, also known as Mobile Satellite Services (MSS), use frequencies in the range of 1.6–2.5 GHz. Little LEO systems provide narrowband data communications such as e-mail, two-way paging, and simple messaging for automated meter reading, vehicle fleet tracking, and other remote data monitoring applications. Big LEO systems provide mobile voice telephony and data services. (A third class of NGSO telecommunications systems, called Broadband LEO, was proposed in the 1990s to provide high-speed data services at Ka- and Ku-band frequencies. None of the proposed Broadband LEO systems, such as Skybridge and Teledesic, were deployed, and none are under active consideration today.)

To date one Little LEO system, ORBCOMM, and two Big LEO systems, Globalstar and Iridium, have been deployed. All three systems are in good health, and their operators are actively planning to launch replacement satellites and next-generation systems. Details about these three systems, and other NGSO telecommunications operations, are provided below. Little LEO systems are summarized in Table 12 and Big LEO systems in Table 13.

Globalstar

Globalstar plans to launch eight spare satellites in the first half of 2007. In October 2005 Globalstar signed a contract with Starsem for the launch of four satellites on a single Soyuz rocket in early 2007. The contract includes an option for a second Soyuz launch. Globalstar also signed a

Table 12. FCC-Licensed Little LEO Systems

System	Operator	Prime Contractor	Satellites: Number	Satellites: Mass kg (lbm)	Orbit Type	First Launch	Status
Operational							
ORBCOMM	ORBCOMM Global LP	Orbital Sciences Corp.	35/30 (in orbit/ operational)	43 (95)	LEO	1997	Operational with 35 satellites on orbit; FCC licensed, October 1994. Filed for bankruptcy protection in September 2000, emerged from bankruptcy protection in March 2002. Launches of replacement satellites scheduled to begin in 2007.
Under Development							
AprizeStar (LatinSat)	Aprize Satellite	SpaceQuest	4/2 (in orbit/ operational)	10 (22)	LEO	2002	Planned 48-satellite system. Received experimental FCC license in 2004. Licensed by Argentine CNC in 1995.

contract with Eurockot in October 2005 for replacement satellite launches. The company will decide after the initial Soyuz launch whether to launch the remaining satellites on a single Soyuz or multiple Rockot launches. The satellites are ground spares that were built under the original 1994 contract between Globalstar, LP and Space Systems/Loral.

Globalstar is also in the initial planning stages for its next-generation satellite system. In April 2006 Globalstar issued a contract to Alcatel Alenia Space to perform initial design studies of a new LEO constellation. However, Globalstar has not set a timetable for making a decision on its next-generation system, and is considering a number of alternatives, including replacing its NGSO system with one or more satellites in GSO. The current Globalstar constellation should remain operational through 2011 after the launch of its spare satellites.

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

Globalstar, Inc., previously Globalstar LLC, was created in April 2004 when Thermo Capital Partners LLC bought most of the assets of the original Globalstar, LP, which filed for Chapter 11 bankruptcy protection in February 2002. (The company converted from a limited liability company to a corporation in March 2006.) Following the exercise of certain rights by the former creditors of Globalstar, LP, Thermo owns about 64 percent of New Globalstar and the former creditors, including QUALCOMM and Loral Space & Communications, hold about 36 percent. Globalstar is planning an initial public offering (IPO) of stock in 2006.

With its existing resources, Globalstar continues to expand its business. In March 2006 the company celebrated its 200,000th customer. The company's data services experienced 300% growth in 2005, to 20,000 subscribers, as the company rolled out those services in various markets around the world. The company has also been expanding its coverage by opening new gateways: one, in Florida, opened in July 2005 to serve the southeastern U.S. and Caribbean; a second is scheduled to open in Alaska in the summer of 2006. Eventually, Globalstar hopes to add gateways to serve Africa, the Indian subcontinent, and Southeast Asia. Globalstar is expanding its service offerings to include new fax and data services, and high data rate terrestrial and aviation products.

With the authorization of the FCC in 2005, Globalstar reconfigured its operational constellation from the original configuration of 48 satellites with six satellites in each of eight planes to 40 satellites with five satellites in each plane. This was done to provide additional on-orbit sparing to ensure service quality.

Iridium

Iridium Satellite LLC announced in February 2006 that it will carry out a study in 2006 on plans for a next-generation satellite system. Its current constellation of 66 operational spacecraft and 11 in-orbit spares is expected to last through at least

2014, with some satellites remaining functional beyond 2020. New satellites will likely be launched gradually, at the rate of several per year, starting around 2013. The new satellites will be backwards compatible with the existing constellation, but Iridium is studying a number of new features that could be included on the next-generation satellites, from high-speed data services to enhanced GPS.

Iridium reported a total of approximately 142,000 voice and data subscribers at the end of 2005, an increase of 24 percent over the end of 2004. The company's revenues increased 55 percent over the prior year, and its EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) was ten times larger in 2005 over 2004, the first year the company had positive EBITDA. In the aftermath of Hurricanes Katrina and Rita on the Gulf Coast, Iridium reported a 3,000-percent increase in traffic and a 500-percent increase in subscribers in the region. The Defense Department, which signed a two-year, $72-million contract with Iridium in 2000, which has since been extended several times, remains a major customer for the company.

