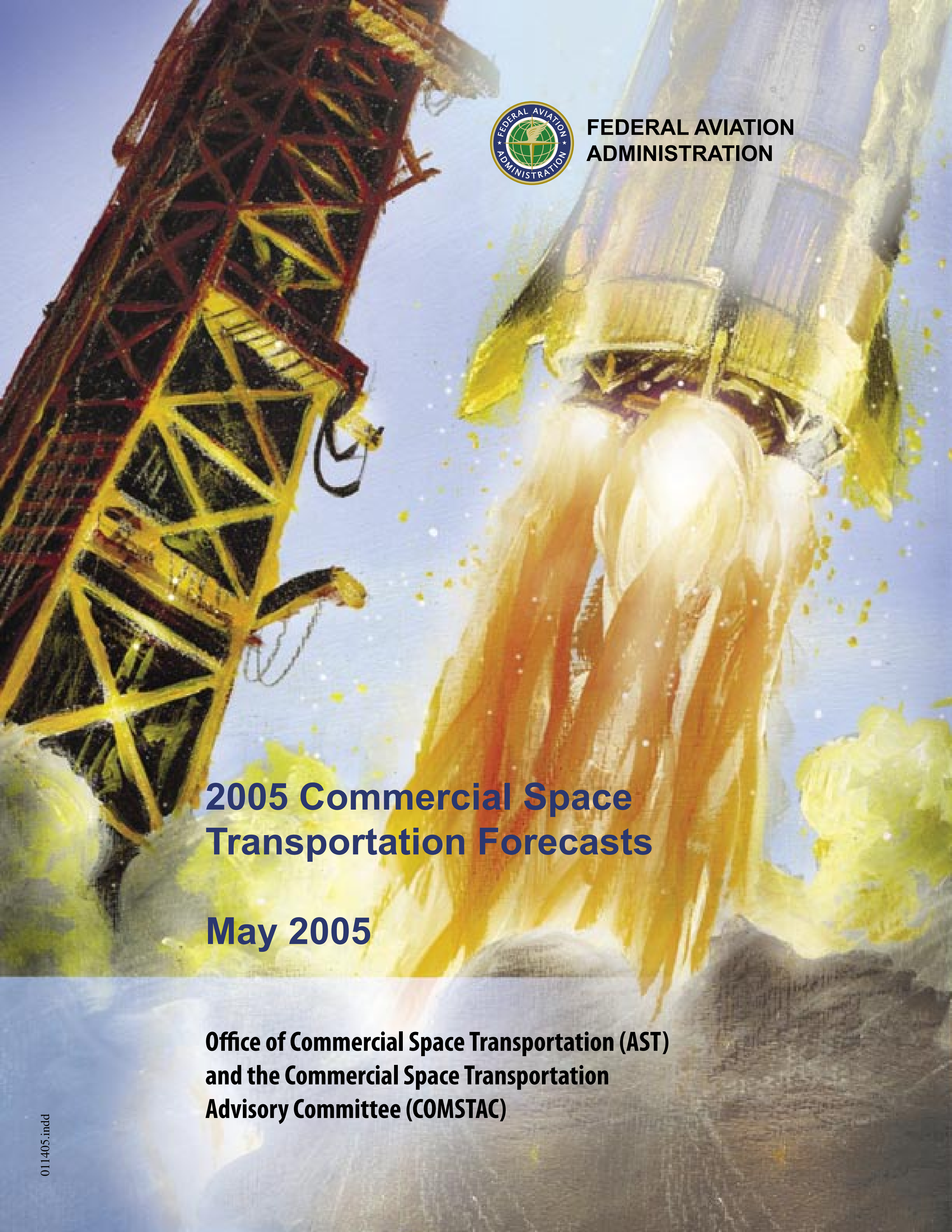

FEDERAL AVIATION
ADMINISTRATION

2005 Commercial Space Transportation Forecasts

May 2005

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

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

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) licenses and regulates U.S. commercial space launch and reentry activity for the Department of Transportation 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 Department of Transportation 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 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 Phil Smith (2005)

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Executive Summary

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) and the Commercial Space Transportation Advisory Committee (COMSTAC) have prepared forecasts of global demand for commercial space launch services for the period 2005 to 2014.

The *2005 Commercial Space Transportation Forecasts* report includes:

- The *COMSTAC 2005 Commercial Geosynchronous Orbit Launch Demand Model*, which projects demand for commercial satellites that operate in geosynchronous orbit (GSO) and the resulting commercial launch demand to geosynchronous transfer orbit (GTO); and

- The *FAA's 2005 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 22.8 commercial space launches worldwide from 2005 to 2014. The combined forecast is similar to last year's forecast of 23.4 launches per year as well as the 2003 forecast of 23.7 annual launches. The forecast projects a demand for up to 25 launches during 2005, including some missions delayed from 2004.

In the GSO market, satellite demand averages 20.5 satellites per year, similar to 21.1 satellites the 2004 forecast. The resulting demand for launches changed from 18.3 per year in 2004 to 16.4 per year because of an adjustment in the number of annual dual-manifested launches from about three last year to four in this year's forecast. An analysis in the report indicates GSO satellite mass is increasing compared to the results of last year's forecast.

The NGSO market includes 144 satellites from 2005–2014, the second significant year-to-year forecast increase since 1998. Despite a 36 percent increase of the number of satellites, launch demand overall is up about 25 percent because a few missions are multiple-manifested with groups of satellites riding on a single vehicle. While demand for medium-to-heavy NGSO launch vehicles is about the same as the 2004 forecast, demand for the number of small launch vehicles in the 2005 forecast increased by an average of one per year.

COMSTAC and FAA project an average annual demand for:

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

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

- 3.9 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 *2005 Commercial Space Transportation Forecasts* report covers the period from 2005 to 2014 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

Prior to the 1980s, launching payloads into Earth orbit was a government-run operation. Since then, launch activity led by commercial companies has increased to meet both commercial and government mission needs. From 1997–2001, a peak era in commercial satellite telecommunications, commercial launches accounted for an average of about 42 percent of worldwide launches. During 2004, 15 out of 54 worldwide launches were commercial, representing 28 percent of global activity.

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 2005 Commercial Geosynchronous Launch Demand Model

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 baseline model for deployment of NGSO satellites that are considered the most likely to launch and estimates launch demand after a review of multiple manifesting.

2005 Combined Satellite and Launch Forecast

This year's COMSTAC GSO and FAA NGSO combined forecast contains 349 international satellites expected to seek commercial launch services between 2005 and 2014, as shown in Table 1 and Figures 1, 2, and 3. The amount is more than last year's forecast of 317 satellites during the period 2004–2013 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 228 commercial launches to GSO and NGSO destinations is forecast through 2014, as shown in Table 1 and Figure 3. This translates to an average demand of 22.8 worldwide launches per year, similar to the 2004 forecast of 23.4 launches per year.

The GSO launch market contains 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 fifth year in a row. There are 205 GSO satellites in the ten-year forecast, compared with 144 in NGSO.

The GSO forecast contains an average of 20.5 satellites per year with a high of 24 and a low of 18 during the 2005–2014 period. The average is similar to the 21.1 satellites in the 2004 forecast. Demand for up to 22 GSO satellites to launch is projected during 2005 (including some delayed from 2004.) Applying a historical realization factor to this projection indicates that between 13 and 19 satellites are likely to actually launch during 2005.

Although the total number of GSO satellites in the 2005 forecast is down slightly in comparison to last year's forecast, launch demand has declined about two launches per year because COMSTAC increased the number of projected dual-launches from three per year to four per year in the 2005 forecast. The report discusses a trend towards increased mass of GSO satellites and in particular the decline of satellites weighing less than 2,200 kilograms.

In the NGSO market, satellite demand is up 36 percent to 144 satellites or 14.4 satellites per year compared to the 2004 forecast of 106 satellites or 10.6 satellites per year. The increase is spread across sectors with more international science spacecraft, technology demonstration missions, a series of radar satellites, and a few more telecommunications satellites.

Some individual NGSO launches contain multiple satellites. The demand for NGSO launches increased to 64 worldwide launches during the next ten years in comparison to last year's forecast of 51 launches from 2004–2013. The NGSO market increase mostly affect the demand for small launch vehicles which grew an average of one launch per year. Demand for medium-to-heavy launch vehicles held about the same with an average of 2.5 launches per year in the 2005 forecast. 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

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total	Average
Satellites												
GSO Forecast (COMSTAC)	22	22	19	18	18	19	21	21	21	24	205	20.5
NGSO Forecast (FAA)	16	18	31	10	16	14	13	8	10	8	144	14.4
Total Satellites	**38**	**40**	**50**	**28**	**34**	**33**	**34**	**29**	**31**	**32**	**349**	**34.9**
Launch Demand												
GSO Medium-to-Heavy	19	16	15	14	14	15	17	17	17	20	164	16.4
NGSO Medium-to-Heavy	1	8	7	2	1	1	1	1	2	1	25	2.5
NGSO Small	5	5	5	4	4	4	3	3	4	2	39	3.9
Total Launches	**25**	**29**	**27**	**20**	**19**	**20**	**21**	**21**	**23**	**23**	**228**	**22.8**

