2004 COMMERCIAL SPACE TRANSPORTATION FORECASTS

May 2004

Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (AST)

and the

Commercial Space Transportation Advisory Committee (COMSTAC)

About the Associate Administrator for Commercial Space Transportation and the Commercial Space Transportation Advisory Committee

The Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (FAA/AST) licenses and regulates U.S. commercial space launch activity as authorized by Executive Order 12465 (*Commercial Expendable Launch Vehicle Activities*) and 49 United States Code Subtitle IX, Chapter 701 (formerly the *Commercial Space Launch Act*). AST's mission is to license and regulate commercial launch operations to ensure public health and safety and the safety of property, and to protect national security and foreign policy interests of the United States. The Commercial Space Launch Act of 1984 and the 1996 National Space Policy also direct the Federal Aviation Administration to encourage, facilitate, and promote commercial launches.

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

The primary goals of COMSTAC are to:

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

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

Cover: Art by Phil Smith (2004)

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Executive Summary

The Federal Aviation Administration's Associate Administrator for 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 2004 to 2013.

The *2004 Commercial Space Transportation Forecasts* report includes:

- The *COMSTAC 2004 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 2004 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits*, which projects commercial launch demand for satellites to non-geosynchronous orbits (NGSO), such as low Earth orbit, medium Earth orbit, elliptical orbits, and external orbits beyond the Earth.

Together, the COMSTAC and FAA forecasts project that an average of 23.4 commercial space launches worldwide will occur annually from 2004 to 2013. The combined forecasts are similar to last year's forecast of 23.7 launches per year although still down from 26.8 in the 2002 forecast and 32 in the 2001 forecast.

In the GSO market, satellite demand is 211 satellites, or 21.1 satellites per year, a decrease of nine percent compared to the 2003 forecast when there was an average of 23.3 satellites per year. However, the resulting demand for launches per year overall did not decrease proportionately with the number of satellites available because the 2004 forecast identifies fewer dual-manifested launches in the future compared to last year's forecast. An analysis of GSO mass data in the report indicates that the shift to heavier-class satellites may be slowing.

The NGSO market includes 106 satellites in the market from 2004–2013, the first significant forecast increase in the total number of NGSO satellites since the 1998 forecast, mostly because of improved business conditions for two telecommunications companies. Despite a 32.5 percent increase of the number of satellites, launch demand overall is unchanged from last year's forecast of 51 total launches because an increasing
number of NGSO satellites are multiple-manifested; more satellites are riding on one launch vehicle on an average basis.

COMSTAC and FAA project an average annual demand for:

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

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

- 2.8 launches of small vehicles to NGSO.

Introduction

Each year, the Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (FAA/AST) and the Commercial Space Transportation Advisory Committee (COMSTAC) prepare forecasts of global demand for commercial space launch services. The jointly-published *2004 Commercial Space Transportation Forecasts* report covers the period from 2004 to 2013 and includes:

- The *COMSTAC 2004 Commercial Geosynchronous Orbit Launch Demand Model*, which projects demand for commercial satellites that operate in geosynchronous orbit (GSO) and the resulting launch demand to geosynchronous transfer orbit (GTO); and

- The *FAA's 2004 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits*, which projects commercial launch demand for all space systems in non-geosynchronous orbits (NGSO), including low Earth orbit, medium Earth orbit, elliptical orbits, and external orbits such as to the Moon or other solar system destinations.

Growth of Commercial Space Transportation

Prior to the 1980s, governments ran the operation of launching payloads into Earth orbit. Since then, commercial launch activity has steadily increased to meet both commercial and government mission needs. From 1997–2001, a peak era in commercial telecommunications activity, commercial launches accounted for an average of about 42 percent of worldwide launches. During 2003, 17 out of 63 worldwide launches were commercial, representing 27 percent of global activity. Demand for up to 25 GSO and NGSO launches is projected for 2004.

The commercial launch market is directly impacted by activity in the satellite market ranging from global finance and customer demand to satellite lifespan and industry consolidations.

About the COMSTAC 2004 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.

2004 Combined Satellite and Launch Forecasts

This year's COMSTAC GSO and FAA NGSO combined forecasts contain 317 international satellites expected to seek commercial launch services between 2004 and 2013, as shown in Table 1 and Figures 1, 2, and 3. The amount is similar to last year's forecast of 313 satellites during the period 2003–2012 and reflects changed market conditions from the 352 satellites in the 2002 forecast and 456 satellites in the 2001 forecast. However, domestic and worldwide economies show signs of improvement compared to the past few years that could spur growth in satellite demand in both the GSO and NGSO markets.

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 234 commercial launches to GSO and NGSO destinations is forecast through 2013, as shown in Table 1 and Figure 3. This translates to an average demand of 23.4 worldwide launches per year, about the same as last year's forecast of 23.7 launches.

About 78 percent of the launch market is for satellites to geosynchronous orbit compared to about 22 percent to NGSO. The projected satellite market for GSO is significantly greater than NGSO for the fourth year in a row. There are 211 GSO satellites in the ten-year forecast, compared with 106 in NGSO.

This year's GSO forecast contains an average of 21.1 satellites per year with a high of 24 and a low of 16. The average is nine percent less than the 2003 forecast that contained 23.3 GSO satellites per year or a decline of about two satellites per year. Twenty-five GSO satellites are expected to launch in 2004. Although the total number of satellites is less in the 2004 forecast compared to the 2003 forecast, launch demand is about the same because the number of dual-manifested launches declined for the third year in a row in the GSO forecast.

In the NGSO market, satellite demand is up compared to the 2003 forecast but the number of launches is the same. This year's NGSO forecast contains an average of 10.6 satellites per year compared to eight in last year's forecast. Because more satellites are multiple-manifested in the 2004 forecast, the number of launches is the same as last year's forecast including both medium-to-heavy and small launch vehicles.

The peak years in the NGSO forecast are 2006 and 2007 when launches of telecommunications and remote sensing satellite launches are scheduled. Launch demand for NGSO consists of an average of 2.3 launches per year for medium-to-heavy launch vehicles and 2.8 launches of small launch vehicles per year for an average of 5.1 launches or 51 total launches throughout the forecast. Figure 4 shows historical forecasts from 1998 to 2004.