Originally conceived by Motorola in 1991, Iridium's satellite telephony system was developed and deployed at a cost of around $5 billion. Iridium Satellite LLC purchased all the assets of bankrupt Iridium LLC for $25 million and began operations in April 2001. Total investments into the revitalized Iridium are reportedly around $130 million.

A total of 95 satellites have been launched, including seven spare satellites launched in 2002: five on a Delta 2 and two on a Rockot. The company has no spare satellites remaining on the ground and has no plans to build any until it decides to deploy a second-generation satellite system.

ORBCOMM

ORBCOMM is actively developing plans to replace its existing constellation of satellites over the next several years. A demonstration satellite provided by OHB-System, a German company, will be launched non-commercially in 2006 as a secondary payload on a Cosmos 3M booster. OHB-System is the system integrator for the satellite, using a bus provided by Russian manufacturer Polyot and a communications payload from Orbital Sciences Corporation. The satellite will carry the standard ORBCOMM communications payload as well as an Automatic Identification System payload for the U.S. Coast Guard, as part of a contract signed between ORBCOMM and the Coast Guard in the summer of 2004.

ORBCOMM will follow this with the launch of its next-generation satellites. The first launch of six satellites, on a mission dubbed "QuickLaunch" scheduled for 2007,

Table 13. FCC-Licensed Big LEO Systems

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

will be used to replenish Plane A of the ORBCOMM constellation, whose existing satellites are the oldest. Additional launches will follow through 2009. ORBCOMM plans to announce satellite manufacturing and launch services contracts in mid-2006 for the next-generation system. By the time the next-generation system is deployed, ORBCOMM will operate 32 spacecraft in four planes of eight satellites each.

In January 2006 ORBCOMM announced it had raised over $110 million from various investors, including $60 million from the investment fund Pacific Corporate Group. This is in addition to the $26 million ORBCOMM announced in February 2004; several of the investors from that round also participated in the new round. ORBCOMM plans to use the new funds to finance its next-generation satellite system as well as upgrade its network infrastructure.

The ORBCOMM constellation is currently comprised of 35 satellites (30 of which are operational) in orbits of 825 kilometers (513 miles) in altitude, launched primarily between 1997 and 1999. Founded by Orbital Sciences Corporation (later adding major investor Teleglobe Canada), operations began in November 1998 with full commercial service available in March 2000. After shipping over 20,000 units, ORBCOMM filed for U.S. Bankruptcy Court protection in September 2000. A new firm, ORBCOMM Holdings LLC, bought ORBCOMM's assets in April 2001 and currently operates the system under the ORBCOMM name. ORBCOMM has 100,000 communicators installed worldwide, although the exact number of customers is not known since ORBCOMM works through value-added resellers rather than directly with customers. The company is currently operating at around break-even.

Other Systems

Several other ventures obtained FCC licenses for Little LEO systems in the late 1990s but failed to meet the satellite assembly and launch schedules proscribed in the licenses because of difficulty obtaining funding. The FCC declared null and void the licenses of E-Sat and Final Analysis in April 2003 and March 2004, respectively. Leo One USA voluntarily surrendered its license in March 2004. There is little licensing activity regarding Little LEO spectrum at this time.

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

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

In January 2005, ICO filed an application with the FCC seeking approval to modify its NGSO satellite service authorization to substitute a GSO satellite system to access the U.S. market. The FCC approved this application in May 2005. Space Systems/ Loral is building the GSO satellite for ICO, which is scheduled for launch in mid-2007 to meet its 2-GHz license deadline. It is unclear if ICO plans to resume development of an NGSO system at some future time.

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

ContactMEO was granted authority by the FCC in April 2006 for a hybrid GSO/NGSO Ka-band system, featuring four GSO and three NGSO satellites. The GSO satellites have been authorized for construction, launch, and operations, while the NGSO satellites have only been authorized for construction. The launch and operations authority for the NGSO satellites is pending more information from the company on end-of-life disposal plans for those spacecraft.

Market Demand Scenarios

FAA/AST projects that 35 Little LEO satellites will be launched during the coming decade and generate a demand for five launches of small vehicles. FAA/AST also projects that eight Big LEO satellites will be launched during the coming decade to cover the replenishment of one existing system. These payloads will be deployed on two launches of medium-to-heavy vehicles.

Future Markets

Recent years have seen the gradual development of a suborbital space tourism industry, fostered in part by events such as the Ansari X Prize and the successful flights of SpaceShipOne in 2004. New companies, some with considerable financial resources available, are developing suborbital spacecraft with the goal of regular passenger flights beginning as early as 2007– 2008. Since this report only includes orbital commercial missions, the outlook for suborbital vehicles is not included in this forecast. The question is: when will orbital public space travel emerge?