Figure 1. GSO Satellite and Launch Demand

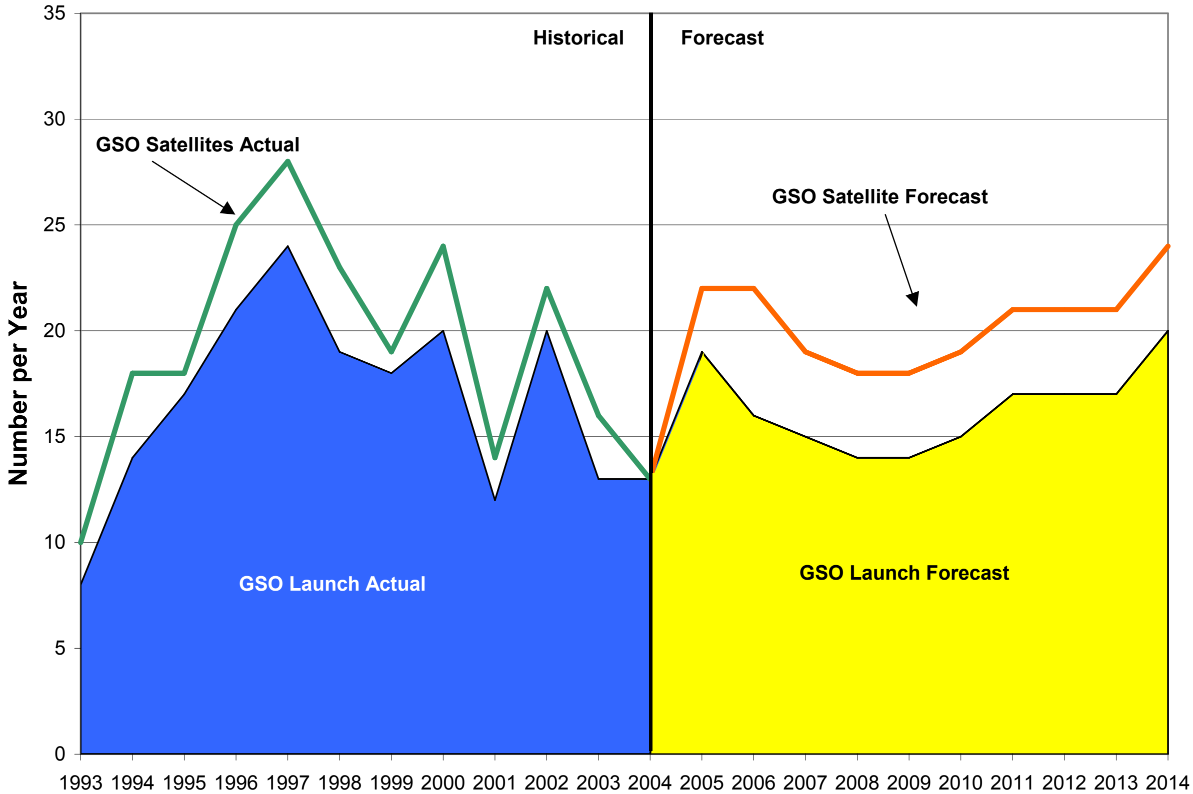


Figure 2. NGSO Satellite and Launch Demand

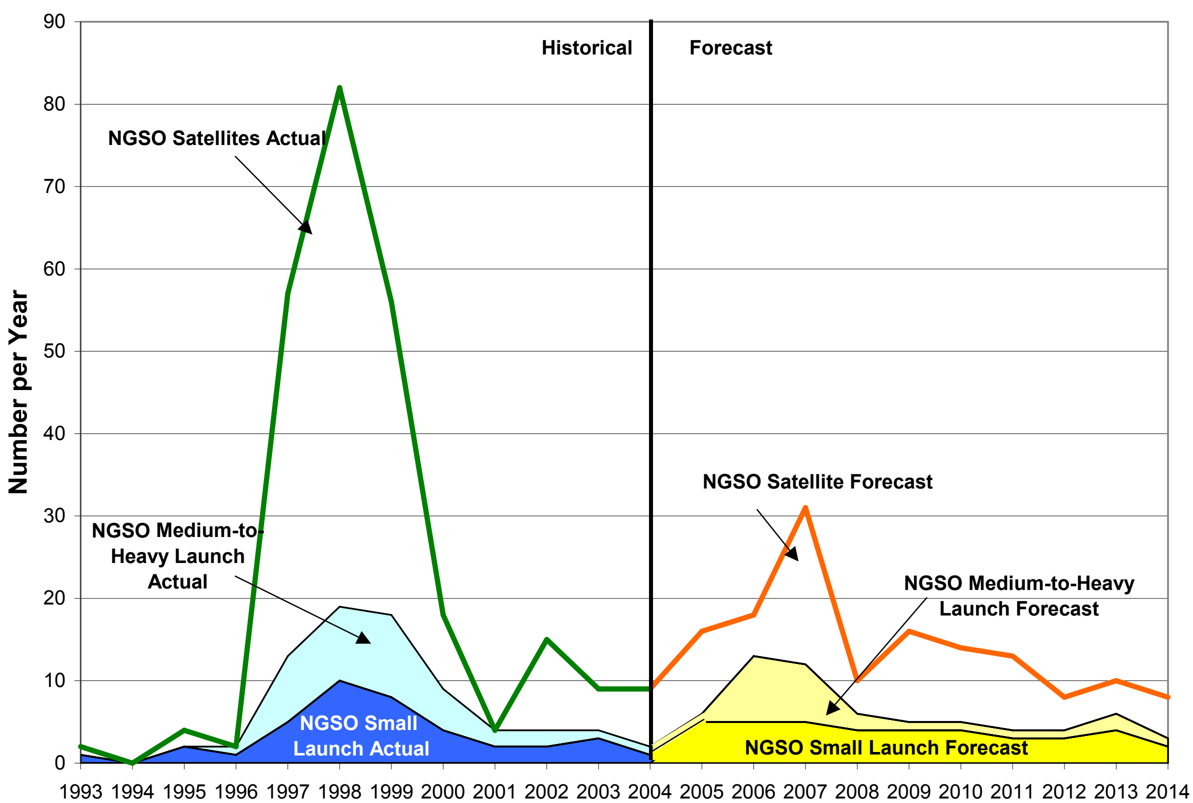


Figure 3. Combined GSO and NGSO Launch Forecasts

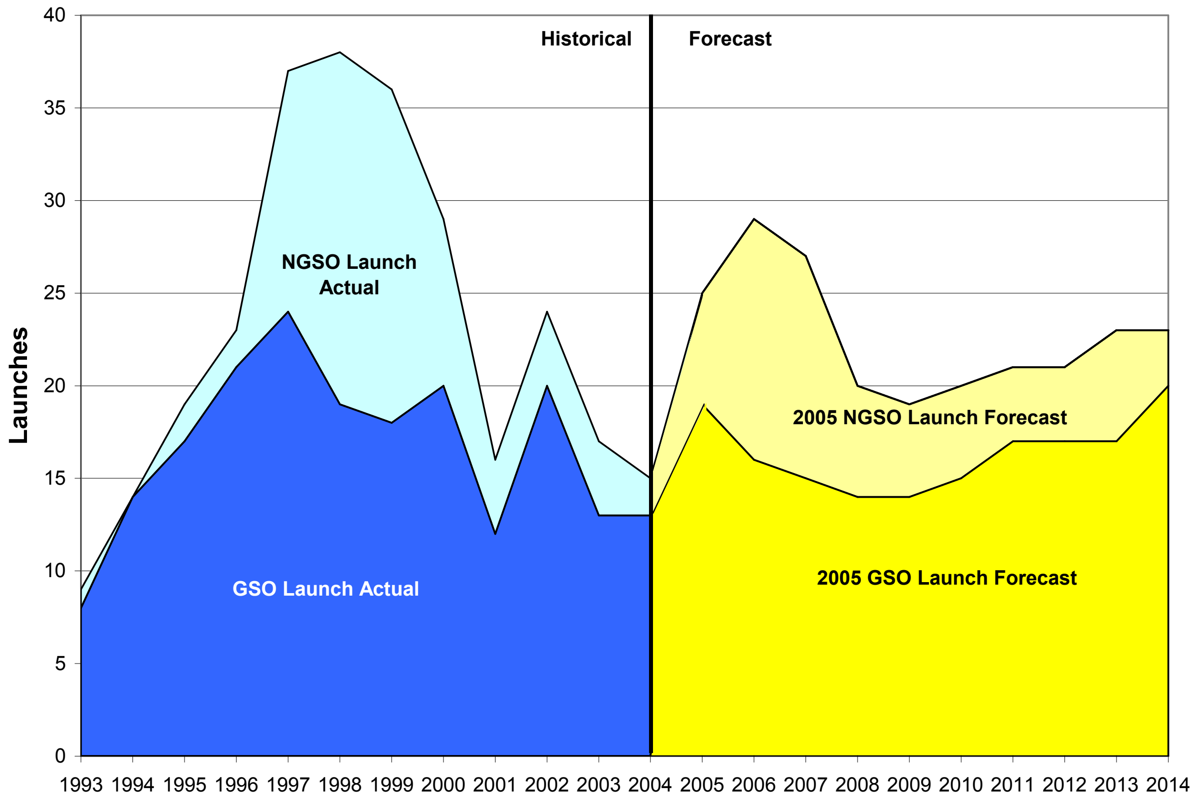
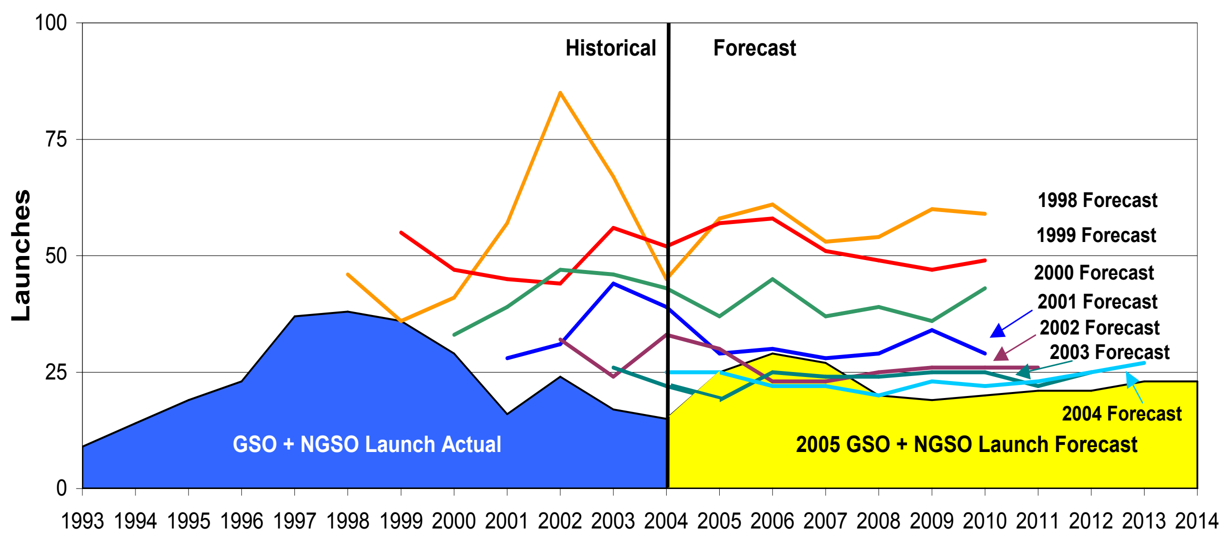


Figure 4. Historical Commercial Space Transportation Forecasts



COMSTAC 2005 Commercial Geosynchronous Orbit (GSO) Launch Demand Model

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 *2005 Commercial Geosynchronous Orbit (GSO) Launch Demand Model* is the thirteenth annual forecast of the worldwide demand for commercial GSO satellites and launches addressable by the U.S. commercial space 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 mission model is updated annually, and is prepared using the inputs from commercial companies across the satellite and launch industries. In this report COMSTAC produces both a satellite and a launch demand forecast. Satellite demand is determined by forecasting the number of GSO satellites that are open to internationally competed launch service procurements. To determine the number of launches in a year, satellite demand is adjusted by the number of satellites projected to be launched with another satellite, referred to in the report as a "dual-manifest" launch.

The near-term forecast, which is based on existing and anticipated satellite programs for 2005 through 2007, shows demand for 22 satellites to be launched in 2005, 22 in 2006, and 19 in 2007. The average annual COMSTAC demand forecasts published in the 2003 and 2004 reports respectively were 23.3 and 21.1 satellites per year over the ten-year forecast period. This year's mission model predicts an average demand of 20.5 satellites to be launched annually from 2005 through 2014, which is nearly the same 10-year average as the 2004 report.

Several factors impact the demand for commercial GSO satellites, including global economic conditions, operator strategies, and availability of financing for satellite projects. The influence of these factors is addressed in more detail later in the report.

In addition to the number of satellites launched, other relevant measures of activity in the commercial space industry have been analyzed. The number of transponders launched and the mass of satellites launched over time show a continuing trend in average satellite mass and a leveling of average number of transponders per satellite. The large predicted increase in satellite mass to be launched in 2005 along with the average number of transponders to be launched indicates an increase in the use of transponders other than C-, Ku-, and Ka-band.

It is important to distinguish between forecasted demand and the actual number of satellites expected to be launched (see Appendix A. Use of the COMSTAC GSO Launch Demand Model). Satellite projects, like many high-technology projects, are subject to schedule slips, which tend to make the forecasted demand an upper limit of the number of satellites that might actually be launched. To provide additional guidance to the reader, a "launch realization factor" has been applied to the near-term forecast based on the actual satellites launches versus predicted demand in previous commercial GSO forecasts.

In 2004, 13 commercial GSO satellites were launched, a decrease of 13 percent from the 2003 total of 15 satellites launched. Last year's commercial model projected a 2004 demand of 20 satellites, with an expected actual launch realization of between 12 and 17 satellites. Of the 13

satellites launched in 2004, 12 were correctly anticipated and one forecast for 2005 (AMC-16) launched early. The remaining eight satellites not launched in 2004 are expected to launch in 2005 and are included in this year's near-term forecast.

Over the thirteen 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. The realization factor is derived by using the calculated historical variance between the forecast and the actual number of satellites launched. Using this methodology, the 2005 demand of 22 satellites will be discounted to an actual number of satellites launched of somewhere between 13 and 19. The variance between forecast demand and the actual number of satellites launched will be discussed in more detail.

The COMSTAC 2005 Commercial GSO Launch Demand Forecast, shown in Figure 5, projects the number of satellites to be launched and the number of launches over the forecast period. It is important to note that the number of satellites launched will likely be greater than the number of launches conducted in any given period because of dual-manifest launches (flying two satellites on the same launch). Table 2 provides an estimate of the number of dual-manifested launches in each year and shows how that affects the number of projected launches.

Figure 5. COMSTAC Commercial GSO Launch Demand Forecast

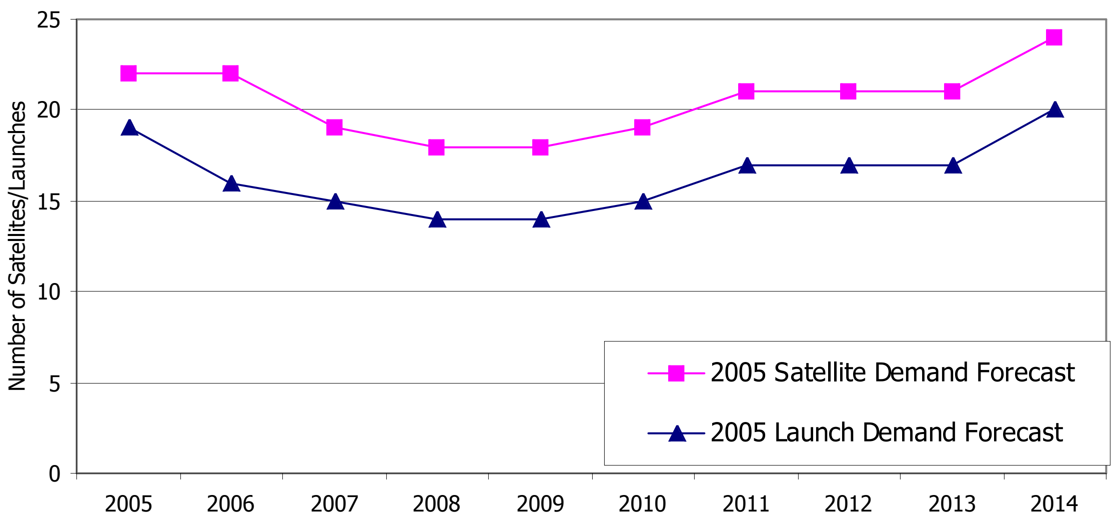


Table 2. Commercial GSO Launch Demand Forecast Data

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total	Average 2005 to 2014
Satellite Demand	22	22	19	18	18	19	21	21	21	24	205	20.5
Dual Launch Forecast	3	6	4	4	4	4	4	4	4	4	41	4.1
Launch Demand Forecast	19	16	15	14	14	15	17	17	17	20	164	16.4

Introduction

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) of the U.S. Department of Transportation (DOT) endeavors to foster a healthy commercial space launch capability in the United States. The DOT feels that it is important to obtain the commercial space industry's view of future space launch requirements and has therefore requested that its industry advisory group, the Commercial Space Transportation Advisory Committee (COMSTAC), prepare a commercial geosynchronous orbit (GSO) satellite launch demand mission model and update it annually.

This report presents the 2005 update of the worldwide commercial GSO satellite mission model for the period 2005 through 2014. It is based on market forecasts obtained in early 2005 from major satellite manufacturers, satellite service providers, and launch service providers worldwide.

It should be emphasized that this is not a forecast of the actual number of satellites launched for any given year. It is a forecast of the demand, i.e., the number of new or replacement satellites that customers wish to launch in a given year. The number of actual launches realized for that year depends on other factors such as performance to schedule by satellite manufacturers and launch providers, and financial health of programs and customers. A more thorough explanation of this difference and the factors that potentially affect the realization of actual launches for a given year is included in the Methodology section of this report.

Included in this report is a "realization factor" based on historical forecast data. This adjusts the demand for satellites to show the range of anticipated actual satellites launched in a given year. The intent is to provide the reader not only with a projection of near-term demand, but also with an estimate of the number of near-term satellites one might reasonably expect to be launched.

Also included is a discussion of factors that can affect future launch demand and of trends in the commercial satellite industry. The report examines data on the number of transponders per satellite and the mass of commercial GSO satellites over time. This analysis shows growth in satellite mass and a stabilization of the number of transponders per satellite from 1993 through 2005.

For the convenience of the reader the Working Group has included a list of historical commercial GSO launches from 1993-2004 in Appendix D.

Background

COMSTAC prepared the first commercial mission model in April 1993 as part of a report on commercial space launch systems requirements. Each year since 1993, COMSTAC has issued an updated model. The process has been continuously refined and industry participation broadened to provide the most realistic portrayal of space launch demand possible. Over the years, the COMSTAC mission model has been widely used by industry, government agencies and international organizations.

The first report in 1993 was developed by the major launch service providers in the U.S. 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 market demand database. In 1995, the Technology and Innovation Working Group (the Working Group) was formally chartered to prepare the annual Commercial Payload Mission Model Update. Since then, the participation in the preparation of this report has grown. This year the committee received 26 inputs from satellite service providers, manufacturers, and launch service providers. COMSTAC would like to thank all of the participants in the 2005 mission model update.

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
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

Methodology

Except for minor adjustments, the Working Group's launch demand forecast methodology has remained consistent throughout the history of the forecast. As in previous years, the Working Group solicited input from satellite operators, manufacturers and launch service providers via letters from the Associate Administrator for Commercial Space Transportation. Separate letters were sent to satellite operators (requesting a projection of their individual company requirements for the period 2005-2014) and to manufacturers and launch service providers (requesting comprehensive industry forecasts of annual addressable commercial GSO satellites for the period 2005-2014).

Addressable payloads in the context of this report are satellites open to internationally competitive launch service procurement. Excluded from this forecast are satellites captive to national flag launch service providers (i.e., USAF or NASA satellites, or similar European, Russian, Japanese, Chinese, or Indian government satellites that are captive to their own launch providers). The remainder of the commercial market, comprised of non-geosynchronous orbit (NGSO) satellites, is addressed in a separate forecast developed by FAA/AST. These projections are included as a separate report within this document.

Commercial GSO satellites are divided into mass classes based on the satellite's separated mass that is to be inserted into geosynchronous transfer orbit (GTO) - these satellites then use their own propulsion systems to reach geosynchronous orbit (GSO). The mass categories are logical divisions based on standard satellite models offered by manufacturers. A detailed explanation of how these categories were developed can be found in the 2002 report. The satellite models associated with each category are shown in Table 3.

The following organizations (noted with the country in which their headquarters are located) responded with data used in the development of this report:

- Alcatel (France)
- Arianespace (France)
- Asia Satellite Telecommunications, Ltd. (China-Hong Kong)
- The Boeing Company* (U.S.)
- Broadcasting Satellite System Corp. (Japan)
- Intelsat (U.S.)
- JSAT Corporation (Japan)
- Kistler* (U.S.)
- Lockheed Martin Space Systems Co.* (U.S.)
- Loral Skynet (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.)
- Satmex (Mexico)
- Sea Launch* (U.S.)
- SES Americom (U.S.)
- SES Astra (Luxembourg)
- Sirius Satellite Radio (U.S.)
- Space Communications Corporation (Japan)
- Space Systems/Loral* (U.S.)

- Spacecom (Israel)
- Telesat Canada
- Thuraya Telecommunications (U.A.E.)

Comprehensive mission model forecasts from the domestic organizations marked by an asterisk (*) were used in determining the demand forecast. The comprehensive inputs provided projections of the total addressable market of customers seeking commercial launch services for GSO spacecraft from the years 2005 to 2014.

The Working Group used the comprehensive inputs from the U.S. respondents to derive the average launch rate for years 2008 through 2014. The comprehensive inputs for each mass category in a given year are averaged. The total forecast for that year is then calculated by adding the averages for each of the four mass categories.

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 new and existing satellite applications
- Attrition
- Availability of financing for commercial space projects
- Industry consolidation
- Competition from terrestrial systems
- Regulatory environment

Forecasting the commercial launch market presents significant difficulty and uncertainty. The satellite production cycle for an existing design is approximately two years. Orders within this two-year window are generally known. Satellites in the third year and beyond become more difficult to identify by name as many of these satellites are in various stages of the procurement cycle. Beyond a five-year horizon, new markets or new uses of satellite technology may emerge. The long-term projection shown in this forecast, therefore, is based on both the replenishment of existing satellites and assessments of new spacecraft potential in new and existing satellite markets.