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

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total	Average
Satellites												
GSO Forecast (COMSTAC)	20	22	16	19	19	22	22	23	24	24	211	21.1
NGSO Forecast (FAA)	6	8	24	17	7	12	6	11	7	8	106	10.6
Total Satellites	**26**	**30**	**40**	**36**	**26**	**34**	**28**	**34**	**31**	**32**	**317**	**31.7**
Launch Demand												
GSO Medium-to-Heavy	19	19	13	16	16	19	19	20	21	21	183	18.3
NGSO Medium-to-Heavy	3	2	5	3	1	1	1	1	2	4	23	2.3
NGSO Small	3	4	4	3	3	3	2	2	2	2	28	2.8
Total Launches	**25**	**25**	**22**	**22**	**20**	**23**	**22**	**23**	**25**	**27**	**234**	**23.4**

Figure 1. GSO Satellite and Launch Demand

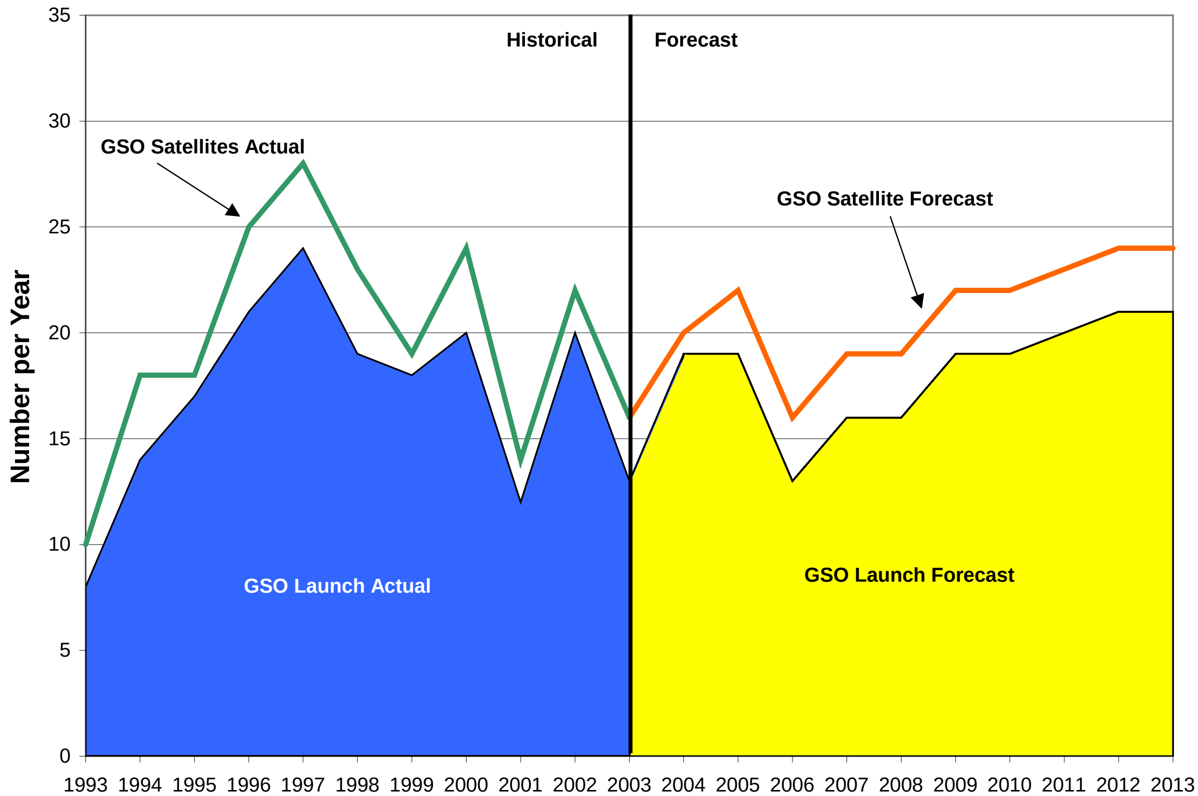


Figure 2. NGSO Satellite and Launch Demand

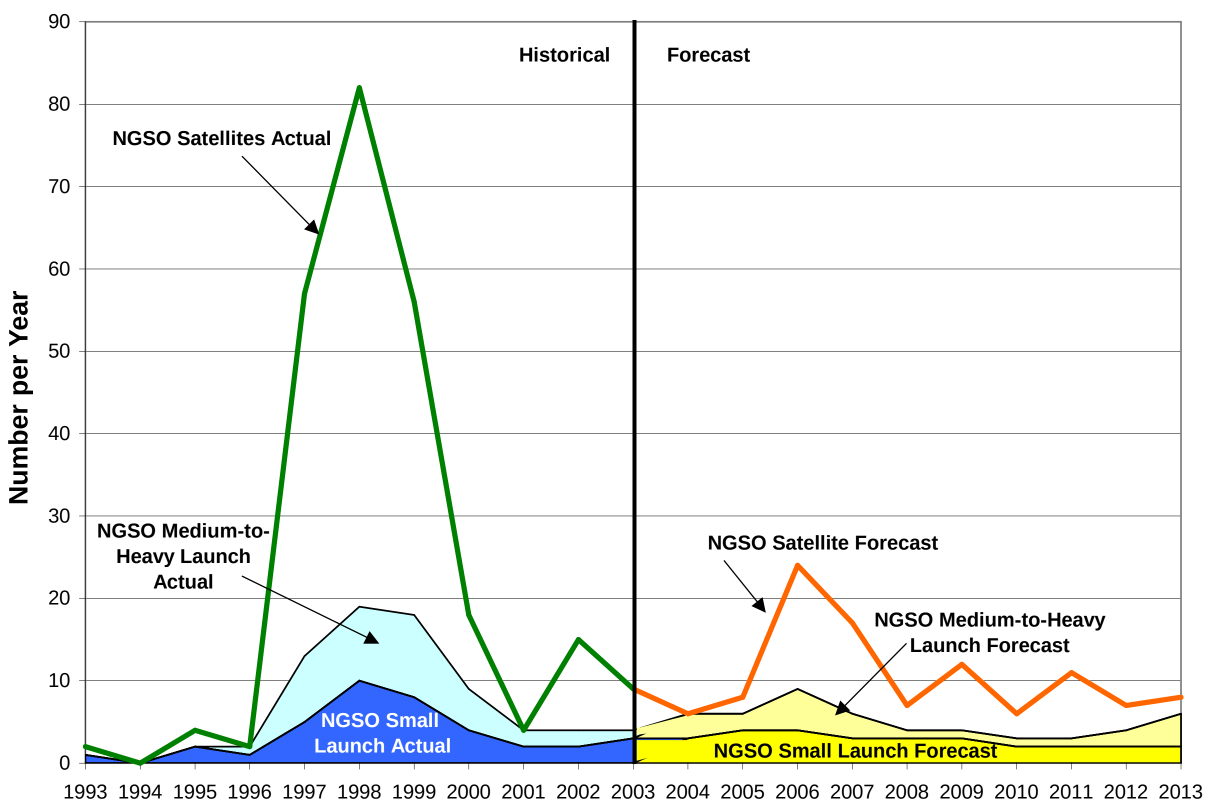