Bigelow Aerospace announced America's Space Prize in the fall of 2004: a new $50-million orbital contest for a privately-funded spacecraft capable of carrying people to an altitude of 400 kilometers (240 miles) by January 2010. The orbital spacecraft must demonstrate the ability to rendezvous and dock with Bigelow's expandable space habitat, complete two orbits, return safely, and repeat a second mission within 60 days carrying a crew of at least five people. Numerous companies both large and small have expressed an interest in pursuing the prize. Currently, Bigelow Aerospace is moving ahead with plans to deploy subscale technology demonstrators, to test and prove fundamental aspects of expandable habitat technology. The first series of demonstrators are called Genesis-1 and 2, which will be followed by other more complex and larger demonstrators such as the Galaxy and Guardian classes. Four demonstrator launches are currently planned to take place over the course of 2006 and 2007. Advances made and lessons learned from the subscale missions will eventually lead to the deployment of the company's first, full-scale prototype, the BA-330, whose name is derived from the fact that the habitat will offer 330 cubic meters (11,654 cubic feet) of usable volume.

To date there have been three orbital space tourist flights, all scheduled missions were launched by Russia as part of regular crew visits to the International Space Station (ISS). Dennis Tito launched on a Soyuz to the ISS for a one-week visit in 2001, Mark Shuttleworth launched in 2002, and Gregory Olsen in 2005. Two other tourists, Daisuke (Dice-K) Enomoto and Charles Simonyi, have signed contracts to fly to the station in late 2006 and as early as 2007, respectively.

The X Prize Foundation plans follow-on activity, including suborbital contests for the X Prize Cup in a series of promotional and contest events starting in 2005, and possible future contests for point-to-point long-distance travel. The foundation has no plans at this time for orbital prizes, but most companies planning suborbital passenger vehicles are also considering transitional vehicles for orbital space flight.

NASA's "Centennial Challenges" prize competition program, part of the Vision for Space Exploration, may include future Challenges for spacecraft missions, including breakthrough technology demonstration missions and missions to the Moon and other destinations that could stimulate demand for low-cost, emergent launch capabilities. The agency plans competitions in the next few years in areas such as non-toxic rocket engine development, subscale orbital fuel depots, and lunar lander analogs, among other areas. A provision of the National Aeronautics and Space Administration Authorization Act of 2005 allows NASA to award multimillion-dollar prizes, although awards in excess of $10 million require Congressional notification.

Another future market that NASA is attempting to stimulate is the commercial servicing of the ISS. In January 2006 NASA issued a Final Announcement for its Commercial Orbital Transportation Services (COTS) program, a $500-million, four-year effort where NASA will help fund the development of commercial vehicles that can carry cargo, and eventually crew, to and from the ISS. Bidders must identify in their proposals what markets in addition to NASA they plan to service with their vehicle. Any demonstration flights carried out under the COTS program will be licensed by the FAA. NASA plans to announce COTS contract awards in 2006.

Risk Factors That Affect Satellite and Launch Demand

Several factors could negatively or positively impact the NGSO forecast:

- **U.S. national and global economy**—It is not coincidental that the NGSO market's peak activity was during a time of continued U.S. economic expansion when investment capital soared during the 1990s. Similarly, economic good times in other countries generated high interest in new telecommunications services from space. While these ideal situations are no longer present, economic conditions are certain to change. As with other businesses, growth or decline in space markets is often affected by national economies.

- **Investor confidence**—After investors suffered large losses from the bankruptcies of high-profile NGSO systems, confidence in future and follow-on NGSO telecommunications systems plummeted. 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. Although satellite radio is steadily growing in the United States, it is only now gaining interest among investors in Europe.

- **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 purchased excess capacity on communications satellites. 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, especially for satellites three or four years ahead, 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 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 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 also puts 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. Developers of new space systems have to plan ahead extensively for design, construction, and testing of space technologies, while developers of terrestrial technologies can react and build to market trends more quickly and possibly convince investors of a faster return on investment.

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

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

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

- **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. 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, low prices have not increased satellite 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. Prize competitions can also stimulate the development of new markets, allowing both winning and losing competitors to pursue a return on the investment made to capture a prize. A successful competition can inspire other competitions.

Methodology

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

Traditionally, very small satellites—those with masses of less than 100 kilograms (220 pounds)—ride as secondary payloads and thus do not generate "demand" for a single launch in this forecast. However, the launch providers for the Russian/Ukrainian Dnepr and Russia's 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 with masses less than 10 kilograms (22 pounds) 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.

International launch providers were surveyed for the latest available near-term manifests. Table 14 shows the announced near-term manifests for the markets analyzed in this report.