COMSTAC Demand Projection vs. Actual Launches Realized

Factors That Affect Launch Realization

The near-term COMSTAC mission model (2005–2007) is a compilation of the currently manifested launches and an assessment of potential satellite programs to be assigned to launch vehicles. This forecast reflects a consensus developed by the Working Group based on the current manifests of the launch vehicle providers and the satellite manufacturers.

Several factors can affect the execution of a scheduled launch. These can include launch failures, launch vehicle component problems, or scheduling issues. Satellite suppliers may have factory, supplier, or component issues that can delay the delivery of a spacecraft to the launch site or halt a launch of a vehicle that is already on the pad. Even minor delays of these types for satellites scheduled for launch near the end of a calendar year can easily push launches into the following year. Therefore, these factors will cause differences between the demand for launches and the actual launches for that year. This pattern of firm schedule commitments, followed by delays, has been consistent over the history of the industry.

Regulatory issues also affect launch and satellite businesses. 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.

Customers may also face business issues, including delays in obtaining financing or reprioritizing their business focus, thereby delaying or canceling satellite programs and their launches. More than one issue can affect the schedule of satellite programs; it is not uncommon for both production problems and launch manifesting issues to affect a satellite's schedule.

2004 Space Industry Performance on Launch Demand

In the 2004 COMSTAC Commercial GSO Demand Model, the Working Group listed 20 satellites that were then manifested in that year. Of these 20 satellites, only 12 satellites were actually launched in 2004 and another satellite launched early (AMC-16 had been forecast to launch in 2005). While there was a demand for 20 satellites to be launched as forecasted by the COMSTAC Working Group, the execution on that manifest was impacted primarily by satellite production delays. The eight satellites that did not make their launch dates were affected in the following ways:

- 6 satellites were delayed due to satellite issues
- 2 satellites were delayed due to launch vehicle issues

All eight of these satellites are expected to launch in 2005, with five of the satellites already launched at the time of the writing of this report.

Projecting Actual Launches

The three-year near-term mission model 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 estimate 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 manufacturing or launch schedule delays.

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 first three years of the forecast. The variance in the first forecast year is shown in the historical portion of Figure 6. Since 1996, the variance between forecasted demand and the actual number of satellites launched in the first three forecast years has averaged 24 percent for the first year and 29 percent for the second year. The range of variance between the forecast and real experience is shown in Table 4.

The range of expected actual satellites launched is calculated by multiplying the near-term demand forecast totals for the first and second years by the historical highest and lowest variance for the first and second years (the "realization factor"). Applying this methodology to this year's 2005 demand forecast of 22 satellites, the probable number of satellites that will actually be launched in 2005 will be between 13 and 19 (as illustrated in Figure 6). For the 2006 demand forecast of 22 satellites,

Table 4. Range of Variance Between COMSTAC GSO Forecast and Actual Launches

Variance Between Forecast and Actual Launches	Near-Term GSO Forecast of Demand	
	First Year	Second Year
Highest Variance	42%	55%
Lowest Variance	13%	10%
Average Variance	24%	29%

a realized number of launches of between 10 and 20 is expected.

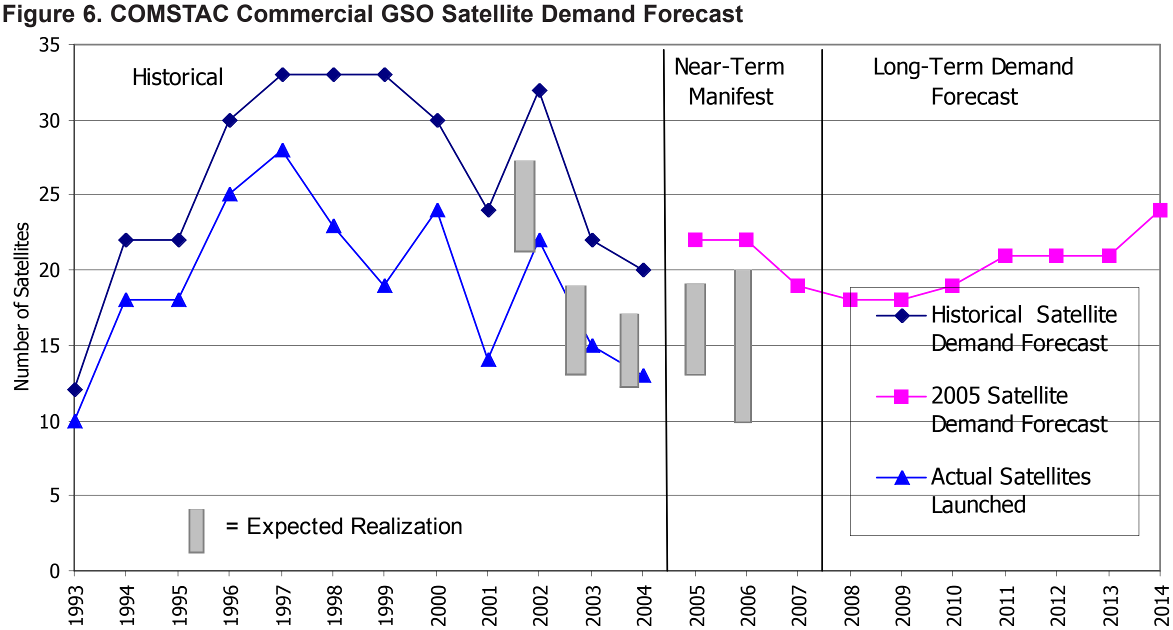
Applying the realization factor to estimate actual satellites launched was first used in the 2002 report. In that report, actual launches were projected for the first year of the near-term forecast. In 2004, based on requests from COMSTAC, the realization factor was expanded to all three years of the near-term forecast. The actual number of satellites launched in 2003 and 2004 fell within the expected range projected using the realization factor. In the 2003 report, the number of actual satellites launched was projected at between 13 and 19 satellites; in 2003, 15 commercial GSO satellites were launched. In the 2004 report, the realization factor indicated actual launches of between 12 and 17; in 2004, 13 commercial GSO satellites were launched.

The Working Group provides this additional guidance to the reader to more clearly illustrate the difference between launch demand and actual launches. The risks and technological complexity of this industry make delays in production and launch cycles highly likely. Presenting the demand forecast results and projected realization of actual launches in this report and describing in detail the actual and potential impacts to the launch schedule should provide the reader with insight to the magnitude and causes of manufacturing and launch delays.

Although an expected launch realization was provided for the third year of the forecast in the 2004 Report, the Working Group has determined that providing a realization factor for the third year does not add value, and has removed it from this year's report. The third year of the near-term forecast is always the most difficult to project because very few satellites are under contract three years prior to launch. This has resulted in substantial differences in the projected third-year satellite demand from one report to the projected second-year satellite demand of the next year's report. For example, the 2004 report projected demand for 16 satellites in 2006 (the third year of that forecast), but the 2005 report projects demand for 22 satellites in 2006 (the second year of that forecast), because more satellites have been put under contract and launch vehicle manifests have become more firm.

Figure 6 shows the demand forecast that is produced using the methodology described. The figure indicates the difference between the near-term manifest and the longer-term forecast, and shows the expected launch realization as described above.

Figure 6. COMSTAC Commercial GSO Satellite Demand Forecast



2005 Near-Term Demand Model

Table 5 shows the near-term mission model for 2005 through 2007, which is a compilation of the currently manifested launches and an assessment of satellites to be assigned to launch vehicles. This mission model projection reflects a consensus developed by the Working Group. The near-term forecast shows 22 satellites to be launched in 2005, 22 in 2006, and 19 in 2007.

Satellite Launch Mass Classes

Satellites comprising the demand forecast are presented in four mass classes; 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). As described earlier, these mass classes are representative of the various satellite models available. More specifically, the definition refers to the separated mass of a satellite to a nominal geosynchronous transfer orbit. In the near-term forecast, the Working Group tried to place each satellite in the appropriate class based on what was known of its mass. For the remaining years of the forecast, the total in each mass class is the average of the domestic comprehensive inputs for each class.

Table 5. Commercial GSO Near-term Mission Model, as of April 28, 2005

	2005	2006	2007
Total	22	22	19
Below 2,200 kg (<4,850 lbm)	3	1	2
	Galaxy 14* – Soyuz Galaxy 15 – Ariane 5 Telkom 2 – Ariane 5	AMC-18 – Ariane 5	AMOS 3 – TBD Bsat 3A - TBD
2,200 – 4,200 kg (4,850-9,260 lbm)	5	8	6
	Arabsat 4A – Proton DirecTV 8 - Proton Insat 4A* – Ariane 5 Spainsat – Ariane 5 XTAR EUR* – Ariane 5	Arabsat 4B – Proton Astra 1L- Ariane 5 Galaxy 17 – TBD Hot Bird 7A – Ariane 5 Insat 4B – Ariane 5 JCSat 10 – Ariane 5 Optus D1 – Ariane 5 Star One C1 – Ariane 5	Measat 4 – TBD Optus D2 – Soyuz PAS 11 – TBD Sirius 4 (NSAB) – Proton Star One C2 – Ariane 5 Thaicom 5 – TBD
4,200 – 5,400 kg (9,260 – 11,905 lbm)	7	10	8
	AMC-12* - Proton Anik F1R - Proton Astra 1KR - Proton EchoStar X – Sea Launch JCSat 9 – Ariane 5 Measat 3 – Proton XM-3* – Sea Launch	AMC-14 – Proton AMC-23 – Proton Anik F3 – Proton Galaxy 16 – TBD Hot Bird 8 – Proton Koreasat 5 – Sea Launch Skynet 5A – Ariane 5 Thuraya D3 – TBD Wildblue 1 – Ariane 5 XM-4 – Sea Launch	AMC-17 – TBD AMC-TBD – TBD Astra 1H – TBD EchoStar 11 – TBD Galaxy 18 – TBD Skynet 5B – Ariane 5 Telstar 11R – TBD XM-5 - TBD
Over 5,400 kg (>11,905 lbm)	7	3	3
	Intelsat Americas 8* (was Telstar 8)– Sea Launch Inmarsat 4F1* – Atlas V Inmarsat 4F2 – Sea Launch IPStar – Ariane 5 NSS-8 – Sea Launch Spaceway 1* – Sea Launch Spaceway 2 – Ariane 5	DirecTV 9S – Ariane 5 Inmarsat 4F3 – TBD Satmex 6 – Ariane 5	DirecTV 10 – TBD DirecTV 11 – TBD Intelsat Americas-9 – TBD

*indicates slip from 2004 projection from COMSTAC 2004 GSO Report

Figure 7 and Table 6 show the trends in annual GSO satellite mass distribution. Actual data are presented for 1993 through 2004, followed by the distribution projected in this year's demand forecast.

Comparison to International Comprehensive Inputs

In addition to the comprehensive inputs provided by the U.S. satellite manufacturers and launch service providers, the Working Group also received comprehensive inputs from two major international launch service providers (Arianespace and Mitsubishi Heavy Industries) and one major international satellite manufacturer (Alcatel). Analyzing the combined average of these international inputs reveals very similar trends to the calculated 2005 demand forecast. The international input average projection for total demand for 2005 through 2014 is 20.7 satellites per year, very close to the demand forecast of 20.5 satellites per year. The distribution of projected satellites among the lowest and highest mass categories (below 2,200 kilograms and above 5,400 kilograms) for the international inputs is nearly identical to the distribution in the 2005 demand forecast. One notable difference between the 2005 demand forecast and the international comprehensive inputs is that the 2005 demand forecast projects more satellites in the 4,200 to 5,400 kilograms mass category than the 2,200 to 4,200 kilograms category, while the international inputs project the reverse.

Figure 7. Forecast Trends in Annual GSO Satellite Mass Distribution

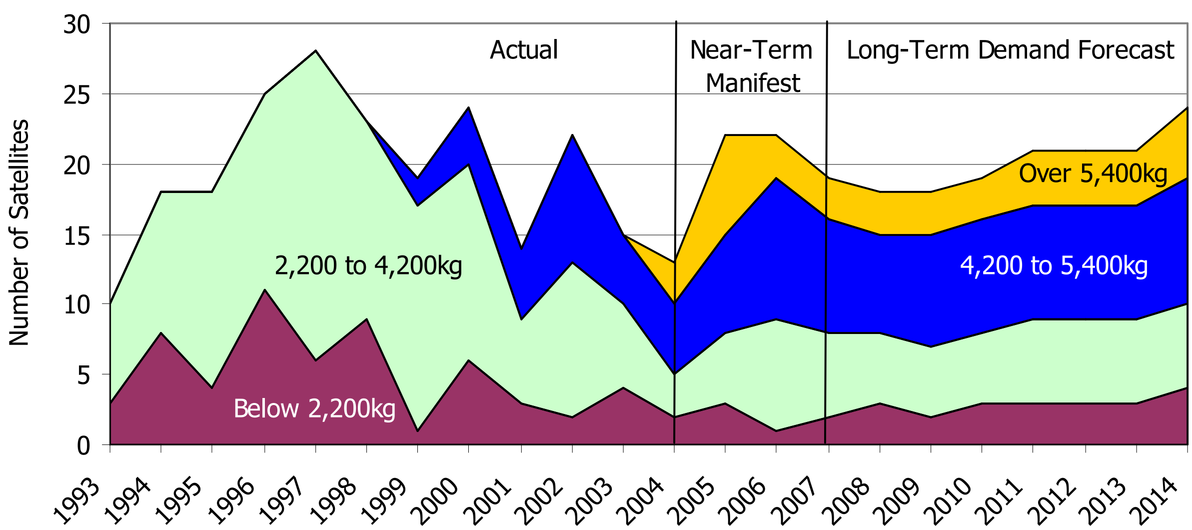


Table 6. Forecast Trends in Satellite Mass Distribution

	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	Total 2005 to 2014	Avg 2005 to 2014	% of Total
Below 2,200 kg (<4,850 lbm)	3	8	4	12	6	9	1	6	3	2	4	2	3	1	2	3	2	3	3	3	3	4	27	2.7	13%
2,200 to 4,200 kg (4,850 – 9,260 lbm)	7	10	14	14	22	16	16	14	6	11	6	3	5	8	6	5	5	5	6	6	6	6	58	5.8	28%
4,200 to 5,400 kg (9,260 – 11,905 lbm)	0	0	0	0	0	0	2	4	5	9	5	5	7	10	8	7	8	8	8	8	8	9	81	8.1	40%
Above 5,400 kg (>11,905 lbm)	0	0	0	0	0	0	0	0	0	0	0	3	7	3	3	3	3	3	4	4	4	5	39	3.9	19%
Total	**10**	**18**	**18**	**26**	**28**	**25**	**19**	**24**	**14**	**22**	**15**	**13**	**22**	**22**	**19**	**18**	**18**	**19**	**21**	**21**	**21**	**24**	**205**	**20.5**	

Commercial GSO Satellite Trends

Industry Metrics

Figure 8 and Table 7 show the number of transponders launched per year and the average number of transponders per satellite launched. The total number of transponders launched tracks the number of satellites launched per year, while the average number of transponders per satellite correlates to a trend to heavier, higher-power satellites. The total number of transponders launched in 2004 increased from the previous year, and the projection for 2005 indicates another steady increase over 2004. The average number of transponders has retreated from last year's peak of 50 transponders per satellite.

It should be noted for the purpose of this analysis a small number of satellites were excluded because their application is substantially different from the standard commercial GSO satellite. The satellites excluded are those used primarily for mobile applications because their communication payloads are not easily analyzed in terms of typical C-band, Ku-band and Ka-band transponders. Examples include the Inmarsat, Skynet (belonging to the British Ministry of Defence), Thuraya, and XM satellites.