Figure 3. Combined GSO and NGSO Launch Forecasts

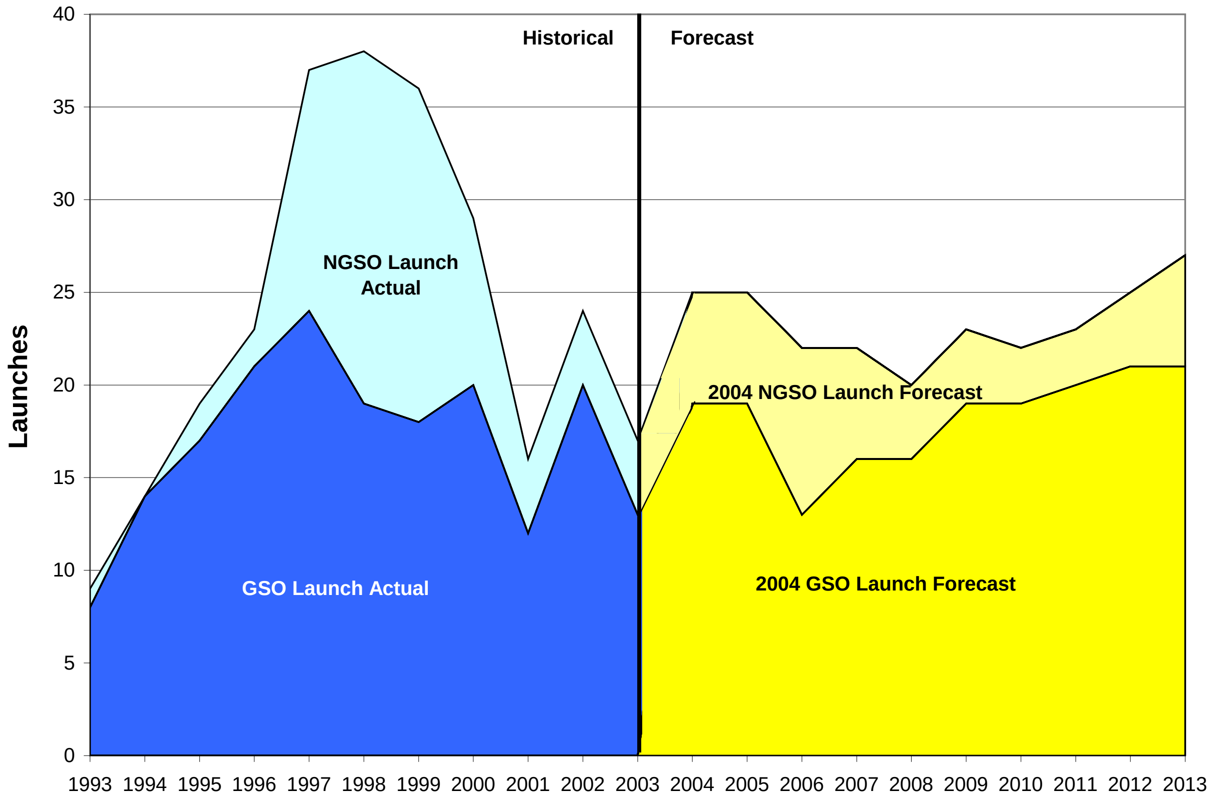
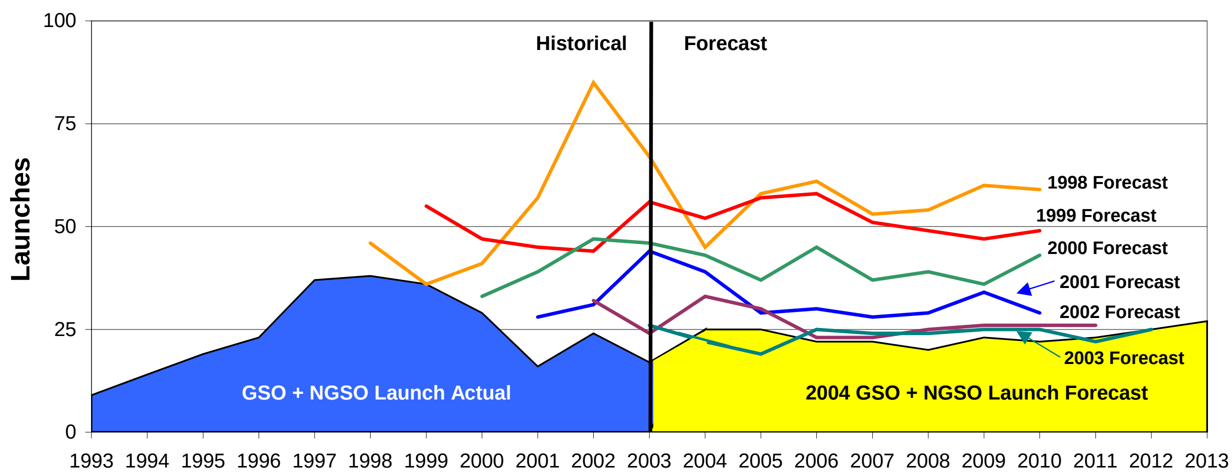


Figure 4. Historical Commercial Space Transportation Forecasts



COMSTAC 2004 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 the Associate Administrator for Commercial Space Transportation of the Federal Aviation Administration (FAA/AST). The *2004 Commercial Geosynchronous Orbit (GSO) Launch Demand Model* is the twelfth 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 from the inputs of commercial companies from across the satellite and launch industries. In this report COMSTAC produces a satellite and 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 possible launches in a year, satellite demand is adjusted by the number of satellites projected to be launched in dual-manifest circumstances.