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 (5,000 pounds), at 185 kilometers (100 nautical miles) 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;

Table 14. Near-Term Identified NGSO Satellite Manifest

Service Type	2006	2007	2008	2009
Commercial Remote Sensing	Radarsat 2 - Soyuz	GeoEye 1 - Delta 2	WorldView 2 - TBA	EROS C - START
	EROS B - START 1	RapidEye (5) - Dnepr		TanDEM X - TBA
	TerraSAR X - Dnepr	WorldView - Delta 2		
International Science	Kompsat 2 - Rockot	GOCE - Rockot	CASSIOPE - Falcon 9	Cryosat 2 - TBA
	RazakSAT - Falcon 1	SMOS - Rockot		
	AGILE - PSLV	THEOS - Rockot		
	LAPAN-TUBSAT - PSLV			
	Egyptsat - Dnepr			
	Saudisat 3 - Dnepr			
	SaudiComsat 3-7 - Dnepr			
	AKS 1-2 - Dnepr			
	Corot - Soyuz 2			
Telecommunications		ORBCOMM (6) - TBA	ORBCOMM (6) - TBA	ORBCOMM (6) - TBA
		Globalstar (4) - Soyuz	ORBCOMM (6) - TBA	ORBCOMM (6) - TBA
		Globalstar (4) - TBA		
Other	Genesis Pathfinder 1 - Dnepr	Galaxy - Dnepr	Sirius Radio 4 - Proton	
	Genesis Pathfinder 2 - Dnepr	Guardian 1 - Dnepr	SAR Lupe 5 - Cosmos	
	SAR Lupe 1 - Cosmos	SAR Lupe 3 - Cosmos	Cosmo-Skymed 3 - TBA	
	SAR Lupe 2 - Cosmos	SAR Lupe 4 - Cosmos	Cosmo-Skymed 4 - TBA	
	Cosmo-Skymed 1 - TBA	Cosmo-Skymed 2 - TBA		
Total Payloads	22	29	18	15
Total Launches	13	14	8	5

Note: This manifest includes only those satellites announced as of April 28, 2006.
It does not include secondary payloads that do not generate launch demand.

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

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

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

Satellite and Launch Forecast

In this forecast, the number of satellites seeking future commercial launch is approximately 160, 11 percent higher than the 2005 forecast, which predicted 144 satellites to be launched in the 2005–2014 timeframe. This comes after two years of significant increases in the number of satellites; the number of satellites in the 2005 forecast was 80 percent greater than in the 2003 forecast. An increase in the number of international science and other satellites as well as plans for a replacement Little LEO system are the primary drivers of this year's increase. The number of launches in this year's forecast is 69, up eight percent from the 2005 forecast, which estimated 64 launches.

The forecast anticipates the following satellite market characteristics from 2006–2015:

- International science and other satellites (such as technology demonstrations) will comprise about 61 percent of the NGSO satellite market with 97 satellites, slightly higher than the 87 satellites in the 2005 forecast.

- Telecommunications satellites account for 27 percent of the market with 43 satellites, a slight increase from the 40 in last year's forecast because of emerging details regarding the deployment schedules for next-generation Big LEO and Little LEO systems.

- Remote sensing satellites that serve commercial missions will encompass 12 percent of the market with 20 satellites, comparable to forecasts from the previous three years, which ranged between 16 and 20 satellites.

Table 15 and Figures 12 and 13 show the forecast in which 160 satellites will be deployed between 2006 and 2015. Table 16 shows the mass distributions of known manifested satellites over the next four years. As in the recent past, small satellites dominate: 71 percent of the satellites in the near-term manifest weigh 600 kilograms or less, compared to 68 percent in the 2005 forecast and 78 percent in the 2004 forecast.

After accounting for multiple manifesting, the 160 satellites in the forecast yields a commercial launch demand of 69 launches over the forecast period. This demand breaks down to an average of three and a third launches annually on small launch vehicles and three and a half launches annually on medium-to-heavy launch vehicles. The total number of launches is about the same as in