Figure 9 and Table 8 show the total mass launched per year and the average mass per satellite launched. The total mass launched per year also shows a correlation to the number of satellites launched per year while the average mass per satellite again correlates with the trend to heavier, higher-power satel-

Figure 8. Total C/Ku/Ka Transponders Launched and Average per Satellite

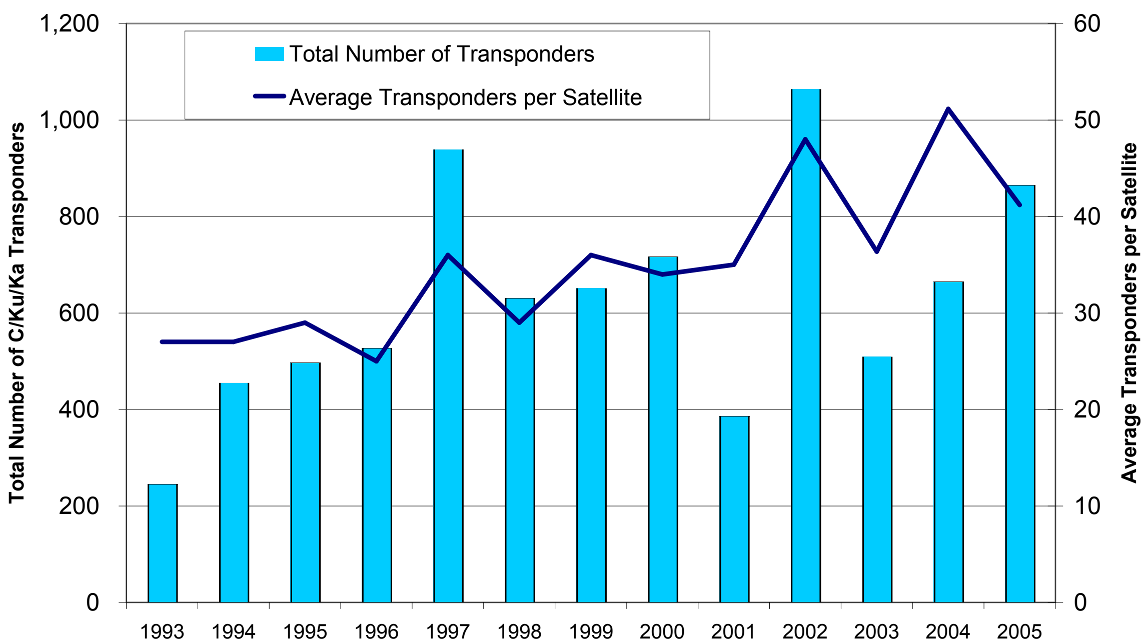


Table 7. Total C/Ku/Ka Transponders Launched and Average per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total Number of Transponders	245	455	497	527	939	630	651	717	386	1,064	509	665	865
Average Transponders per Satellite	27	27	29	25	36	29	36	34	35	48	36	51	41

lites. In 2004, the total mass launched dipped from the previous year. However, the projected mass to be launched in 2005 would be an all time high - almost 100,000 kg. This is due primarily to the slip of the 8 launches from 2004 into 2005, and the continuing increase of average mass per satellite.

These metrics provide insight that in determining the status of the commercial satellite industry as a whole, the number of satellites launched should be examined in combination with the amount of transponder capacity added and the mass of the satellites launched. The data indicate that the average satellite mass has grown steadily while the average number of transponders per satellite has stabilized over the last several years.

Future Trends

For several years this report had shown consistent growth in the mass of commercial satellites, with a noticeable disruption in this trend in the 2004 report. The 2004 forecast indicated that the shift to heavier satellites appeared be slowing. While demand in the 2004 forecast declined for satellites in all categories, the rate of decline for heavier satellites was twice that of lighter satellites. The 2005 report presents much different results.

The 2004 report indicated that the apparent shift away from larger satellites was likely caused by the reduced desire of most commercial firms to assume risk in the financial environment at that time, as larger

Figure 9. Total Satellite Mass Launched and Average Mass per Satellite

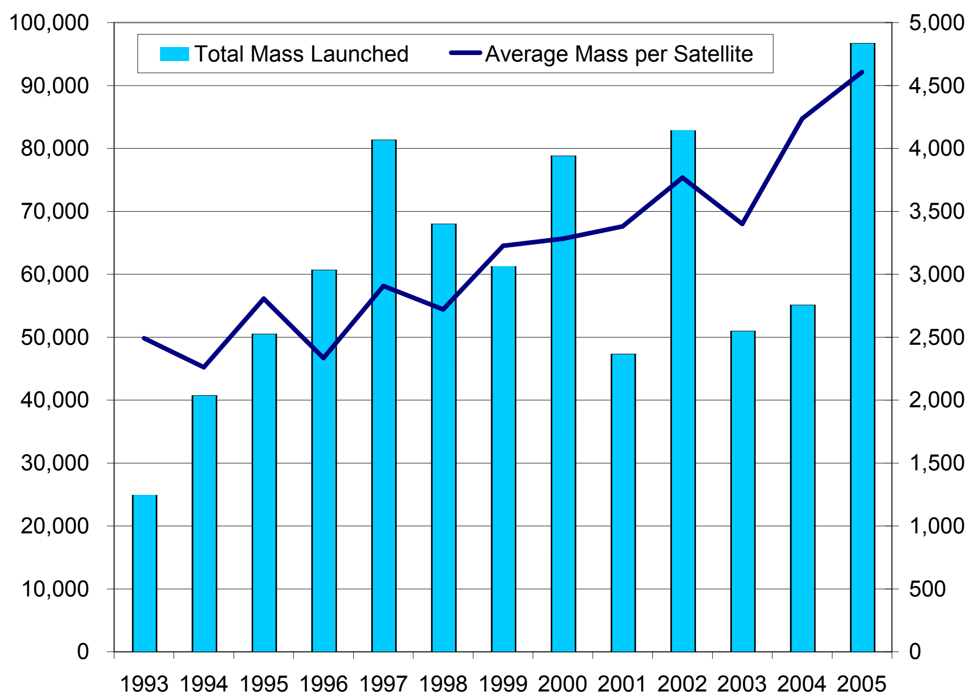


Table 8. Total Satellite Mass Launched and Average Mass per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total Mass (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	96,734
Average Mass/Sat (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	4,606

satellites are typically more expensive and may require longer investment recover periods. Decreased insurance capacity and the ability to raise capital at that time were considered key factors in the decisions on capital expenditures. Some of these financial factors remain at this time, and correspondingly the 2005 forecast shows that the projection of satellites over 5,400 kg only increased from an average of 3.5 per year to an average of 3.9 per year. The projection of satellites in the 4,200 - 5,400 kg category, however, increased from the 2004 forecast, from an average of 7.0 satellites per year to 8.1 satellites per year.

The most significant change in the results in 2005, however, is the decline in satellites in the below 2,200 kg mass category. In 2004, the forecast projected an average annual demand for 4.1 satellites per year in this class, while in 2005 only 2.7 per year are forecasted, a decrease of over 30 percent. In fact, this category was the only one to show a decline in the number of satellite projected relative to the 2004 forecast. This decline is most likely due to the changes in manufacturers' product lines in this segment.

Some satellite designs are "outgrowing" the segment. For example, one of the major products in this mass class, Orbital Science's Star bus, has incorporated design changes that bring its mass close to the 2,500-kg range. The last two satellites of this type put under contract (Optus D1 and D2) have published masses above the 2,200 kg cutoff for the smallest mass class (2,350 kg and 2,500 kg respectively).

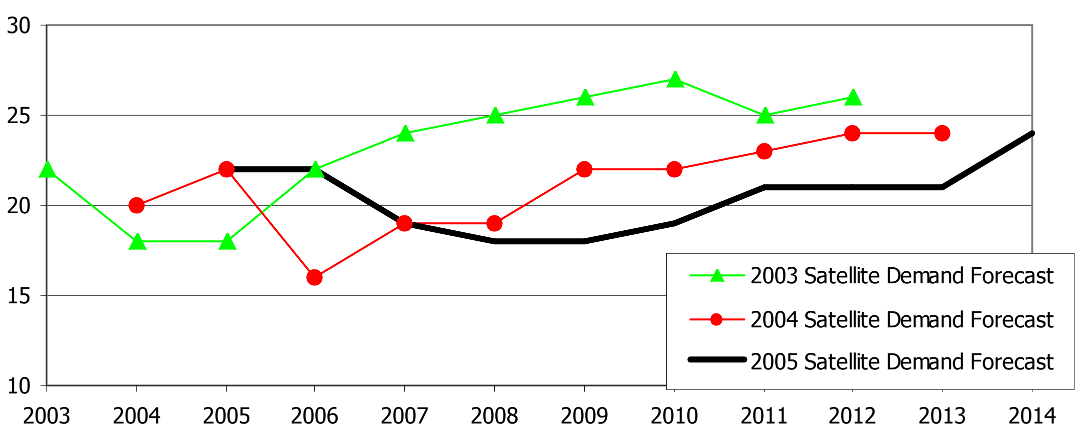
Other manufacturers are removing their products from this segment. Boeing announced in March 2005 that they would no longer offer the long-running 376 model. Over the history of the commercial satellite industry, this had been the mainstay of this mass segment.

Comparison with Previous COMSTAC Demand Forecasts

The 2005 forecast for commercial GSO satellites launched is compared to the 2003 and 2004 forecasts in Figure 10. The average satellite demand over the forecast period 2005 to 2014 is nearly the same as last year's 10-year forecast average. This year's model has an average demand of 20.5 GSO satellites per year for the period 2005 to 2014, with a modest increase in the last four years of the estimate.

There are several factors that have reduced projected demand for satellites over the last few years. In the 2004 report, the Working Group reported that a supplemental survey of satellite service providers indicated that

Figure 10. 2003 and 2004 Versus 2005 COMSTAC Mission Model Comparison



regional or global economic conditions and the ability to obtain export and operating licenses were the key factors that negatively affected demand. The full results of this year's survey questionnaire are shown in Appendix B.

The results of the 2005 survey suggest that economic conditions may be improving for satellite operators. In the 2004 report, 69 percent of respondents felt that regional or global economic conditions caused "significant" or "some" reduction or delay in their procurement plans. In the 2005 survey, only 40 percent of respondents believed that economic conditions had this effect. Consistent with this view, 40 percent of respondents also indicated that the availability of financing caused "significant" or "some" reduction or delay in their procurement plans.

Operators also report that obtaining export licenses continues to curb demand for launches of new satellites, but the magnitude of this impediment seems to have declined from 2004. In this year's survey, 40 percent indicated that the ability to obtain export licenses had "significant" or "some" negative impact on their procurement plans, while 63 percent expressed this view in the 2004 survey.

Launch Vehicle Demand

The commercial GSO launch forecast is based on the forecast for number of satellites launched and an assumption on the amount to which launch vehicles will dual-manifest payloads.

As yet, only Arianespace has the capability to dual-manifest commercial GSO satellites, though it has been long anticipated that competition and economics would induce other launch service providers to develop this capability.

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 launch realization. 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 for the 2008-2014 forecast period. The 2005-2007 near-term forecast includes dual-manifest launches consistent with the best current understanding of the mission set.

Figure 11 and Table 9 present the 2005 satellite and launch demand forecast as well as actual values for 1993 through 2004.

Launch Assurance Agreements

As discussed earlier in the report, launches are regularly delayed by satellite issues, launch vehicle problems, or external factors such as regulatory delays. Occasionally, such delays will result in a customer's 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 capacity available in the launch industry, but 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 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

The global and industry environmental factors that have affected the current forecast are discussed in detail earlier in the report. These and other factors will affect satellite demand in future years as well. The Working Group has identified the following issues that may impact satellite demand in the future:

- **Economic conditions** are improving in some regions but remain depressed in others. Since demand growth is an unknown, current economic conditions generally have had a negative effect on the market outlook. New ventures are under extreme scrutiny, and finding project financing can be difficult, although improving economic conditions could increase the availability of funding for satellite projects. Overcapacity of satellite transponder assets has driven pricing for satellite time down. This low demand for usage will continue to depress the satellite market.

Figure 11. 2005 COMSTAC Launch Demand Forecast

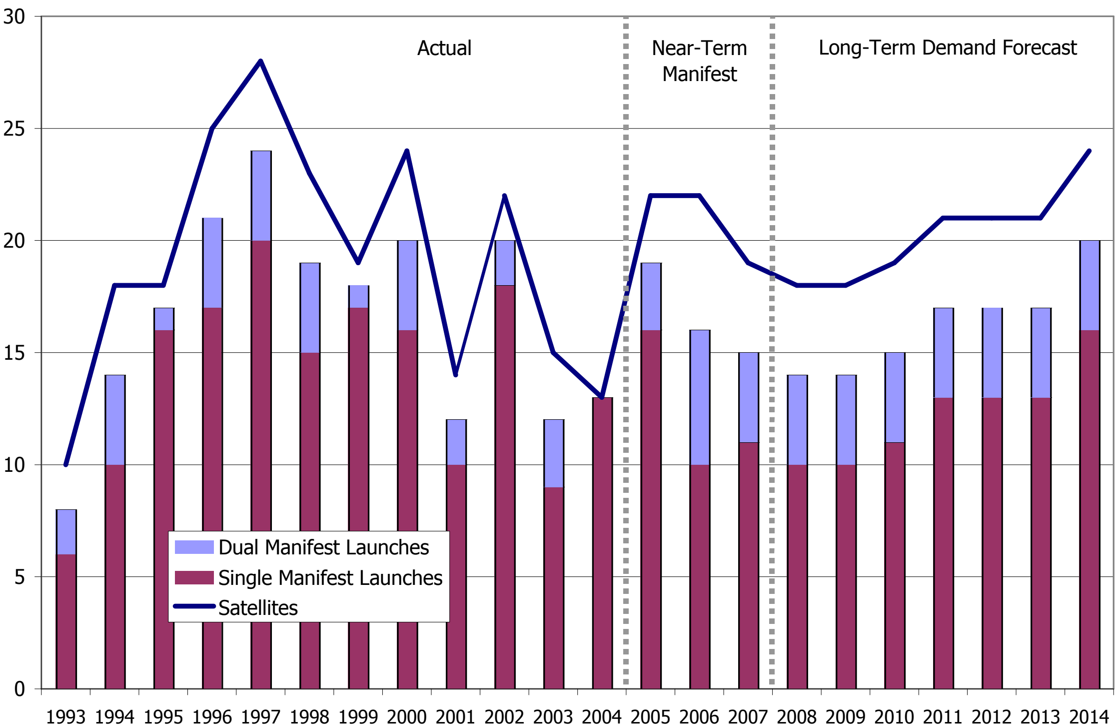


Table 9. COMSTAC Launch Demand Forecast Summary

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total	Average 2005 to 2014
Satellite Demand	22	22	19	18	18	19	21	21	21	24	205	20.5
Dual Launch Forecast	3	6	4	4	4	4	4	4	4	4	41	4.1
Launch Demand Forecast	19	16	15	14	14	15	17	17	17	20	164	16.4

- **New market applications** may increase the demand for satellite services. Broadband applications using Ka-band satellites are becoming a reality with the launch of the Wildblue service (for broadband connectivity) and DirecTV's Spaceway satellites (for HDTV service). Their success will determine the future demand of such satellite systems. New, interactive applications may appear on the horizon with the deployment of these systems.

- **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 land-based fiber optic assets. Use of these assets needs to peak before a stronger demand for space-based alternatives appears.

- **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.

- **Regulatory concerns** continue to be a factor in the redistribution of market share from the domestic market.

- **New commercial competitors**, while not necessarily affecting overall demand, can affect the distribution of market share. Companies not currently recognized as serious competitors may successfully enter the market with value-positioned products. On the satellite manufacturing side, Russian companies are partnering with established western manufacturers to introduce new spacecraft designs. In the launch market, the Chinese Long March vehicle conducted its first commercial launch[1] in seven years in April 2005, and several companies are positioning new vehicles to enter the commercial market (including SpaceX, Kistler, and the Indian Space Research Organization).

- **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.

Summary

This year's COMSTAC Commercial Mission Model forecast predicts an average annual demand of 20.5 satellites per year, nearly the same as the 2004 projection of 21.1 satellites per year. Although the number of satellites launched over the past five years has not reached the peak experienced in 1997, satellites have grown such that the total mass of satellites launched has risen steadily during this period and even surpassed the total mass launched in 1997. At the same time, the number of transponders per satellite, which has averaged over 35 until 2001, has risen to over 40, reaching up to 51 in 2004, indicating that operators continue to seek efficiencies in deploying capacity.