The near-term forecast, which is based on existing and anticipated satellite programs for 2004 through 2006, shows demand for 20 satellites to be launched in 2004, 22 in 2005, and 16 in 2006. The average annual COMSTAC demand forecasts published in the 2002 and 2003 reports were 27.3 and 23.3 satellites per year, respectively, over the ten-year forecast period. This year's mission model predicts an average demand of 21.1 satellites to be launched annually from 2004 through 2013, a decrease of nine percent from the demand forecast of 23.3 satellites per year forecast in the 2003 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 this 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 that although the number of satellites launched in 2003 and the number of satellites forecast for 2004 and 2005 are below the industry peak in 1997, the mass of the satellites and the number of transponders launched and projected in this period approaches and in some cases exceeds the 1997 levels.

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. A launch realization factor has been applied to the near-term forecast to reflect the actual versus predicted satellites launched in previous commercial GSO forecasts.

In 2003, 15 commercial GSO satellites were launched, a decrease of 32 percent from the 2002 total of 22 satellites launched. Last year's commercial model projected a 2003 demand of 22 satellites, with an expected actual launch realization of between 13 and 19 satellites. Of the 15 satellites launched in 2003, 14 were correctly anticipated and one forecast for

2004 (Insat 3E) launched early. The remaining eight satellites anticipated but not launched in 2003 are expected to launch in 2004 and are included in this year's near-term forecast.

Over the twelve years that this report has been published, anticipated demand in the first year of the forecast period has consistently exceeded the actual number of satellites launched in that year. Using this historical variance as an indicator suggests that the 2004 demand of 20 satellites will be discounted to an actual number of satellites launched of somewhere between 12 and 17. The variance between forecast demand and the actual number of satellites launched will be discussed in more detail.

The COMSTAC 2004 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 may be greater than the number of *launches* conducted in any given period. This is because some launch vehicles are capable of "dual-manifesting," meaning that two satellites are flown on a single launch vehicle. 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

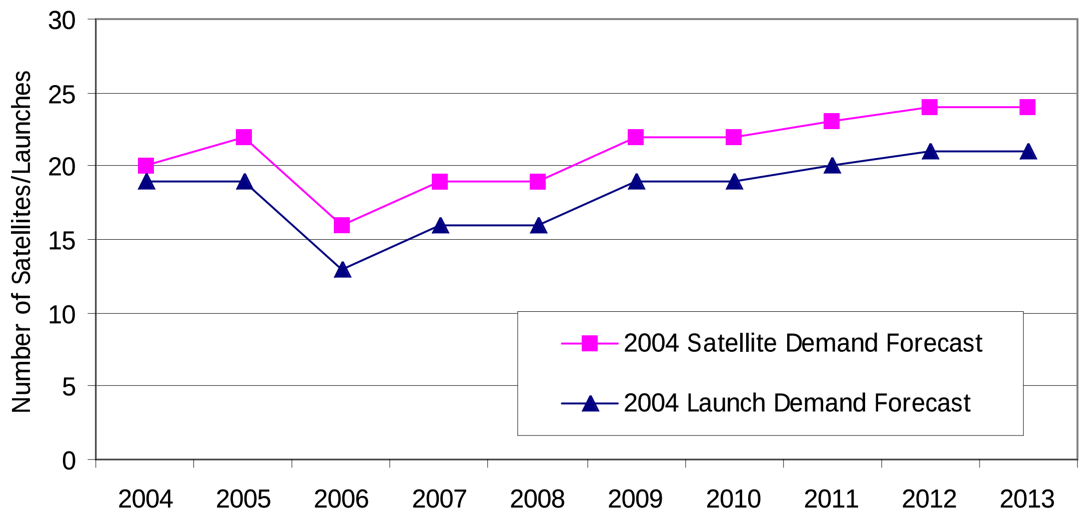


Table 2. Commercial GSO Launch Demand Forecast Data

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total	Average 2004 to 2013
Satellite Demand	20	22	16	19	19	22	22	23	24	24	211	21.1
Dual Launch Forecast	1	3	3	3	3	3	3	3	3	3	28	2.8
Launch Demand Forecast	19	19	13	16	16	19	19	20	21	21	183	18.3

Introduction

The Federal Aviation Administration's Office of the Associate Administrator for 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 2004 update of the worldwide commercial GSO satellite mission model for the period 2004 through 2013. It is based on market forecasts obtained in early 2004 from major satellite manufacturers, satellite service providers, and launch service providers worldwide.

It should be emphasized that this is not a forecast of actual launches for any given year. It is a forecast of the demand for launches, i.e., the number of launches needed to fulfill the projected delivery of satellite orders in a given year. The number of actual launches realized for that year depends on other factors such as satellite deliveries, launch successes, and range availability. 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.

A "realization factor" shows 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.

The Methodology section has been enhanced and other segments of the report re-organized to provide the reader with an improved description of the process used in calculating the demand forecast, the difference between demand and actual satellites launched, and how best to apply the results discussed in the report.

Also included is a discussion of factors that can affect future launch demand and of trends in the commercial satellite industry. The report goes on to examine 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 the number of transponders per satellite from 1993 through 2004.

In this year's report, for the convenience of the reader the Working Group has included a list of historical commercial GSO launches from 1993–2003 in Appendix D. In completing this table, the Working Group has corrected a few minor inconsistencies that appeared in reports from previous years. Specifically, Chinasat 7 was removed from the 1996 count, and Chinastar 1 and Sinosat 1 were removed from the 1998 count because they were determined not to have been openly competed for launch services as defined by the Working Group methodology.

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 29 inputs from satellite service providers, manufacturers, and launch service providers. COMSTAC would like to thank all of the participants in the 2004 mission model update.

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 from 2004–2013) and to manufacturers and launch service providers (requesting comprehensive industry forecasts of addressable commercial GSO payloads per year for the period 2004–2013).

Addressable payloads in this context 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).

Note that the number of projected launches per year is smaller than the satellite demand forecast due to the potential for dual-manifesting of satellites on launch vehicles. 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 in this document.