Figure 12. Satellite Forecast

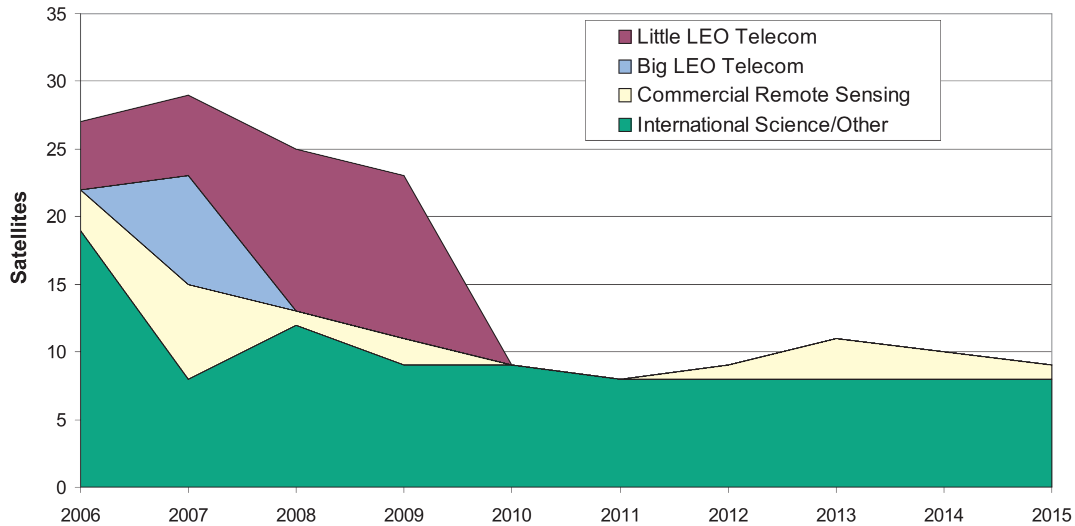


Figure 13. Launch Demand Forecast

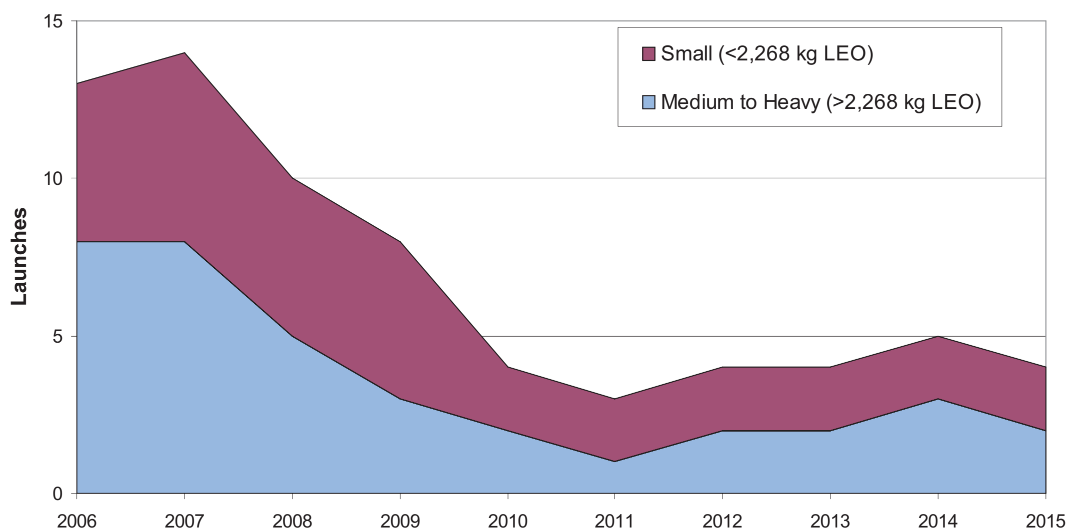


Table 15. Satellite and Launch Demand Forecast

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL	Avg
Satellites												
Big LEO	0	8	0	0	0	0	0	0	0	0	8	0.8
Little LEO	5	6	12	12	0	0	0	0	0	0	35	3.5
International Scientific/Other	19	8	12	9	9	8	8	8	8	8	97	9.7
Commercial Remote Sensing	3	7	1	2	0	0	1	3	2	1	20	2.0
Total Satellites	**27**	**29**	**25**	**23**	**9**	**8**	**9**	**11**	**10**	**9**	160	16.0
Launch Demand												
Medium-to-Heavy Vehicles	8	8	5	3	2	1	2	2	3	2	36	3.6
Small Vehicles	5	6	5	5	2	2	2	2	2	2	33	3.3
Total Launches	**13**	**14**	**10**	**8**	**4**	**3**	**4**	**4**	**5**	**4**	69	6.9

the 2005 forecast, but the mix of vehicles has changed with more medium-to-heavy vehicles and fewer small vehicles. This is attributable to the increased use of medium-class vehicles to launch heavier next-generation commercial remote sensing and international science satellites, at the expense of smaller vehicles. The peak launch activity in the forecast is in 2006 and 2007, with 13 and 14 launches, respectively; all years after 2009 are below the ten-year average of 6.9 launches a year.

As shown in Table 17, 48 of the 69 launches in the current forecast will carry international science and other payloads. Fourteen launches are forecast to carry commercial remote sensing satellites while seven launches will carry telecommunications satellites. International science and other payloads favor small vehicles over medium-to-heavy ones—although by a smaller margin than in the 2005 forecast—as these satellites are typically small enough that several can be manifested on a single small vehicle. Commercial remote sensing satellites, on the other hand, will be launched mostly by medium-to-heavy vehicles because these satellites are generally larger. Telecommunications satellites will use a mix of small vehicles (primarily for Little LEO payloads) and medium-to-heavy vehicles (for Big LEO satellites).

As in the forecasts from the previous three years, this year's report does not include a robust market scenario, because the robust model of scientific and commercial remote sensing payloads did not yield a significant increase nor are there any broadband or new applications systems projected. Furthermore, at this time it is difficult to forecast the complete renewal of orbiting Big LEO satellites. These systems are just entering the design phases for second-generation systems and current systems are healthy and expected to last beyond 2010.