The Working Group continues to foresee market events that have the potential of impacting the 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

[1] This launch of the APStar VI satellite was not internationally competed and is therefore not included in the count of commercial GSO launches in this report.

extra-heavy payloads at competitive prices. Launch failures can cause substantial delays and shifts in the launch schedule (although not necessarily affecting overall demand), as has already been evidenced with the failure of the first launch of the Ariane 5 ECA. The economic atmosphere, availability of financing, and the regulatory environment appear to be the key factors affecting market demand at this time.

Appendix A. Use of the COMSTAC GSO Launch Demand Model

Demand Model Defined

The COMSTAC Demand Model is a count of actual programs or of projected programs that are expected to be launched in a given year. This would be the peak load on the launch service providers if all projected satellite launches were executed. It is not a prediction of what will actually be launched in a given year. The satellite programs and launches in the demand forecast are affected by many factors, which may cause them to slip or be canceled. The actual launches conducted in a given year depend on what factors come into play during that year.

For example, the participants in the 2005 Mission Model Update named actual satellite programs that were currently manifested on each of the launch providers for 2005. Though 22 satellite programs were named for the year 2005, the industry probably will not execute all corresponding launches in this year. However, the demand on the launch industry for 2005 is for the launch of 22 satellites (19 launches, since three dual launches are anticipated).

Based on the many potential delay factors that are possible, however, the Working Group participants have reached a consensus conclusion that the actual number of commercial GSO satellites launched in 2005 will likely fall in the range of 13 to 19. As described in the "Projecting Actual Launches" section, by examining the historical variance between predicted demand and actual launches, the Working Group arrives at this launch realization projection. Using the same methodology, between 10and 20 launches are expected in 2006.

As described earlier in this report, future years of the demand forecast beyond 2007 are calculated using the inputs from U.S. satellite manufacturers and launch providers. Each company providing inputs contributes their assessment of expected launches in future years. The demand forecast for future years therefore represents the best estimate of actual launches based on the compiled projections of U.S. industry.

Appendix B. Supplemental Questionnaire

As part of the 2005 survey of industry participants, the Working Group included a supplemental questionnaire for satellite service providers. The questionnaire that follows asked service providers how certain factors are impacting their plans to purchase and launch satellites. The Working Group felt that additional input from the companies who buy and operate commercial satellites was important given the current environment. The Working Group received inputs from the following 15 satellite service providers:

- Asiasat
- Broadcasting Satellite System Corp.
- Intelsat
- Loral Skynet
- MEASAT
- Mobile Broadcasting Corp.
- Mobile Satellite Ventures
- New Skies
- Satmex
- SES Global
- Sirius Satellite Radio
- Spacecom
- Space Communications Corp.
- Telesat Canada
- Thuraya Telecommunications

The Working Group would like to offer special thanks to these organizations for providing this additional input. While this questionnaire is by no means a scientific instrument from which concrete conclusions can be reached, it does provide some anecdotal insight into factors that are impacting the demand for launching commercial GSO satellites. A summary of the results of this questionnaire is provided on the following page.

Table 10. 2005 COMSTAC Survey Questionnaire

To what extent have your company's plans to purchase and /or launch a geosynchronous satellite system been positively or negatively impacted by the following in the past year? Positive impacts would cause your company to purchase satellites in greater numbers or sooner than expected, while negative impact would cause your company to reduce or delay satellite purchases:

	Significant Negative Impact	Some Negative Impact	No Effect	Some Positive Impact	Significant Positive Impact
Regional or global economic conditions	13%	33%	47%	7%	0%
Demand for satellite services	13%	33%	40%	7%	7%
Ability to compete with terrestrial services	0%	40%	47%	13%	0%
Availability of financing	13%	27%	53%	7%	0%
Availability of affordable insurance	20%	20%	60%	0%	0%
Consolidation of service providers	0%	13%	67%	13%	7%
Increasing satellite life times	0%	33%	67%	0%	0%
Availability of satellite systems that meet your requirements	0%	20%	67%	13%	0%
Reliability of satellite systems	0%	27%	60%	13%	0%
Availability of launch vehicles that meet your requirements	0%	7%	87%	7%	0%
Reliability of launch systems	7%	7%	73%	7%	7%
Ability to obtain required export licenses	13%	27%	60%	0%	0%
Ability to obtain required operating licenses	0%	13%	73%	13%	0%

Appendix C. Letter from the Associate Administrator

U.S. Department of Transportation

Commercial Space Transportation

800 Independence Ave., S.W, Room 331
Washington, D.C. 20591

Federal Aviation Administration

January 12, 2005

Name
Title
Company
Address
City, Country

Subject: Request for Comprehensive Input to 2005 Launch Demand Model

Dear ,

The Office of the Associate Administrator for Commercial Space Transportation (AST) of the Federal Aviation Administration (FAA) commissions an annual update to the Commercial Geosynchronous Orbit Launch Demand Model for geosynchronous satellites. The demand model is developed for the FAA by the Commercial Space Transportation Advisory Committee (COMSTAC). COMSTAC is a chartered industry advisory body that provides recommendations to the FAA on issues that affect the U.S. commercial launch industry. The 2004 demand forecast can be viewed on-line at http://ast.faa.gov/rep_study/forcasts_and_reports.htm.

To support the 2005 model, our office requests comprehensive input from your company based on your forecasts of future spacecraft and launch needs. The COMSTAC Technology and Innovation Working Group will then develop the model based on your and other industry input.

The FAA and the industry use the report from the 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. Your participation is important.

Your response is needed by February 21, 2005, to ensure that the demand model update is ready for publication in May 2005. Please forward this request to the department most appropriate within your organization (e.g., market analysis, marketing, 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. You may also contact my office with any questions or comments at your convenience.

Thank you for your support of this activity.

Sincerely,

Patricia G. Smith
Associate Administrator for Commercial Space Transportation

Enclosures:
(1) 2005 Commercial GSO Mission Model Update Instructions
(2) Satellite Demand Forecast by Payload Mass
(3) COMSTAC 2005 Commercial GSO Launch Demand Questionnaire
(4) COMSTAC Launch Demand Model Report Feedback Form

2005 Commercial GSO Mission Model Update Instructions

As with previous year efforts, the goal for the 2005 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 and two additional forms.

Please provide us with your projection of "addressable" commercial geosynchronous satellites that your company plan to launch through 2014. "Addressable" payloads in this context are those payloads that are open for internationally competitive launch service procurement. If possible, please identify specific satellites by name. In addition, if your forecast has changed significantly from 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.

In the third enclosure, we ask that you comment on the extent to which your company's plans to purchase and/or launch a geosynchronous satellite system have been impacted by various market factors. The fourth enclosure provides a forum for your feedback on the usefulness of this report. COMSTAC and the FAA are very interested in understanding how your company uses the report and any suggestions for improving the final product.

Your input will be combined with those of other satellite services providers, satellite manufacturers, and launch vehicle suppliers to form a composite view of the demand for launch services through 2014. The individual inputs that you provide will be kept confidential by the COMSTAC Technology and Innovation Working Group; only the composite results are released. The composite forecast 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.

We are looking forward to receiving your response by February 21, 2005, in order to support our update schedule. Your responses should be sent directly to Mr. Ethan Haase at the following address:

Ethan Haase
International Launch Services
1660 International Drive
Suite 800
McLean, VA 22102

Phone: 571-633-7445
Fax: 571-633-7537
Email: ethan.e.haase@lmco.com

If you have any questions, please contact Mr. Haase 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?

In the past two reports, an "expected realization" range indicating the most likely number of actual spacecraft that will launch in the next three years has been added to the launch demand projection. This range is calculated using the historical difference between the first three years of the launch demand projection and the actual number of satellites launched.

Has your organization found the addition of the "realization factor" to the first three years of the demand projection to be a worthwhile addition to the report?

Does your company have any questions or comments regarding the methodology applied to determine the "realization factor?"

In the past two reports, sections discussing the total number of transponders launched per year and the total mass launched to orbit have been added and updated. Has your organization found these additional sections to be positive additions to the report?

Appendix D. Historical Launches

Tables 11 through 13 present the historical addressable commercial spacecraft launched from 1993 through 2004. The tables also note which missions were flown on a dual-manifested launch and the resulting total number of launches in each year. Please note that the spacecraft are separated into mass categories as defined in the current COMSTAC report. This may result in slight differences in the categorization of spacecraft compared to earlier COMSTAC publications.

Table 11. 1993–1997 COMSTAC GSO Commercial Satellites

	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
Below 2,200 kg (<4,850 lbm)	3	8	4	11	6

2,200 - 4,200 kg (4,850 - 9,260 lbm)

1993			1994			1995			1996			1997		
	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)

1993			1994			1995			1996			1997		
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

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 12. 1998–2002 COMSTAC GSO Commercial Satellites

	1998	1999	2000	2001	2002
Total Launches	19	18	20	12	20
Total Satellites	23	19	24	14	22
Over 5,400 kg (>11,905 lbm)	0	0	0	0	0

4,200 - 5,400 kg (9,260 - 11,905 lbm)

1998			1999			2000			2001			2002		
	0			2			4			5			9	
				Galaxy 11	Ariane 44L		Anik F1	Ariane 44L		DirecTV 4S	Ariane 44LP		Intelsat 904	Ariane 44L
				$\boxed{\text{Orion 3}}$	Delta III		PAS 1R	Ariane 5G		Intelsat 901	Ariane 44L		Intelsat 905	Ariane 44L
							Garuda 1	Proton K/DM		Intelsat 902	Ariane 44L		Intelsat 906	Ariane 44L
							Thuraya 1	Sea Launch		XM Rock	Sea Launch		NSS-6	Ariane 44L
										XM Roll	Sea Launch		NSS-7	Ariane 44L
													$\boxed{\text{Astra 1K}}$	Proton K/DM
													Echostar 8	Proton K/DM
													Intelsat 903	Proton K/DM
													Galaxy IIIC	Sea Launch

2,200 - 4,200 kg (4,850 - 9,260 lbm)

1998			1999			2000			2001			2002		
	14			16			14			6			11	
DM4	Afristar	Ariane 44L		AMC 4	Ariane 44L	DM1	Asiastar 1	Ariane 5G	DM2	$\boxed{\text{Artemis}}$	Ariane 5G	DMN	Atlantic Bird 1	Ariane 5G
DM3	Eutelsat W2	Ariane 44L	DM1	Arabsat 3A	Ariane 44L	DM3	Astra 2B	Ariane 5G		Atlantic Bird 2	Ariane 44P	DMN	$\boxed{\text{Hotbird 7}}$	Ariane 5ECA
	Hot Bird 4	Ariane 42P		Insat 2E	Ariane 42P		Europe*Star 1	Ariane 44LP	DM1	Eurobird	Ariane 5G		Insat 3C	Ariane 42L
	PAS 6B	Ariane 42L		Koreasat 3	Ariane 42P		Eutelsat W1R	Ariane 44P		Turksat 2A	Ariane 44P	DM1	JCSat 8	Ariane 44L
	PAS 7	Ariane 44LP		Orion 2	Ariane 44LP		Galaxy 10R	Ariane 42L		Astra 2C	Proton K/DM	DM2	Stellat 5	Ariane 5G
	Satmex 5	Ariane 42L		Telkom	Ariane 42P		Galaxy IVR	Ariane 42L		PAS 10	Proton K/DM		Echostar 7	Atlas IIIB
	ST-1	Ariane 44P		Telstar 7	Ariane 44LP		N-Sat-110	Ariane 42L					Hispasat 1D	Atlas IIAS
	Hot Bird 5	Atlas IIA		Echostar V	Atlas IIAS		Superbird 4	Ariane 44LP					Hotbird 6	Atlas V 401
	Intelsat 805A	Atlas IIAS		Eutelsat W3	Atlas IIAS		Echostar VI	Atlas IIAS					Eutelsat W5	Delta IV M+ (4,2)
	Intelsat 806A	Atlas IIAS		JCSat 6	Atlas IIAS		Eutelsat W4	Atlas IIIA					DirecTV 5	Proton K/DM
	$\boxed{\text{Galaxy 10}}$	Delta III		Asiasat 3S	Proton K/DM		Hispasat 1C	Atlas IIAS					Nimiq 2	Proton M/M
	Astra 2A	Proton K/DM		Astra 1H	Proton K/DM		AAP 1	Proton K/DM						
	EchoStar 4	Proton K/DM		LMI 1	Proton K/DM		AMC 6	Proton K/DM						
	PAS 8	Proton K/DM		Nimiq	Proton K/DM		PAS 9	Sea Launch						
				Telstar 6	Proton K/DM									
				DirecTV 1R	Sea Launch									

Below 2,200 kg (<4,850 lbm)

1998			1999			2000			2001			2002		
	9			1			6			3			2	
DM4	AMC 5	Ariane 44L	DM1	Skynet 4E	Ariane 44L	DM3	AMC 7	Ariane 5G	DM1	BSat 2A	Ariane 5G	DM1	Astra 3A	Ariane 44L
DM1	Brazilsat B3	Ariane 44LP				DM4	AMC 8	Ariane 5G	DM2	$\boxed{\text{BSat 2B}}$	Ariane 5G	DM2	N-Star c	Ariane 5G
DM2	BSat 1B	Ariane 44P				DM4	Astra 2D	Ariane 5G	DMN	Skynet 4F	Ariane 44L			
DM1	Inmarsat 3F5	Ariane 44LP				DM2	Brazilsat B4	Ariane 44LP						
DM2	NileSat 101	Ariane 44P				DM1	Insat 3B	Ariane 5G						
DM3	Sirius 3	Ariane 44L				DM2	Nilesat 102	Ariane 44LP						
	Bonum-1	Delta II												
	Skynet 4D	Delta II												
	Thor III	Delta II												

$\boxed{}$ = Launch Failure

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

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

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

Table 13. 2003–2004 COMSTAC GSO Commercial Satellites

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

[ ] = 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

2005 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits

Executive Summary

The *2005 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 that are expected to be available for competitions between providers of commercial launch services or are otherwise sponsored by commercial companies.

The FAA's forecast for 2005 projects 64 commercial launches worldwide from 2005–2014 to non-geosynchronous orbits (NGSO), an increase of 25 percent compared to last year's forecast. The increase is due to a demand to launch more international science satellites, a multisatellite radar system, and a privately-funded technology demonstration system. These increases generally translate to more opportunities for small launch vehicles. The NGSO launch market is poised for a moderate increase in activity after four years of sluggish launch rates.

The 2005 forecast contains 144 satellites during the next ten years, an increase of 36 percent compared to the ten-year projection in the 2004 forecast of 106 satellites; there were only 80 satellites from the 2003 forecast. While the number of satellites grew an average of about four per year, the number of corresponding launches increased by only about one per year because a few launches will have multiple satellites aboard a single launch vehicle.

This year's report has several recurring launch missions scheduled in the near-term including a series of German radar satellites, a privately- funded U.S. space habitat demonstration, and replenishment satellites for two U.S. telecommunications systems.

2005 Launch Forecast: FAA/AST is forecasting an average demand of 6.4 worldwide commercial launches per year during 2005–2014 with more activity in the near-term, including six in 2005, 13 in 2006 and 12 in 2007. The forecast contrasts with 2004 when only two missions launched and the previous three years that produced four launches per year.

Demand is divided into two vehicle size classes with an average of 2.5 medium-to-heavy launch vehicles per year and about 4 small launch vehicles per year over the forecast period. The number of small launches grew from 28 in the 2004 forecast to 39 in the 2005 forecast while medium-to-heavy sized launch vehicles have stayed about the same.

About 60 percent of the 144 satellites in the market are international science or other satellites such as technology demonstrations. Twenty-eight percent of the market is made up of telecommunications satellites and the remaining 12 percent of the market is commercial remote sensing satellites.