Satellite mass classes are based on the spacecraft's separated mass that is to be inserted into a nominal geosynchronous transfer orbit (GTO). 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 spacecraft models associated with each category are shown in Table 3.

Table 3. Satellite Mass Classes

GTO Launch Requirement	Satellite Bus Models
Below 2,200 kg (< 4,850 lbm)	LM A2100A, Boeing 376, Orbital Star 2, Astrium ES 2000, Alcatel SB 2000
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)	LM A2100AXX, Boeing 702/GEM, Loral 1300, Astrium ES 3000, Alcatel SB 4000

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

- AirTV (U.S.)
- Arianespace (France)
- Asia Satellite Telecommunications, Ltd. (China–Hong Kong)
- Astrium (France)
- The Boeing Company* (U.S.)
- Broadcasting Satellite System Corp. (Japan)
- Eurasiasat (Monaco)
- EUROCKOT GmbH (Germany)
- JSAT Corporation (Japan)
- Kistler* (U.S.)
- KT Corporation (South Korea)
- Lockheed Martin Space Systems Co.* (U.S.)
- Loral Skynet (U.S.)
- Miraxis, LLC (U.S.)
- Mobile Broadcasting Corp. (Japan)
- Mobile Satellite Ventures (U.S.)
- Taiwan National Space Program Office
- SingTel Optus (Australia)
- Orbital Sciences Corp. (U.S.)
- PanAmSat (U.S.)
- Satmex (Mexico)
- Shin Satellite (Thailand)
- SingTel (Singapore)
- SES Global (Luxembourg)
- Space Communications Corporation (Japan)
- Space Systems/Loral* (U.S.)
- Star One (Brazil)
- Telesat Canada
- Thuraya Telecommunications (U.A.E.)

Comprehensive mission model forecasts from the 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 2004 to 2013. Other responses provided partial market or company-specific satellite launch demand information.

The Working Group used the comprehensive inputs from the U.S. respondents to derive the average launch rate for years 2007 through 2013. 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

There is some difficulty and uncertainty involved in forecasting the commercial launch market. 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 growth shown in this forecast, therefore, is based on both the replenishment of existing satellites and assessments of growth in new and existing satellite markets.

COMSTAC Demand Projection vs. Actual Launches Realized

Factors That Affect Launch Realization

The near-term COMSTAC mission model (2004–2006) 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. Since the near-term demand represents visibility at the time of publication of this report, it does not account for delays in the realization of launch demand.

Several launch vehicle and/or satellite factors can affect the execution of a scheduled launch. These can include launch failure, launch vehicle component problems, or manifesting issues. Satellite suppliers also 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. 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. 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, and International Telecommunications Union (ITU) registration 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 to see, for example, a satellite delayed due to both factory and launch manifesting issues.

2003 Space Industry Performance on Launch Demand

In the 2003 COMSTAC Commercial GSO Demand Model, the Working Group listed 22 satellites that were then manifested in that year. Of these 22 satellites, only 14 satellites were actually launched in 2003 and another satellite launched early (Insat 3E had been forecast to launch in 2004). While there was a demand for 22 satellites to be launched as forecasted by the COMSTAC Working Group, the execution on the manifest was impacted primarily by satellite production delays. A list of the factors that affected the 8 satellites that did not make their launch dates follows:

- 6 satellites were delayed due to satellite issues
- 1 satellite was delayed due to issues related to both the satellite and the launch vehicle
- 1 satellite was delayed due to regulatory issues (export control)

Projecting Actual Launches

As noted earlier, the three-year near-term mission model is based on input from each U.S. satellite manufacturer and launch service provider. Development of the near-term forecast estimate in this way results in a projection of the maximum identified demand for satellites to be launched each year. Identified demand for any particular year is defined as the number of satellites that customers desire to have launched, with no adjustment for manufacturing or launch schedules. The consensus estimate of identified demand for 2004 is 20 GSO payloads.

As discussed above, launch schedules can be delayed by many factors. Given that one or more of these factors have delayed missions each year that the COMSTAC forecast of identified demand has been presented, it is very likely that satellites expected to launch in 2004 will also experience delays. A "realization factor", based on the variance between forecasted demand and actual launches, is applied to the first three years of the forecast.

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, 29 percent for the second year, and 39 percent for the third year. The range of variance between the forecast and real experience is shown in Table 4.

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.

Applying the historical variances to this year's 2004 demand forecast of 20 satellites, the probable number of satellites that will actually be launched in 2004 will be between 12 and 17 (as illustrated in Figure 6). In the last two years, a substantial number of satellites have been delayed from the first year of the forecast to the following two years. Because of this effect, and because the Working Group has attempted to be as rigorous as possible in "scrubbing" the near-term manifest to reflect production schedules, the range of expected realization of actual satellite launches in the second and third years of the forecast is defined as a range between the historical average variance and the predicted demand. Using this methodology, the actual number of satellites launched should be between 16 and 20 in 2005, and between 12 and 14 in 2006.

The Working Group provides this additional guidance to the reader in this year's report 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.

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.

Table 4. Range of Variance Between Forecast and Real Experience

	Near-Term GSO Forecast of Demand		
Variance Between Forecast and Actual Launches	First Year	Second Year	Third Year
Highest Variance	42%	55%	64%
Lowest Variance	13%	10%	15%
Average Variance	24%	29%	39%