Historical NGSO Market Assessments

The 2006 FAA/AST forecast of commercial NGSO launches and payloads for 2006–2015 shows similar trends to those in the forecast projected in 2005. Historically, there have been significant changes in the amount of payloads and launches that are expected in the forecast period, but the forecast does not project a major change in

Table 16. Distribution of Satellite Masses in Near-Term Manifest

	2006	2007	2008	2009	Total	Percent of Total
< 200 kg (< 441 lbm)	10	11	12	12	45	54%
200-600 kg (441-1323 lbm)	3	9	1	1	14	17%
600-1200 kg (1323-2646 lbm)	5	5	1	2	13	15%
> 1200 kg (> 2646 lbm)	4	4	4	0	12	14%
Total	22	29	18	15	84	100%

Table 17. Distribution of Launches Among Market Sectors

		Launch Demand		
	Satellites	Small	Medium to Heavy	Total
Telecommunications	43	5	2	7
International Science/Other	97	26	22	48
Commercial Remote Sensing	20	2	12	14
Total	**160**	**33**	**36**	**69**

these amounts from last year. Figure 14 provides a historical comparison of FAA/AST forecasts from 2001 to the present, with actual launches to date included. In 1998, FAA/AST forecasted a demand of 1,202 payloads over a 13-year period (1998–2010), with a peak year of 59 launches in 2002. However, from 1999 through 2002, FAA/AST reduced its annual forecasts as demand in the marketplace fell. The next three years' forecasts showed a slight upward trend in the amount of forecasted payloads and launches. The 2006 forecast continues that trend, with 160 payloads projected to launch on 69 vehicles from 2006–2015. This represents an increase of 16 payloads from last year's forecast, the fourth consecutive year of increased payload projections. The 69 launches is a five-launch increase from the 2005 forecast, which had been the only year since 1998 that the total number of launches forecast increased from the previous year's forecast. Figure 15 illustrates these trends by displaying the average number of launches each year in forecasts dating back to 1998, as well as the maximum number of launches in any given year of each forecast.

The number of international science satellites and commercial remote sensing satellites combined are more than those in the telecommunications sector throughout the entire forecast, except for 2007 when the two sectors are equal because of planned Globalstar and ORBCOMM replacement satellite launches. The 2002 forecast was the first occurrence of this sector turnaround from the communications-dominated forecasts of the late 1990s. The satellite communications constellations of Iridium, Globalstar, and ORBCOMM created the most active year for NGSO launches in 1998, when 19 launches occurred.

Table 18 lists actual payloads launched by market sector and total commercial launches that were internationally competed or commercially sponsored from 1993–2005. Medium-to-heavy vehicles performed 41 launches during this period while small vehicles performed 40. Unlike last year's forecast, the 2006 forecast estimates launch demand for more medium-to-heavy vehicle launches (36) than small vehicle launches (33) from 2006–2015. The 2006 forecast projects that 13 of these launches will occur during the 2006 calendar year.

Historical satellite and launch data for the period 1993–2005 are shown in Table 19. Secondary and piggyback payloads on launches with larger primary payloads were not included in the payload or launch tabulations.

Table 18. Historical Commercial NGSO Activity*

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
Satellites														
Big LEO	0	0	0	0	46	60	42	5	1	7	0	0	0	161
Little LEO	1	0	3	0	8	18	7	0	0	2	0	2	0	41
International Science/Other	1	0	0	2	1	4	5	11	1	6	1	7	8	47
Commercial Remote Sensing	0	0	1	0	2	0	2	2	2	0	8	0	0	17
Total Satellites	**2**	**0**	**4**	**2**	**57**	**82**	**56**	**18**	**4**	**15**	**9**	**9**	**8**	266
Launches														
Medium-to-Heavy Vehicles	0	0	0	1	8	9	11	6	2	2	1	1	0	41
Small Vehicles	1	0	2	1	5	10	7	3	2	2	3	1	3	40
Total Launches	**1**	**0**	**2**	**2**	**13**	**19**	**18**	**9**	**4**	**4**	**4**	**2**	**3**	**81**