Introduction

The international commercial market for non-geosynchronous orbit is set to experience a slight increase of activity in the near-term after a slump during the past four years. The 2005 forecast is the second consecutive forecast to show a significant increase in total number of satellites from the previous year since the 1998 FAA forecast.

More than half of the satellites seeking a ride to NGSO in today's commercial launch services market are connected to international science programs, a consistent mix of small mass satellites from experienced spacefaring countries and fledgling new space programs on a low budget.

As more countries and companies expand their interest in space, partnerships have increased between nations and the cost barriers to entry have fallen on the satellite side. Technology has improved while mass and cost have decreased for certain capabilities, especially for those interested in NGSO. However, developing an indigenous orbital launch vehicle remains an expensive and technically challenging endeavor. As a result, there is a small but steady demand for launch services to non-geosynchronous orbits.

The international flavor of the space industry is reflected by the forecast: only two of 26 assigned launches from 2005–2008 have a satellite owner/operator that will fly on a launch vehicle built by its home country. The launch provider market is led by Russian/Ukrainian-built vehicles, which hold 81 percent of announced launches in the near-term, although half have non-Russian marketing partners. The U.S. has 15 percent and India has four percent, having won its first commercial primary satellite launch competition.

Table 14. 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 est.	6	19	**25**

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

The NGSO commercial forecast of about 6.4 launches per year over the next 10 years is a shadow of its former self, when plentiful spectrum and finance propelled three visionary telecommunications systems into orbit—as well as other systems—during 1997–1999, when 195 satellites were launched. The NGSO commercial launch market peaked with 19 launches in 1998 and 18 launches in 1999. But business plans failed, investors lost confidence and no other telecommunications systems were able to launch. Several companies declared bankruptcy and broadband data service proponents shifted completely to GSO. After 18 satellites were orbited on nine launches in 2000, the market fell to just four launches per year from 2001 to 2003 and two launches during 2004 (Table 14). During the last four years, NGSO satellites launched commercially were a mixture of 22 small science satellites, 12 telecommunications satellites (including four weighing around 10 kilograms each) and three commercial remote sensing satellites.

For the 2005 forecast, there are new players expanding the diversity of the NGSO market. One is the German

Defense Ministry and its SAR-Lupe program, a constellation of five radar satellites requiring five small launches. Another is Bigelow Aerospace, which contracted for four launches by 2007 to launch demonstration platforms for a future inflatable space station habitat.

NGSO telecommunications systems in orbit have proven themselves as survivors and have restructured for growth. ORBCOMM plans two commercial and one non-commercial launch in the near-term followed by additional replacement launches of their orbital data messaging system.

While it is still too early to forecast deployment of all-new systems for Iridium and Globalstar, each company has been reenergized with new investors, debt-free operations, relatively healthy constellations, introduction of new services, and a growing number of subscribers. Both companies are now talking about new systems and planning specific years to acquire new satellites. Iridium is reporting profitability and Globalstar plans two replacement launches in 2007. However, Iridium and Globalstar won't use the same rapid launch approach as they did for their first-generation systems. Each company will spread out launches and costs over perhaps five or ten years and launch when needed to replace existing orbital satellites.

Although this forecast only includes orbital launches, a new market for suborbital public space travel is approaching, created by the right combination of the Ansari X Prize competition, promising public demand, and development of new suborbital vehicles backed by sufficient funding. At this time, it is too difficult to forecast when commercial orbital passenger space travel will occur. Over 30 U.S. companies are planning to develop orbital vehicles to compete in the $50 million America's Space Prize sponsored by Bigelow Aerospace.

To assess demand for international commercial launch services for the deployment of NGSO satellites, 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 low Earth orbit (LEO), medium Earth orbit (MEO), elliptical orbit (ELI), and external orbit (EXT) such as to the Moon, Mars, and beyond.

The results of this forecast do not indicate FAA support or preference for any particular satellite system. The report represents FAA's assessment of how many systems will actually be deployed with the ultimate purpose of projecting future commercial space transportation demand. The report is not a projection of how many systems will attract enough business to prosper after deployment. 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 2005 forecast.

NGSO Satellite Systems

International Science and Other Payloads

The growth of satellite development efforts in countries without indigenous launch capabilities has generated increased demand for commercial launch services. 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 three years, science or demonstration payloads have been launched commercially for operators in a number of countries, including France, Germany, Italy, Nigeria, Saudi Arabia, South Korea, Taiwan, and Turkey. The new U.S. Space Transportation Policy, enacted in December 2004, continues the practice of generally restricting 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. The imagery products generated from these satellites are usually offered for free or at cost. An example of such systems is the Disaster Monitoring Constellation (DMC), a set of five to seven Earth observation microsatellites designed to take images in support of disaster relief efforts. The DMC includes participation from space agencies in Algeria, China, Nigeria, Thailand, Turkey, Vietnam, and the United Kingdom. The first DMC satellite, AlSat-1, was launched non-commercially in 2002; three more DMC satellites, Bilsat, BNSCSat, and Nigeriasat, were launched commercially on a Russian Cosmos in September 2003. A Chinese satellite, China DMC+4, is scheduled for a commercial Cosmos launch in mid-2005. COSMO Skymed, short for Constellation of small Satellites for Mediterranean basin Observation, is a series of at least two and possibly four optical and radar remote sensing satellites funded and managed by the Italian Space Agency (ASI). First launch is planned in late 2006 with succeeding satellites to be launched at eight-month intervals; the launch vehicles to be used have not been determined.

A second class of satellites includes spacecraft designed to carry out other scientific work in space, ranging from specialized Earth sciences work 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 Russian Rockot in 2006. A similar example is AGILE, a gamma-ray astronomy satellite funded by ASI, which will be launched 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. The Planetary Society, Cosmos Studios, and Russia's Babakin Space Center are developing Cosmos 1, which will be the first spacecraft to use a solar sail. The spacecraft launch has been delayed several times, but is now scheduled for 2005 on a submarine-launched Volna booster. Topsat, a spacecraft funded by British National Space Centre and the British Ministry of Defence, will test a number of technologies that could be used on future government and commercial remote sensing spacecraft. Topsat is scheduled for launch in mid-2005 on the same Cosmos booster that will launch China DMC+4.

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. CubeSat developers are taking advantage of the miniaturization of low-cost electronics in products such as cellular telephones and handheld computers. Development time is decreased through sale of an off-the-shelf CubeSat Kit™ that one California company has sold to over ten customers. 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; some of those satellites are still functioning while others failed shortly after launch. Launch costs per CubeSat can be as low as $40,000. One Dnepr launch in 2005 is scheduled to deploy 14 CubeSats.

Digital Audio Radio Services

Satellite radio is already among the fastest adopted consumer electronics products in U.S. history. Sirius Satellite Radio (formerly CD Radio) launched three satellites to a high elliptical orbit (ELI) in 2000 and rolled out service in 2002. Sirius has a fourth satellite as a ground spare, but its three operational spacecraft remain in good health and the company expects them to continue operating through 2015. Its main U.S. rival, XM Satellite, operates two satellites in GSO, launched in 2001; a third was launched to GSO in early 2005. WorldSpace, another radio company with listeners in Europe, Africa, Asia and the Middle East, has two GSO satellites and is slowly adding customers. While the number of U.S. subscribers reached over five million for Sirius and XM combined in April 2005, compared to two million combined a year earlier, this has not translated into new systems either to compete with Sirius and XM or to provide service in other countries. At least two ventures are considering developing a European satellite radio system; given the requirements to reach high northern latitudes on the continent, it is more likely that a Sirius-like system, with satellites in ELI, would be used. However, given the uncertainty over the status of such future systems, no DARS systems are included in the 2005 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 satellites will be placed into three 500-kilometer 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 ($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 Cosmos 3M boosters, starting in 2006; Dnepr vehicles will be used as a backup if necessary. A key milestone for the SAR-Lupe launches was achieved in January 2005 when a Cosmos launched two Russian military satellites using a modified payload fairing designed to accommodate the three-meter parabolic antenna of the SAR-Lupe satellites.

Market Demand Scenarios

FAA/AST projects that approximately 87 satellites of the international science or other category will be launched during the forecast period. These payloads will be deployed on 44 launches, including 15 medium-to-heavy vehicles. This is the largest single market sector of the baseline 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. Total sales for all sectors of the U.S. remote sensing and GIS industry were estimated to be about $3.2 billion in 2004, according to the American Society for Photogrammetry and Remote Sensing. However, satellite imagery providers accounted for only approximately $340 million in worldwide sales in 2004, according to other estimates, and are expected to grow to just over $700 million by 2010.

There are several reasons why the commercial market for satellite-based, high-resolution imagery has grown more slowly than anticipated several years ago. Users do not care whether an image came from a satellite or an airplane, as long as it meets their technical requirements. Also, industry experts maintain that the number of trained GIS professionals is still too small to enable the transformation of imagery into useful information for widespread applications. This has led companies, particularly those based in the U.S., to seek more business from the Defense Department and other government agencies. A new federal policy issued on April 25, 2003 directs government agencies to "rely to the maximum practical extent on U.S. commercial remote sensing space capabilities" for civil and military imagery needs. Consistent with this policy, the National Geospatial-Intelligence Agency (NGA), formerly the National Imagery and Mapping Agency (NIMA), has issued three ClearView contracts with American companies to purchase high-resolution satellite imagery. NGA has also issued two NextView contracts with DigitalGlobe and ORBIMAGE to enable the development and launch of next-generation commercial remote sensing satellites. U.S. imagery providers are expected to rely heavily on these contracts to fund their next-generation systems. The budget amount available for these programs will influence the pace of growth for this industry over the next several years.

In addition to the high-resolution imagery of interest to the military and intelligence community, medium- and low-resolution Landsat data are critical to a range of scientific studies in agriculture, forestry, coastal change, geology, and other applications. Several years ago the federal government proposed a Landsat Data Continuity Mission (LDCM), a public-private partnership in which the government would buy data from a commercial provider, as a way to continue the Landsat program. However, the sole LDCM bid was rejected in 2003 and the government has since decided to place Landsat instruments on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) spacecraft scheduled for deployment beginning late this decade.

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

DigitalGlobe

DigitalGlobe, formerly EarthWatch, was established in 1993 and was granted the first National Oceanic and Atmospheric Administration (NOAA) license (under the

Table 15. 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	Space Imaging	Lockheed Martin	IKONOS 1 IKONOS IKONOS Block II	816 (1800) 816 (1800) TBD	1 1 0.5	1999 1999 TBD	IKONOS 1 lost due to launch vehicle malfunction. IKONOS continues to operate.
OrbView	ORBIMAGE	Orbital Sciences Corp.	OrbView 1 OrbView 2 OrbView 3 OrbView 4 OrbView 5	74 (163) 372 (819) 304 (670) 368 (811) TBD	10,000 1,000 1 1 0.41	1995 1997 2003 2001 2007	OrbViews 1, 2, and 3 continue to operate. OrbView 4 lost due to launch vehicle failure.
QuickBird	DigitalGlobe	Ball Aerospace	EarlyBird QuickBird 1 QuickBird WorldView	310 (682) 815 (1797) 909 (2004) TBD	3 1 0.6 0.5	1997 2000 2001 2006	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) TBD	8 3 TBD	1995 2006 2012	Radarsat 1 continues to operate. Radarsat 3 will be a three-satellite constellation.
Under Development							
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 TerraSAR L	1,023 (2,255) 2,060 (4,540)	3 5	2006 2008	TerraSAR X will provide commercial imagery, TerraSAR L appears largely restricted to government applications.
TrailBlazer	TransOrbital	TransOrbital	TrailBlazer	420 (926)	1	2006	TrailBlazer will conduct remote sensing of the Moon in 1-meter resolution, but requires NOAA license to image the Earth from a distance.

Table 16. Commercial Satellite Remote Sensing Licenses

	Licensee	Date NOAA License Granted	Remarks
1	EarthWatch	1/4/1993	Originally issued to WorldView.
2	Space Imaging	6/17/1993	Originally issued to EOSAT.
3	Space Imaging	4/22/1994	Originally issued to Lockheed.
4	ORBIMAGE	5/5/1994	Originally issued to Orbital Sciences Corp.
5	ORBIMAGE	7/1/1994	Originally issued to Orbital Sciences Corp.
6	EarthWatch	9/2/1994	
7	AstroVision	1/23/1995	Only license issued so far for commercial GEO system.
8	GDE Systems Imaging	7/14/1995	
9	Motorola	8/1/1995	
10	Boeing Commercial Space	5/16/1996	License for Resource21 system.
11	CTA Corporation	1/9/1997	
12	RDL Corporation	6/16/1998	License for Radar1 system, which has since been cancelled.
13	STDC	3/26/1999	Acquired by ESSI, license issued for operation of NEMO system.
14	Ball Aerospace	11/21/2000	
15	EarthWatch	12/6/2000	First licenses issued to commercial operators for 0.5 meter resolution.
16	Space Imaging	12/6/2000	First licenses issued to commercial operators for 0.5 meter resolution.
17	EarthWatch	12/14/2000	
18	TransOrbital	3/6/2002	TransOrbital requires license from NOAA to image Earth from lunar orbit, not for imaging the Moon's surface.
19	DigitalGlobe	9/29/2003	License for four-satellite high-resolution system.
20	Space Imaging	10/14/2003	License for two-satellite 0.25-meter resolution system.
21	Northrop Grumman	2/20/2004	MEO system with 0.5-meter resolution.

name WorldView Imaging Corporation) in the same year. The company contracted with Boeing for the launch of QuickBird aboard a Delta 2 on October 18, 2001. QuickBird is capable of imaging objects 0.6 meters 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. Space Imaging and ORBIMAGE have also won similar contracts. The contract is for three years and is dependent on availability of funds.

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 disclosed that it will use the NextView contract to build a spacecraft called WorldView that will be able to provide 0.5-meter panchromatic and 2.0-meter multispectral images. WorldView will operate in an 800-kilometer orbit designed to reduce revisit times, and has an estimated lifetime of seven years. WorldView is scheduled for launch by early 2006 on a Delta 2.

ImageSat International

ImageSat, founded as West Indian Space in 1997, provides commercial high-resolution imagery from its Earth Remote Observation Satellite (EROS) family of remote sensing satellites. A Netherlands Antilles company, ImageSat's strategic partners include Israel Aircraft Industries Ltd. and Electro Optics Industries, developers of the company's satellites and cameras, respectively. ImageSat currently operates one satellite, EROS A, which was launched from Svobodny, Russia in December 2000. In early 2006, the company plans to launch EROS B, a very-high-resolution satellite with panchromatic resolution of 0.7 meters. EROS B, like its predecessor, will offer flexible imaging capabilities at various angles, azimuth, and light conditions. 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. Both spacecraft are scheduled to launch on START vehicles.

InfoTerra GmbH

Infoterra GmbH, a subsidiary of EADS Astrium GmbH, holds the exclusive commercial exploitation rights for the TerraSAR X one-meter 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 for launch on a Dnepr during the second quarter of 2006. Infoterra GmbH will be responsible for the commercial exploitation of TerraSAR X data, while the DLR will oversee science operations. A larger L-band spacecraft, TerraSAR L, is tentatively scheduled for launch in 2008.

Northrop Grumman

In February 2004 NOAA granted Northrop Grumman a commercial remote sensing license for a system called Continuum. The system would use two satellites in elliptical MEO orbits ranging in altitude from 1,340 to 6,188 kilometers. Despite their altitude, the spacecraft will be able to take still and video images at a resolution of 0.5 meters, thanks to a design similar to the James Webb Space Telescope that Northrop Grumman is building for NASA. The orbits allow each spacecraft to observe particular geographic areas for up to 40 minutes at a time, several times a day. 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.

ORBIMAGE

In September 2004 the NGA awarded ORBIMAGE the second NextView contract, valued at approximately $500 million, for the development of a high-resolution remote sensing satellite. OrbView 5 will operate in a Sun-synchronous orbit at an altitude of 660 kilometers. The spacecraft will be able to take panchromatic images with a resolution of 0.41 meters and multispectral images with a resolution of 1.64 meters. The spacecraft will be built by a team that includes General Dynamics C4 Systems (formerly Spectrum Astro) and Kodak/ITT Industries. The spacecraft is scheduled for launch in early 2007 on a Delta 2.