Figure 6. COMSTAC Commercial GSO Satellite Demand Forecast

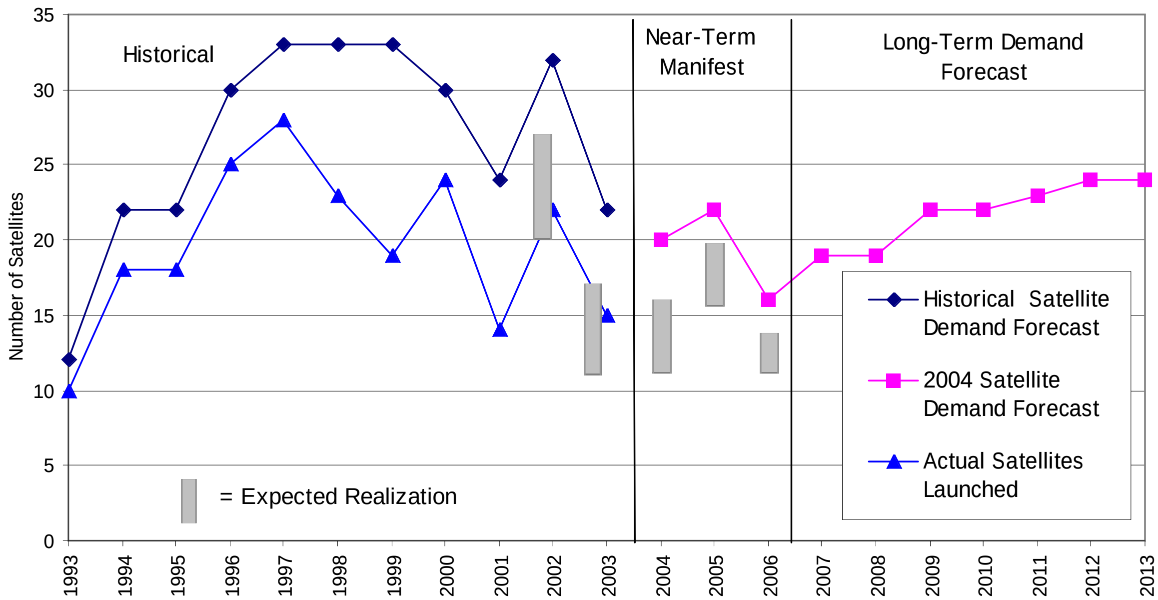


Figure 7. COMSTAC Commercial GSO Satellite and Launch Demand Forecast

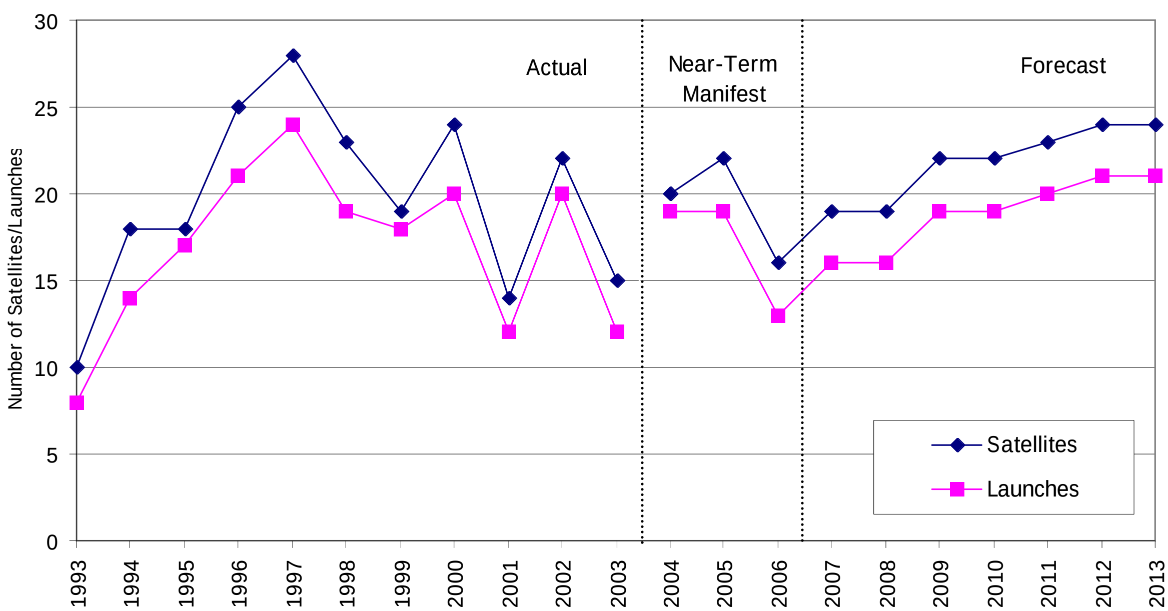


Table 5. COMSTAC Commercial GSO Satellite Forecast

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total	Average
High				21	23	23	24	24	25	27		
2004 Satellite Demand	**20**	**22**	**16**	**19**	**19**	**22**	**22**	**23**	**24**	**24**	**211**	**21.1**
Low				16	16	18	18	18	18	18		

2004 Satellite Launch Demand Model

Figure 7 shows the demand forecast for commercial satellite launches to GSO for the years 2004 through 2013. Also plotted in Figure 7 is the actual number of satellites launched for each year from 1993 to 2003, for reference. The range of individual estimates from the various comprehensive inputs is also shown in Table 5. COMSTAC does not present "high" or "low" cases for the demand forecast. The high and low inputs are simply the highest and lowest of all individual estimates provided for any one year. This variation is shown to give the reader a sense of the range of the individual inputs.

This year's mission model predicts an average demand of 21.1 satellites to be launched per year over the period from 2004 through 2013. This is a nine percent decrease from the average forecast of 23.3 satellites per year in the 2003 report. Several factors impact the demand for commercial GSO satellites, including economic conditions, availability of financing for satellite projects, availability of affordable insurance, and export control regulations. The factors affecting demand are addressed in more detail later in this report.

Table 6 shows the near-term mission model for 2004 through 2006, 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 20 satellites to be launched in 2004, 22 in 2005, and 16 in 2006.