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

Figure 14. Comparison of Past Baseline Launch Demand Forecasts

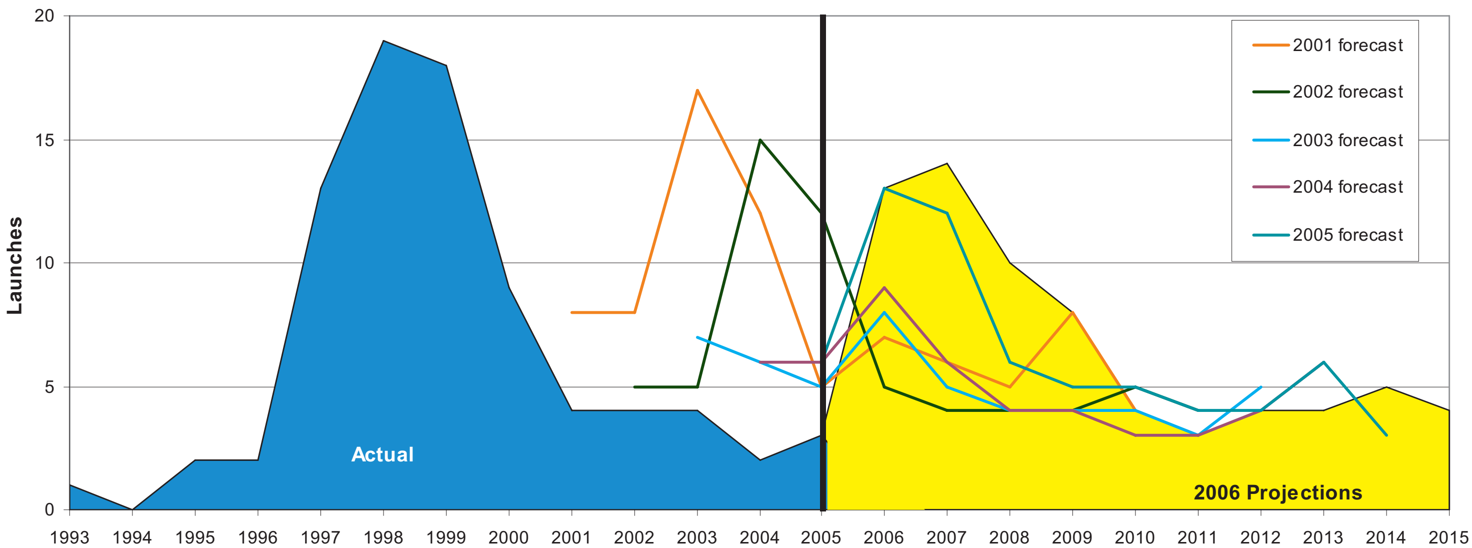


Figure 15. Average and Maximum Launches per Year from NGSO Forecasts 1998–2006

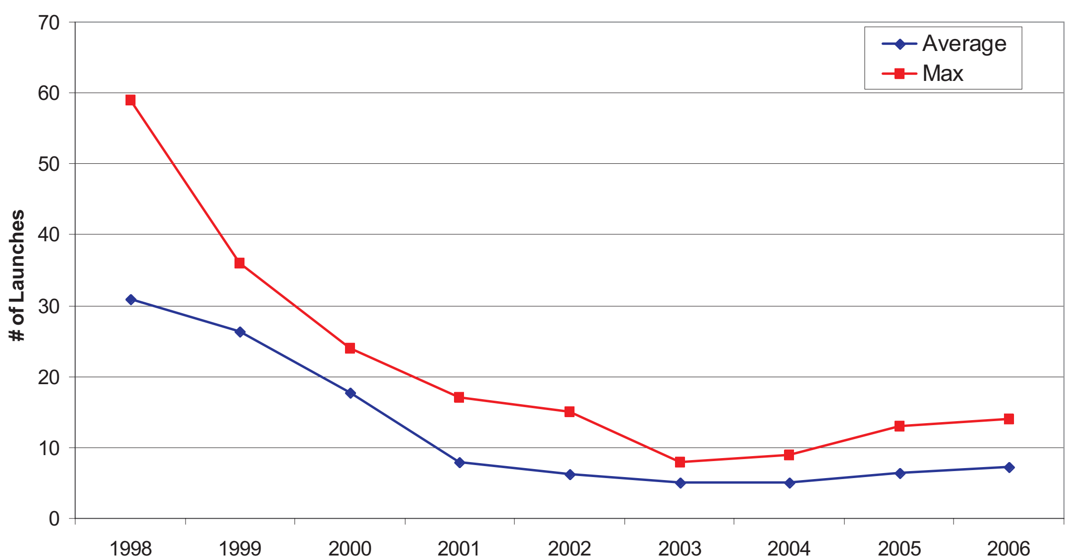


Table 19. Historical NGSO Satellite and Launch Activities (1993–2005)†

Summary	Market Segment	Date	Satellite	Launch Vehicle	
2005					
8 Satellites	**International Science**	6/21/05	Cosmos 1	Volna[F]	Small
8 Int'l Science		10/8/05	CryoSat	Rockot[F]	Small
		10/27/05	Beijing 1	Cosmos	Small
			Mozhayets 5		
			Rubin 5		
3 Launches			Sinah 1		
0 Medium-to-Heavy			SSETI Express		
3 Small			Topsat		
2004					
9 Satellites	**Little LEO**	6/29/04	LatinSat (2 sats)*	Dnepr	Medium-to-Heavy
2 Little LEO					
7 Int'l Science	**International Science**	5/20/04	Rocsat 2	Taurus	Small
		6/29/04	Demeter	Dnepr	Medium-to-Heavy
			AMSat-Echo		
2 Launches			SaudiComSat 1-2		
1 Medium-to-Heavy			SaudiSat 2		
1 Small			Unisat 3		
2003					
9 Satellites	**Remote Sensing**	6/26/03	OrbView 3	Pegasus XL	Small
1 Remote Sensing					
8 Int'l Science	**International Science**	6/2/03	Mars Express	Soyuz	Medium-to-Heavy
			Beagle 2		
		9/27/03	BilSat 1	Cosmos	Small
			BNSCSat		
			KaistSat 4		
4 Launches			NigeriaSat 1		
1 Medium-to-Heavy			Rubin 4-DSI		
3 Small		10/30/03	SERVIS 1	Rockot	Small
2002					
15 Satellites	**Big LEO**	2/11/02	Iridium (5 sats)	Delta 2	Medium-to-Heavy
7 Big LEO		6/20/02	Iridium (2 sats)	Rockot	Small
2 Little LEO					
6 Int'l Science	**Little LEO**	12/20/02	LatinSat (2 sats)**	Dnepr	Medium-to-Heavy
	International Science	3/17/02	GRACE (2 sats)	Rockot	Small
		12/20/02	SaudiSat 1C	Dnepr	Medium-to-Heavy
			Unisat 2		
4 Launches			RUBIN 2		
2 Medium-to-Heavy			Trailblazer Structural		
2 Small			Test Article		
2001					
4 Satellites	**Big LEO**	6/19/01	ICO F-2	Atlas 2AS	Medium-to-Heavy
1 Big LEO					
2 Remote Sensing	**Remote Sensing**	9/21/01	OrbView 4	Taurus[F]	Small
1 Int'l. Science		10/18/01	QuickBird 2	Delta 2	Medium-to-Heavy
4 Launches	**International Science**	2/20/01	Odin	START 1	Small
2 Medium-to-Heavy					
2 Small					