ORBIMAGE, the first company to operate a commercial remote sensing satellite (OrbView 2, launched in 1997), filed for Chapter 11 bankruptcy protection in April 2002. In 2003 the company worked with Orbital Sciences Corporation (OSC) and its other creditors to complete a restructuring agreement as well as arrange the launch of the OrbView 3 high-resolution imaging satellite. A federal bankruptcy court approved the final restructuring agreement in October 2003, and the company emerged from Chapter 11 protection at the end of the year.

On June 26, 2003, a Pegasus XL booster successfully launched OrbView 3 into a 470-kilometer Sun-synchronous orbit. ORBIMAGE released the first images from the spacecraft, which is capable of providing 1-meter resolution panchromatic and 4-meter resolution multispectral imagery, in December 2003. OrbView 1, launched in 1995, and OrbView 2 continue to operate, providing images with 10-kilometer and 1.1-kilometer resolution, respectively. ORBIMAGE is also a U.S. distributor of worldwide imagery from the Canadian Radarsat 2 satellite, planned for launch in 2006. OrbView 4 was lost due to a launch failure in 2001. In March 2004 NGA awarded ORBIMAGE a ClearView contract for OrbView 3 imagery. The 22-month contract guarantees ORBIMAGE a minimum of $27.6 million in imagery orders over that time.

Radarsat International

Radarsat International, a wholly-owned subsidiary of Canadian firm MacDonald Dettwiler and Associates (MDA), was formed in 1989 to market and distribute Radarsat 1 data. Radarsat 1, launched in 1995 aboard a Delta 2 rocket, has gathered synthetic aperture radar (SAR) data over nearly the Earth's entire surface and provides radar data with resolutions between 8 and 100 meters. Radarsat 2, planned for launch in 2006 on a Delta 2, will continue the mission of its predecessor while offering significant technical advancements. In 2004, MDA was commissioned by the Canadian Space Agency (CSA) 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. That system is scheduled for deployment early next decade.

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. Radarsat International is responsible for satellite mission management operations and satellite programming, as well as international marketing and data distribution.

RapidEye AG

RapidEye, a commercial remote sensing company based in Germany, is pursuing a five-satellite system designed to provide imagery and services for customers interested in agricultural and cartographic applications. The constellation of satellites was designed specifically to provide 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. RapidEye and MDA signed an Agreement of Principle in September 2002 to work jointly on the project, with MDA providing the satellites, launch arrangements, and ground infrastructure, although the satellite platforms will be built by the UK's Surrey Satellite Technology Ltd. (SSTL). The German company Jena-Optronik GmbH will provide the optical payload for the RapidEye satellites as a subcontractor to MDA. MDA's Radarsat International and U.S.-based EarthSat will provide support to RapidEye by marketing and selling its products. Product development and customer service are done by RapidEye at its Brandenburg facilities. The satellites, each with a resolution of 6.5 meters, will be launched together in the first half of 2007 on a single Dnepr.

Space Imaging

In early 2005 Space Imaging put itself up for sale, hiring Banc of America Securities to serve as an advisor. NGA awarded Space Imaging with a multi-year satellite-imagery capacity contract under the ClearView program in January 2003. Under the terms of the contract, NGA acquires worldwide imagery from IKONOS. For the first three years, the contract has a minimum value of $120 million, with a five-year ceiling of $500 million.

Space Imaging, founded in 1994 and based near Denver, Colorado, provides map-accurate, high-resolution satellite imagery from its IKONOS satellite to government and commercial customers. Launched in 1999, IKONOS is the first commercial space platform with a ground resolution of 0.82 meters. In December 2000, Space Imaging was granted a license by NOAA authorizing the company to develop a satellite capable of generating 0.5-meter resolution imagery; the company received a similar license for a 0.25-meter resolution system in October 2003. In addition to imagery from its own IKONOS satellite, Space Imaging also markets and sells imagery from Landsat, India's remote sensing satellites, and Canada's Radarsat 1. As of early 2005, the company had more than 200 million square kilometers of nearly cloud-free imagery in its digital archive. Through its Regional Affiliate program, Space Imaging has 13 ground stations around the globe for direct IKONOS tasking.

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 now moving ahead with plans to launch the actual operational spacecraft, TrailBlazer.

After several delays, TrailBlazer, which is now scheduled for launch in 2006 aboard a

Russian Dnepr vehicle, will provide live streaming video of the Moon's surface, pictures of Earth from lunar orbit, maps of the lunar surface, and, at the conclusion of the mission, a fast pass over lunar terrain as it heads toward impact with the surface. TrailBlazer's sensors will have a resolution of about one meter, enabling it to photograph areas in great detail, such as historical Russian and U.S. landing sites.

Market Demand Scenarios

FAA/AST projects that the commercial satellite remote sensing sector will yield about 17 payloads throughout the forecast period, with a peak in 2006–2007 due to replacement cycles and the launch of five RapidEye satellites. Those satellites will be deployed on 13 launches, including eight medium-to-heavy vehicles.

"Little LEO" Telecommunications Systems

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. The name "Little LEO" derives from the comparatively lower frequencies-below 1 GHz-used by such systems compared to "Big LEO" systems. Only ORBCOMM has fully deployed its system. Little LEO systems are listed in Table 17.

Recent Developments

ORBCOMM is moving ahead with plans to deploy replacement satellites in the near future. In March 2005 the company announced a contract with OHB-System, a German company, to build and launch a demonstration satellite. OHB-System will serve as the systems integrator for the satellite: the bus will be provided by a Russian company, Polyot, while Orbital Sciences Corporation will provide the payload. The spacecraft will be launched into polar orbit in the first quarter of 2006 as a secondary payload on a non-commercial Cosmos 3M booster from Plesetsk Cosmodrome in Russia. 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 summer 2004.

ORBCOMM is also planning to quickly launch six satellites as a partial replacement for its existing constellation. The "Quick Launch" mission will be awarded in June 2005 for launch by the third quarter of 2006. The six satellites will be used to populate Plane A of the ORBCOMM constellation, whose existing satellites are the oldest. By late 2005 ORBCOMM plans to award a separate contract for a complete next-generation system consisting of four launches of 26

Table 17. FCC-Licensed Little LEO Systems

System	Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
			Number	Mass kg (lbm)			
Operational							
ORBCOMM	ORBCOMM Global LP	Orbital	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. Demo satellite launch planned for early 2006.
Under Development							
AprizeStar (LatinSat)	Aprize Satellite	SpaceQuest	4/4 (in orbit/ operational)	10 (22)	LEO	2002	Planned 48-satellite system. Received experimental FCC license in 2004. Licensed by Argentine CNC in 1995.

satellites, with the first launch scheduled by the end of 2007. By the time the next-generation system is deployed, ORBCOMM will operate 32 spacecraft in four planes of eight satellites each.

In February 2004, ORBCOMM announced the closing of a $26-million equity financing round with commercial satellite operator SES Global as the leading investor. Other investors included OHB-System, a German satellite technology company; investment firms Ridgewood Capital and Northwood Ventures; and several other existing investors, including senior management. The funding will be used primarily to support the company's expansion into new markets. The satellite replacement effort will be funded by existing cash on hand as well as cash flow from the company's continuing operations.

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 potential providers of low-data-rate satellite services struggled to gain necessary funding, which forced them to fall behind the milestones for spacecraft assembly and launch mandated in their FCC licenses. 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, depending on availability of secondary payload launch opportunities. 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.

Market Demand Scenarios

FAA/AST projects that 32 Little LEO satellites will be launched during the coming decade and generate a demand for five launches of small vehicles.

"Big LEO" and Mobile Satellite Services

Big LEO systems provide mobile voice telephony and data services in the 1–2 GHz frequency range. Also known as Mobile Satellite Services (MSS), two Big LEO systems have been fully deployed to date: Iridium and Globalstar. Both systems are fully operational, have relatively healthy satellites serving thousands of subscribers, and have at least several years of operational lifespan remaining. Big LEO systems are detailed in Table 18.

GLOBALSTAR

Globalstar anticipates launching eight spare satellites in late 2006 or early 2007. With the launch of these spares, the constellation is expected to last through 2011. A contract competition for launches is planned in 2005. The on-orbit constellation was previously launched using the Boeing Delta 2 and the Starsem Soyuz launch vehicles.

In April 2004 Globalstar, LP completed the sale of most of its assets to Thermo Capital Partners, LLC and its affiliates and reformed as Globalstar LLC ("New Globalstar"). This brought an end to the company's Chapter 11 bankruptcy case that began in February 2002. 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. At the end of 2004, Globalstar reported it had 133,000 subscribers.

The eight spare satellites were built under the original 1994 satellite contract between Globalstar, LP and Space Systems/Loral. In addition to launching the spare satellites, Globalstar plans to expand its coverage by constructing new gateways to serve the Alaska and the North Pacific region as well as the Southeastern U.S. and Northern and Eastern Caribbean areas. 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.

In July 2001 Globalstar was granted a separate license by the FCC to construct and launch a next-generation constellation of NGSO and GSO satellites that would operate in the 2-GHz band to provide broad-

Table 18. FCC-Licensed Big LEO Systems

System	Operator	Prime Contractor	Satellites: Number	Satellites: Mass kg (lbm)	Orbit Type	First Launch	Status
Operational							
Globalstar	Globalstar LP	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.
Iridium	Iridium Satellite LLC	Motorola	95/79 (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.

band services, but the FCC canceled the authorization in early 2003. Globalstar has asked the FCC to reconsider its decision.

In March 2005 the company filed an application with the FCC to add an ancillary terrestrial component (ATC) to its system. The company envisions using terrestrial repeaters for a number of applications, including improving service in urban areas where buildings can block satellite line-of-sight, providing local and long-distance telephone service in areas where local networks do not exist, and creating temporary "mini-cells" to support emergency operations in remote areas. The company expects the FCC to act on the application during the summer of 2005.

Iridium

Iridium Satellite LLC is planning a methodical satellite replacement program to gradually launch an entirely new orbital constellation beginning around 2013. New satellites would be launched over a period of up to ten years, possibly at a rate of five or six per year. Manufacturing contracts for new spacecraft could be awarded around 2008 or 2009. The current lifespan of the 66-satellite operational system and 12 in-orbit spares is expected to extend until about 2014, according to Iridium statements in 2005. At the end of 2004, the company reported around 114,000 subscribers, a 22.5 percent increase compared to totals at the end of 2003. About one third of all subscribers are defense/government users while the rest are commercial users. Iridium has indicated it will be in a position to self-fund the building of its new satellite system. Iridium ended 2004 with positive EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) versus negative EBITDA in 2003—a positive change of more than $20 million.

The FCC granted access to an additional 3.1 MHz of spectrum in 2004 so Iridium could meet increasing services demand. More than 2,500 aircraft have Iridium equipment onboard. Originally created mostly for voice communications, some 20 percent of Iridium signal traffic is data messaging, an area expected to grow in the near future.

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.

In 2002, Iridium Satellite successfully launched seven spare satellites: five by Delta 2 and two by Russia's 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.

In October 2004, the Defense Information Systems Agency of the U.S. Department of Defense (DoD) renewed its contract for another year of Iridium "airtime" services. The DoD contract began in 2000 as a two-year, $72-million deal with three additional one-year options. The original contract included unlimited minutes for up to 20,000 users.

ICO

In January 2005, ICO filed an application with the FCC seeking approval to modify its non-geosynchronous satellite service authorization to substitute a geosynchronous satellite system to access the United States market. This was later followed by an announcement that Space Systems/Loral signed a contract with ICO Satellite Management LLC for a geosynchronous satellite to provide mobile satellite services for voice and data to serve the United States along with an ATC. A launch is planned in 2007.

It is unclear if a move to GSO will mark the end of ICO's proposed non-geosynchronous orbit system of ten operational satellites and two spares. ICO's current FCC 2-GHz license requires that its system be in full operation by July 2007 and ICO intends to meet this requirement with a GSO approach. ICO officials now say that if the modification request is granted, the GSO satellite would serve the U.S. market and the NGSO system could still service other markets.

One NGSO ICO satellite was launched successfully in 2001 to an altitude of 10,390 kilometers (6,450 miles) but no other satellites have since been launched. Ten satellites in various stages of construction, intended for this particular orbit, are still owned by ICO. 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.

Market Demand Scenarios

FAA/AST 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

With the successful flights of SpaceShipOne, capture of the Ansari X Prize by Mojave Aerospace Ventures, and the announcement of new space prizes, the outlook for space tourism, or public space travel, brightened dramatically during 2004. Regular suborbital public space travel is a new market that is about to arrive. 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 in the fall of 2004 America's Space Prize: 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 inflatable space habitat, complete two orbits, return safely, and repeat a second mission within 60 days carrying a crew of at least five people. The contest is open to U.S.-located companies. Over 30 companies have entered the competition as of April 2005, surpassing the number of entrants in the Ansari X Prize. By 2014, Bigelow Aerospace intends to operate two orbital modules and a propulsion bus requiring three heavy-lift launches. In order to ferry crew and cargo to these habitats, at least 50 flights by 2014 are planned. More modules and flights would occur in a robust scenario. Meanwhile, Bigelow is moving ahead with plans to deploy test habitats, named Genesis Pathfinder and Gaurdian, in a series of four launches beginning in 2006 and 2007. Full-scale prototype modules could be launched in 2009 or 2010.

To date there have been two orbital space tourist flights, both non-commercial missions launched by Russia as part of regular crew visits to the International Space Station. Dennis Tito launched on a Soyuz to the International Space Station (ISS) for a one-week visit in 2001 and a second private space traveler, Mark Shuttleworth, launched in 2002. Other paying passengers are reportedly negotiating for Soyuz missions.

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. Other Challenges to demonstrate breakthroughs in space transportation capabilities and technologies are also under consideration. Although NASA is expected in 2005 to begin acquisition of cargo launch services to and from the International Space Station for future missions, these non-Space Shuttle missions may be done for and by the government and therefore would not be commercial.

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. Growth or decline in space markets is often affected by national economies, similar to other businesses.

- **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. About 80 percent of the communications bandwidth used by

DoD during Operation Iraqi Freedom was through commercially operated satellites in both GSO and NGSO. NASA has also purchased science data such as with OrbView 2.

- **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. Because many active satellites in NGSO today are first-generation systems, their lifespans are uncertain and their health may be guarded for competitive reasons.

- **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 concerns 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. 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 low-price launches are available on Russian launch vehicles, low prices have not increased satellite demand for the past four 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, 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 yet to be 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 constitute a “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.

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 generates deployment schedules by year based on either known or estimated launch activity and the number of satellites in a constellation. The model also delineates market segments, assigns small or medium-to-heavy vehicles based on satellite mass (unless vehicles are already designated), and calculates total payloads and launches throughout the forecast period. For the international science market, 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 19 shows the announced near-term manifests for these markets utilized 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 160-2400 kilometers (100–1,500 miles) in altitude, varying between 0° inclination for equatorial coverage and 101° inclination for global coverage;
- Medium Earth orbits (MEO) begin at 2,400 kilometers (1,500 miles) in altitude and are typically at a 45° inclination

Table 19. Near-Term Identified NGSO Satellite Manifest

Service Type	2005	2006	2007	2008
Commercial Remote Sensing		Radarsat 2 - Delta 2	OrbView 5 - Delta 2	TerraSAR L - Soyuz
		EROS B - START 1	RapidEye (5) - TBA	
		TerraSAR X - Dnepr		
		TrailBlazer - Dnepr		
		WorldView - Delta 2		
International Science	Kompsat 2 - Rockot	GOCE - Rockot	Cosmo Skymed 2 - TBA	
	China DMC+4 - Cosmos	Corot - Soyuz 2	SMOS - Rockot	
	Topsat - Cosmos	Cosmo Skymed 1 - TBA		
	SSETI Express - Cosmos	AGILE - PSLV		
	RazakSAT - Falcon 1			
	Cryosat - Rockot			
	Cosmos 1 - Volna			
	EgyptSat 1 - Dnepr			
	Saudisat 3 - Dnepr			
	SaudiComsat 3-7 - Dnepr			
	AKS 1-2 - Dnepr			
Telecommunications		ORBCOMM (6) - TBA	ORBCOMM (6) - TBA	
			Globalstar (4) - TBA	
			Globalstar (4) - TBA	
Other		Genesis Pathfinder 1 - Dnepr	Guardian 1 - Dnepr	SAR-Lupe 4 - Cosmos
		Genesis Pathfinder 2 - Dnepr	Guardian 2 - Dnepr	SAR-Lupe 5 - Cosmos
		SAR-Lupe 1 - Cosmos	SAR-Lupe 2 - Cosmos	
			SAR-Lupe 3 - Cosmos	
Total Payloads	16	18	26	3
Total Launches	6	13	11	3

Note: This manifest includes only those satellites announced as of May 5, 2005.