Table 6. Commercial GSO Near-term Mission Model, as of April 28, 2004

	2004	2005	2006
Total	20	22	16
Below 2,200 kg (<4,850 lbm)	3	3	2
	AMC-10 – Atlas IIAS AMC-11 – Atlas IIAS Galaxy 14 – Ariane 5	Galaxy 15 – Ariane 5 Optus D1 – TBD Telkom 2 – Ariane 5	AMOS 3 – TBD Sirius 4 - TBD
2,200 – 4,200 kg (4,850-9,260 lbm)	5	6	8
	Superbird 6 – Atlas IIAS MBSat – Atlas III XTAR EUR – Ariane 5 AMC 15 – Proton Insat 4A – Ariane 5	Spainsat – Ariane 5 Arabsat 4A – Proton Hot Bird 7A – Ariane 5 Insat 4B – Ariane 5 DirecTV 8 - TBD AMC 16 -- Proton	Hot Bird 8 – Ariane 5 StarOne C1 – Ariane 5 JCSat 9 – Ariane 5 Arabsat 4B – Proton Astra 1L – Proton AirTV 1 – TBD JCSat 10 - TBD Optus D2 – TBD
4,200 – 5,400 kg (9,260 – 11,905lbm)	6	7	6
	Eutelsat W3A - Proton Estrela do Sul – Sea Launch Apstar V – Sea Launch Worldsat 2 - Proton Amazonas - Proton XM-3 - Sea Launch	WorldSat 3 – Proton Anik F1R – Proton Astra 1KR – Ariane 5 Measat 3 - Proton Wildblue 1 – Ariane 5 Echostar 10 – TBD Thuraya - TBD	Galaxy 16 - TBD Galaxy 17 - TBD Telstar 11R - TBD Koreasat 5 – TBD AMC 14 – Atlas V Telesat (tbd) - TBD
Over 5,400 kg (>11,905 lbm)	6	6	0
	Anik F2 – Ariane 5 DirecTV 7S – Sea Launch Intelsat 10 – Proton Inmarsat 4F1 – Atlas V Spaceway 1 - Sea Launch Telstar 8 - Sea Launch	NSS 8 - Sea Launch Spaceway 2 - Sea Launch iPSTAR – Ariane 5 Satmex 6 – Ariane 5 Inmarsat 4F2 – Sea Launch DirecTV 9S - TBD	

Satellite Launch Mass Classes

Payloads 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 requirements of various satellite models. 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 remainder of the forecast, the total in each mass class is an average of the domestic comprehensive inputs for each class for each year beyond the near-term forecast. In some instances, a satellite's mass fell on the line between two mass classes. Thus, a variance between total numbers in a mass class in a given year can be anticipated.

Figure 8 and Table 7 show the trends in annual GSO satellite mass distribution. Actual data are presented for 1993 through 2003, followed by the distribution projected in this year's demand forecast.

Figure 8. Forecast Trends in Annual GSO Satellite Mass Distribution

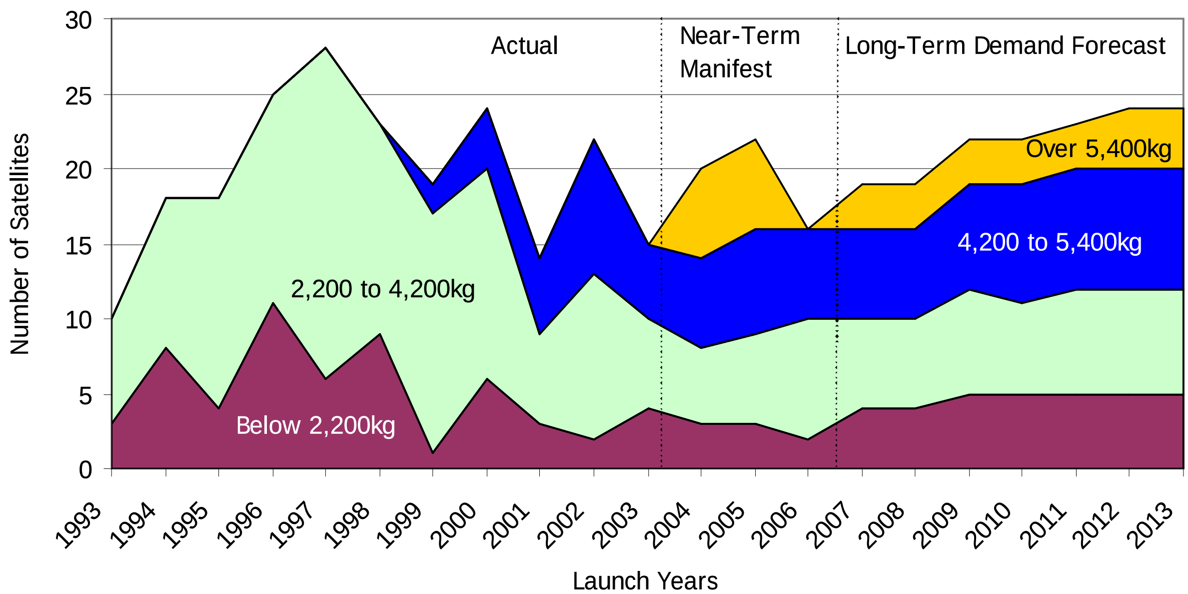


Table 7. Forecast Trends in Satellite Mass Distribution

	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	Total 2004 to 2013	Avg 2004 to 2013	% of Total
Below 2,200 kg (<4,850 lbm)	3	8	4	11	6	9	1	6	3	2	4	3	3	2	4	4	5	5	5	5	5	41	4.1	19%
2,200 to 4,200 kg (4,850 – 9,260 lbm)	7	10	14	14	22	14	16	14	6	11	6	5	6	8	6	6	7	6	7	7	7	65	6.5	31%
4,200 to 5,400 kg (9,260 – 11,905 lbm)	0	0	0	0	0	0	2	4	5	9	5	6	7	6	6	6	7	8	8	8	8	70	7.0	33%
Above 5,400 kg (>11,905 lbm)	0	0	0	0	0	0	0	0	0	0	0	6	6	0	3	3	3	3	3	4	4	35	3.5	17%
Total	**10**	**18**	**18**	**25**	**28**	**23**	**19**	**24**	**14**	**22**	**15**	**20**	**22**	**16**	**19**	**19**	**22**	**22**	**23**	**24**	**24**	**211**	**21.1**	

Commercial GSO Satellite Trends

Industry Metrics

Figure 9 and Table 8 below 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. In 2003 the total number of transponders launched dipped to less than 50% of that launched in 2002. The forecast for 2004 is for the number of launched transponders to recover. This "recovery" represents a slip of several satellite launches from 2003 to 2004. Figure 9 also shows a gradual increase in the number of transponders carried per satellite from an average of 27 during 1993–1996 to an average of 45 projected for 2002–2004. The 2004 forecast predicts a peak average number of transponders per satellite of 52.