† 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 19. Historical NGSO Satellite and Launch Activities (1993–2005) [Continued]

Summary	Market Segment	Date	Satellite	Launch Vehicle	
2000					
18 Satellites	**Big LEO**	2/8/00	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
5 Big LEO		3/12/00	ICO F1	Zenit 3SL[F]	Medium-to-Heavy
2 Remote Sensing					
8 Int'l. Science	**Remote Sensing**	11/21/00	QuickBird 1	Cosmos[F]	Small
3 Other		12/5/00	EROS A1	START 1	Small
	International Science	7/15/00	Champ	Cosmos	Small
			Mita		
			RUBIN		
		9/26/00	MegSat 1	Dnepr 1	Medium-to-Heavy
			SaudiSat 1-1		
			SaudiSat 1-2		
			Tiungsat 1		
			Unisat		
9 Launches	**Other**	6/30/00	Sirius Radio 1	Proton	Medium-to-Heavy
6 Medium-to-Heavy		9/5/00	Sirius Radio 2	Proton	Medium-to-Heavy
3 Small		11/30/00	Sirius Radio 3	Proton	Medium-to-Heavy
1999					
56 Satellites	**Big LEO**	2/9/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
42 Big LEO		3/15/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
7 Little LEO		4/15/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
2 Remote Sensing		6/10/99	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
5 Int'l. Science		6/11/99	Iridium (2 sats)	LM-2C	Small
		7/10/99	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
		7/25/99	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
		8/17/99	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
		9/22/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
		10/18/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
		11/22/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
	Little LEO	12/4/99	ORBCOMM (7 sats)	Pegasus	Small
	Remote Sensing	4/27/99	IKONOS 1	Athena 2[F]	Small
		9/24/99	IKONOS 2	Athena 2	Small
	International Science	1/26/99	Formosat 1	Athena 1	Small
		4/21/99	UoSat 12	Dnepr 1	Medium-to-Heavy
18 Launches		4/29/99	Abrixas	Cosmos	Small
11 Medium-to-Heavy			MegSat 0		
7 Small		12/21/99	Kompsat	Taurus	Small
1998					
82 Satellites	**Broadband LEO**	2/25/98	Teledesic T1 (BATSAT)	Pegasus	Small
1 Broadband LEO					
60 Big LEO	**Big LEO**	2/14/98	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
18 Little LEO		2/18/98	Iridium (5 sats)	Delta 2	Medium-to-Heavy
3 Int'l. Science		3/25/98	Iridium (2 sats)	LM-2C	Small
		3/29/98	Iridium (5 sats)	Delta 2	Medium-to-Heavy
		4/7/98	Iridium (7 sats)	Proton	Medium-to-Heavy
		4/24/98	Globalstar (4 sats)	Delta 2	Medium-to-Heavy
		5/2/98	Iridium (2 sats)	LM-2C	Small
		5/17/98	Iridium (5 sats)	Delta 2	Medium-to-Heavy
		8/20/98	Iridium (2 sats)	LM-2C	Small
		9/8/98	Iridium (5 sats)	Delta 2	Medium-to-Heavy
		9/10/98	Globalstar (12 sats)	Zenit 2[F]	Medium-to-Heavy
		11/6/98	Iridium (5 sats)	Delta 2	Medium-to-Heavy
		12/19/98	Iridium (2 sats)	LM-2C	Small
	Little LEO	2/10/98	ORBCOMM (2 sats)	Taurus	Small
		8/2/98	ORBCOMM (8 sats)	Pegasus	Small
		9/23/98	ORBCOMM (8 sats)	Pegasus	Small
19 Launches					
9 Medium-to-Heavy	**International Science**	7/7/98	Tubsat N & Tubsat N 1	Shtil	Small
10 Small		10/22/98	SCD 2	Pegasus	Small

Table 19. Historical NGSO Satellite and Launch Activities (1993–2005) [Continued]

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