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 space-craft 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 services has increased by 38 satellites compared to the 2004 forecast. This is the second consecutive year there has been a significant increase in the number of satellites; the number of satellites in the 2005 forecast is 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 also up 25 percent from the 2004 forecast to accommodate the growth in international science and other payloads.

Baseline Forecast

The baseline forecast anticipates the following satellite market characteristics from 2005–2014:

- International science and other satellites (such as technology demonstrations) will comprise about 60 percent of the NGSO satellite market with 87 satellites, well above the 58 and 60 satellites in the 2004 and 2003 forecasts, respectively.

- Telecommunications satellites account for 28 percent of the market with 40 satellites, slightly above the 32 satellites in last year’s forecast.

- Remote sensing satellites that serve commercial missions will encompass 12 percent of the market with 17 satellites, in line with the 16 in the 2004 forecast and 20 in the 2003 forecast.

Table 20 and Figures 12 and 13 show the baseline forecast in which 144 satellites will be deployed between 2005 and 2014. In comparison to last year’s forecast of 106 total satellites (2004–2013), this year’s projections are up 36 percent. Table 21 shows the mass distributions of known manifested satellites over the next four years. As in the recent past, small satellites dominate, although not to the same degree as in last year’s forecast: 68 percent of the satellites in the near-term manifest weigh 600 kilograms or less, compared to 78 percent in the 2004 forecast. This is because of the introduction of the heavier SAR-Lupe and Bigelow Aerospace payloads in this year’s forecast.

After accounting for multiple manifesting, the 144 satellites in the forecast yields a commercial launch demand of 64 launches over the forecast period. This demand breaks down into about four launches annually on small launch vehicles and two

Figure 12. Baseline Satellite Forecast

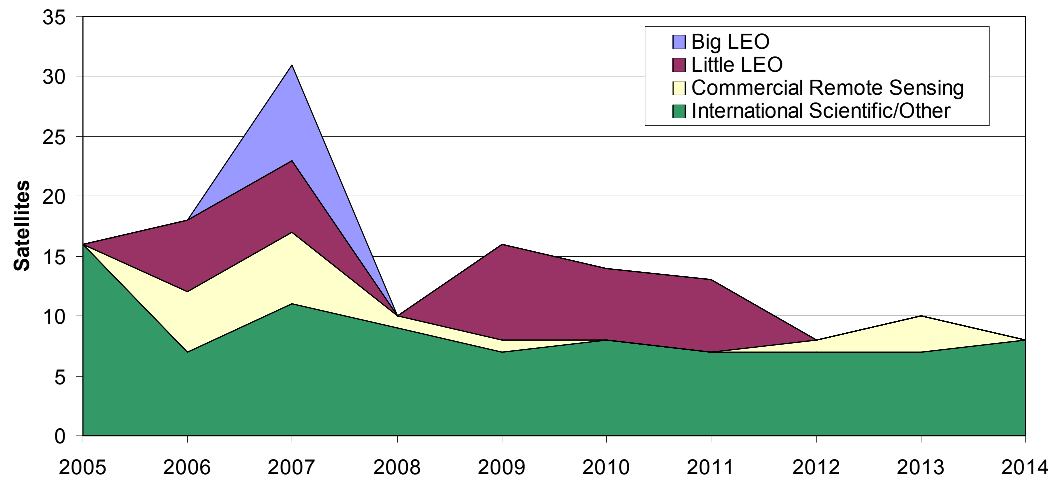


Figure 13. Baseline Launch Demand Forecast

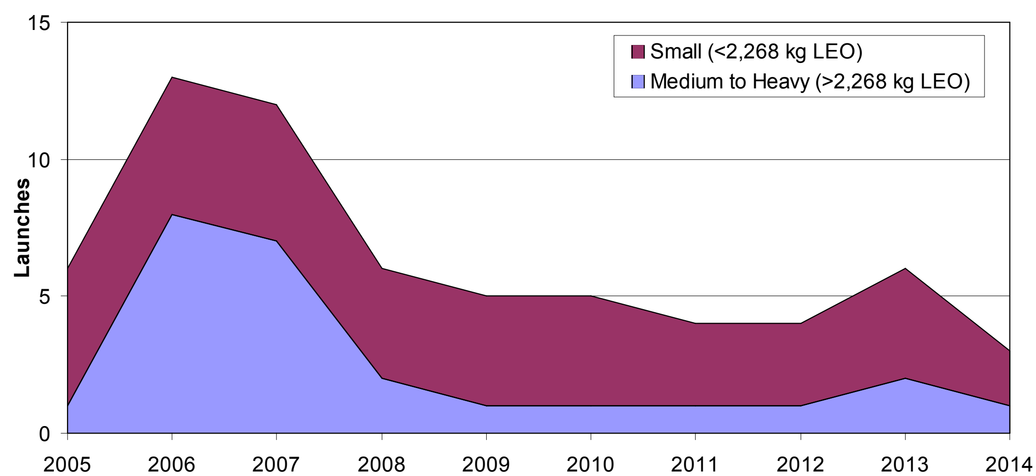


Table 20. Baseline Satellite and Launch Forecast

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL	Avg
Satellites												
Big LEO	0	0	8	0	0	0	0	0	0	0	8	0.8
Little LEO	0	6	6	0	8	6	6	0	0	0	32	3.2
International Scientific/Other	16	7	11	9	7	8	7	7	7	8	87	8.7
Commercial Remote Sensing	0	5	6	1	1	0	0	1	3	0	17	1.7
Total Satellites	**16**	**18**	**31**	**10**	**16**	**14**	**13**	**8**	**10**	**8**	144	14.4
Launch Demand												
Medium-to-Heavy Vehicles	1	8	7	2	1	1	1	1	2	1	25	2.5
Small Vehicles	5	5	5	4	4	4	3	3	4	2	39	3.9
Total Launches	**6**	**13**	**12**	**6**	**5**	**5**	**4**	**4**	**6**	**3**	64	6.4

and a half launches annually on medium-to-heavy launch vehicles. These 64 launches represent a 25 percent increase over the 51 launches in the 2004 and 2003 forecasts. The peak launch activity in the forecast is in 2006 and 2007, with 13 and 12 launches, respectively; all other years are slightly below the ten-year average of 6.4 launches a year.

As shown in Table 22, 44 of the 64 launches in the current forecast will carry international science and other payloads. Thirteen launches are forecast to carry commercial remote sensing satellites while seven launches will carry telecommunications satellites. International science payloads favor small vehicles over medium-to-heavy ones by a two-to-one margin, 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, tend to favor 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), although no vehicle selections for these payloads have yet been announced.

As in the 2003 and 2004 forecasts, 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 will not enter design phases for second-generation systems for several years and current systems are healthy and expected to last well into the next decade. The robust scenario could return in future years, though, depending on the emergence of new markets.

Historical NGSO Market Assessments

A historical comparison of FAA/AST baseline forecasts from 1998 to the present is in Figure 14. Actual launches to date are also displayed. There have been significant changes in the forecasted demand for commercial NGSO launches based on market conditions. 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

Table 21. Distribution of Satellite Masses in Near-Term Manifest

	2005	2006	2007	2008	Total	Percent of Total
< 200 kg (< 441 lbm)	14	6	11	0	31	49%
200-600 kg (441-1323 lbm)	0	3	9	0	12	19%
600-1200 kg (1323-2646 lbm)	2	5	4	2	13	21%
> 1200 kg (> 2646 lbm)	0	4	2	1	7	11%
Total	16	18	26	3	63	100%

Table 22. Distribution of Launches Among Market Sectors

		Launch Demand		
	Satellites	Small	Medium to Heavy	Total
Telecommunications	40	5	2	7
International Science/Other	87	29	15	44
Commercial Remote Sensing	17	5	8	13
Total	**144**	**39**	**25**	**64**

through 2002 FAA/AST reduced its annual forecasts as demand in the marketplace fell. This year's forecast, though, is the third consecutive forecast in which the number of payloads has increased from the previous forecast: the 144 payloads in the 2005 forecast is an 82 percent increase over the 79 payloads in the 2002 forecast. The 64 launches in this year's forecast represents a 25 percent increase over the 2004 forecast, marking the first time since 1998 that the total number of launches forecast increased from the previous year's forecast. Figure 15 illustrates this increase 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.

For the fourth consecutive year, the number of baseline international science satellites and commercial remote sensing satellites combined are more than those in the telecommunications sector throughout the entire forecast. The 2002 forecast was the first occurrence of this turnaround from the communications-dominated forecasts of the late 1990s.

Table 23 lists actual payloads launched by market sector and total commercial launches that were internationally competed or commercially sponsored from 1995–2004. Medium-to-heavy vehicles had 41 launches during this period while small vehicles had 36. NGSO activity peaked with 19 launches in 1998 when Iridium, Globalstar, and ORBCOMM were active. As was the case in last year's forecast, the 2005 forecast estimates launch demand for more small vehicle launches (35) than medium-to-heavy vehicle launches (24) from 2005–2014. The 2005 forecast estimates six launches during the 2005 calendar year.

Historical satellite and launch data for the period 1993–2004 are shown in Table 24. Secondary and piggyback payloads on launches with larger primary payloads were not included in the payload or launch tabulations.

Table 23. Historical Commercial NGSO Activity*

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Satellites												
Big LEO	0	0	0	46	60	42	5	1	7	0	0	161
Little LEO	0	3	0	8	18	7	0	0	2	0	2	40
International Science/Other	0	0	2	1	4	5	11	1	6	1	7	38
Commercial Remote Sensing	0	1	0	2	0	2	2	2	0	8	0	17
Total Satellites	**0**	**4**	**2**	**57**	**82**	**56**	**18**	**4**	**15**	**9**	**9**	**256**
Launches												
Medium-to-Heavy Vehicles	0	0	1	8	9	11	6	2	2	1	1	41
Small Vehicles	0	2	1	5	10	7	3	2	2	3	1	36
Total Launches	**0**	**2**	**2**	**13**	**19**	**18**	**9**	**4**	**4**	**4**	**2**	**77**

* 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

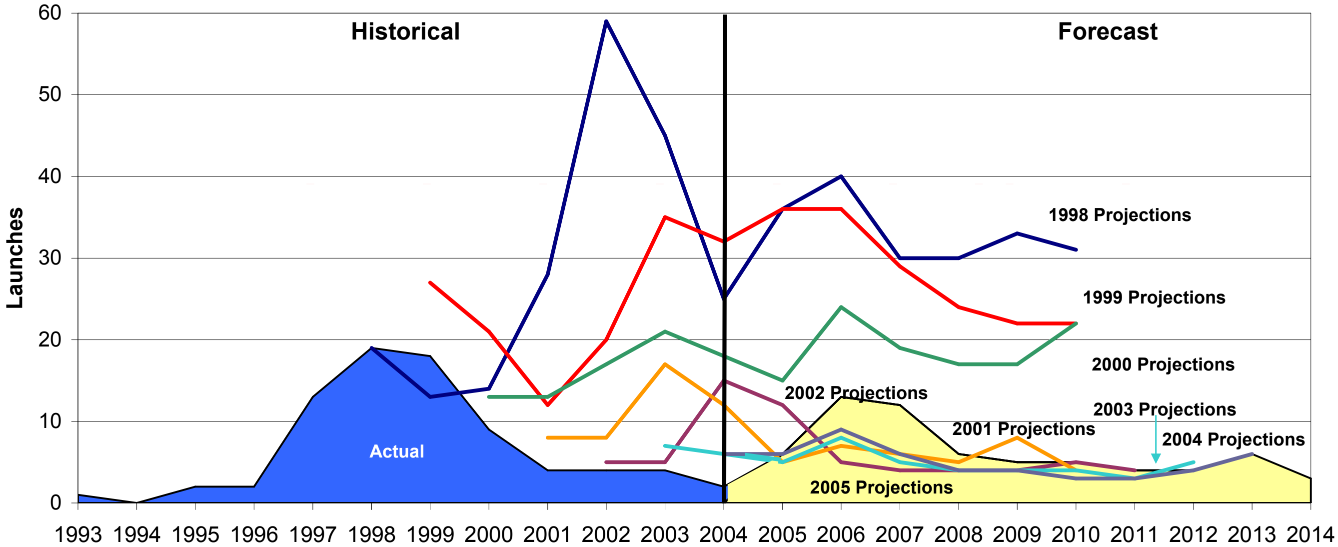


Figure 15. Average and Maximum Launches per Year from NGSO Forecasts 1998–2005

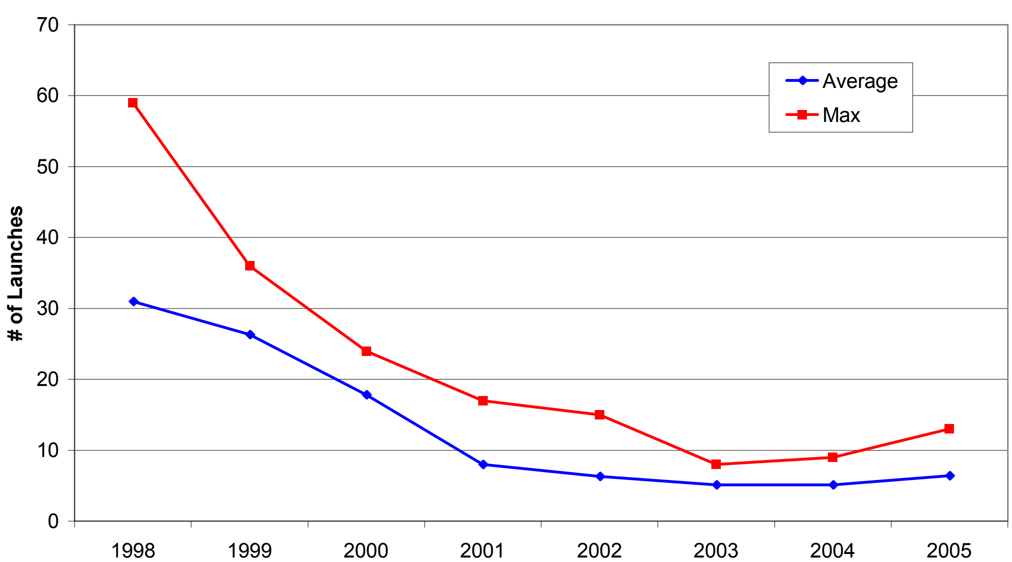


Table 24. Historical NGSO Satellite and Launch Activities (1993–2004)†

Summary	Market Segment	Date	Satellite	Launch Vehicle	
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 3		
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 2	Dnepr	Medium-to-Heavy
			Unisat 2		
4 Launches			RUBIN 2		
2 Medium-to-Heavy			Trailblazer Structural Test Article		
2 Small					
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	Small
1 Int'l. Science		10/18/01	QuickBird	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.

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

Table 24. Historical NGSO Satellite and Launch Activities (1993–2004) [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 Z-1	Zenit 3SL	Medium-to-Heavy
2 Remote Sensing					
8 Int'l. Science	**Remote Sensing**	11/21/00	QuickBird 1	Cosmos	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	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	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 24. Historical NGSO Satellite and Launch Activities (1993–2004) [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	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					