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

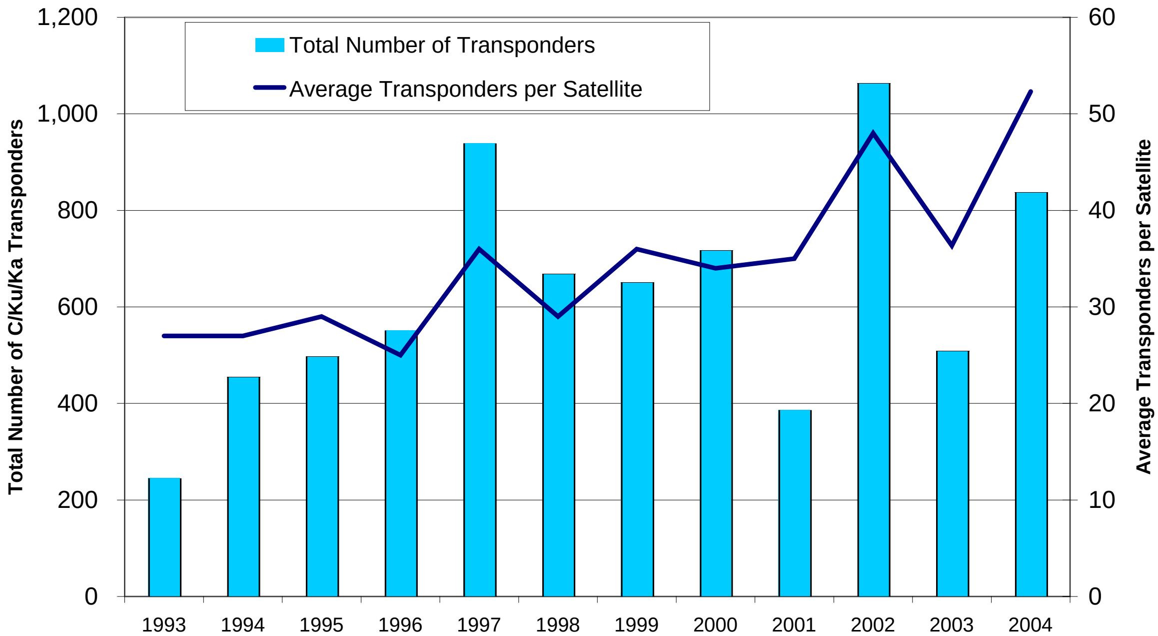


Table 8. Total C/Ku/Ka Transponders Launched and Average C/Ku/Ka Transponders per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total Number of Transponders	245	455	497	551	939	668	651	717	386	1,064	509	837
Average Transponders per Satellite	27	27	29	25	36	29	36	34	35	48	36	52

Figure 10 and Table 9 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 satellites. In 2002 the total mass launched was slightly larger than that launched in 1997, even though there were there were 27 percent more satellites launched in 1997. The average commercial GSO satellite was more than 30 percent heavier in 2002 than it was in 1997. Over the 12-year period shown, the average satellite mass has grown by nearly 69 percent and has exceed 4,000 kg.

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 and the average number of transponders per satellite have grown steadily over the last several years.

Future Trends

For several years this report has been showing consistent growth in the mass of commercial satellites. This growth has been attributed to new applications, new requirements, greater efficiency, and service providers expanding the coverage of their satellites. While these factors still exist, the current forecast provides evidence that the shift to heavier satellites

Figure 10. Total Satellite Mass Launched and Average Mass per Satellite

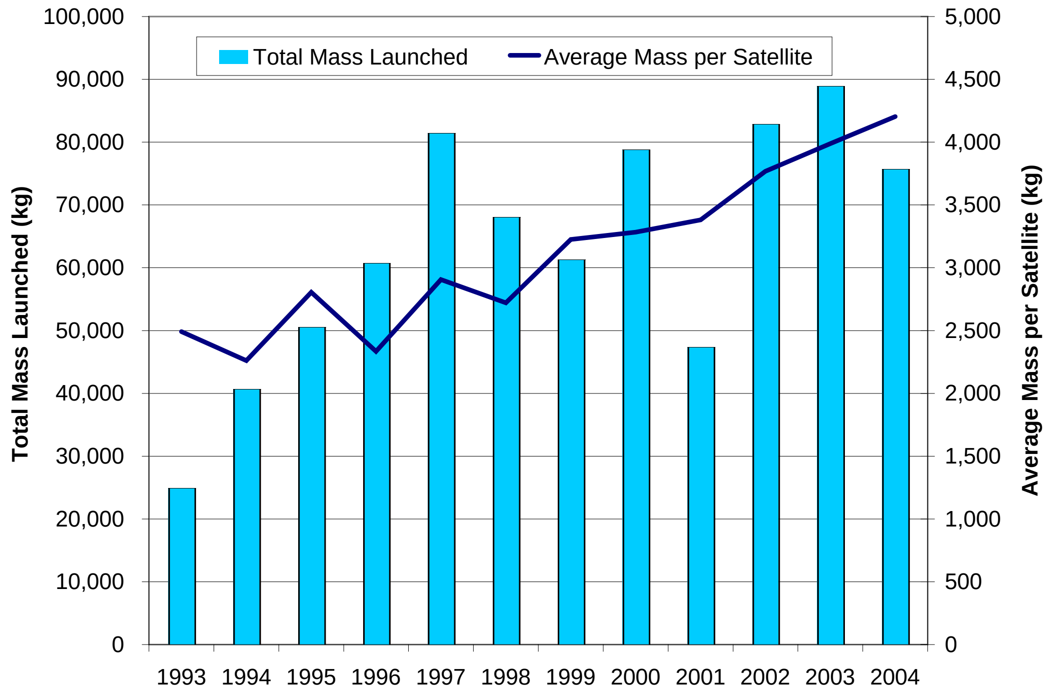


Table 9. Total Satellite Mass Launched and Average Mass per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total Mass (kg)	24,910	40,689	50,502	60,695	81,373	68,015	61,295	78,784	47,329	82,880	88,925	75,660
Average Mass/Sat (kg)	2,491	2,261	2,806	2,334	2,906	2,721	3,226	3,283	3,381	3,767	3,987	4,203

appears to be slowing. Last year, the report forecast that satellites launched in the two heaviest mass categories would drop from 134 to 107 over the 2003–2011 period. This year's report shows a further drop in the same mass categories from 110 to 93 over the 2004–2013 period, a rate of 15 percent. In contrast, the number of satellites forecast to be launched in the two lightest mass categories has dropped less than 8 percent, from 101 to 94 over the 2004–2013 period. While demand is declining for satellites in all categories, the rate is twice that among heavier satellites than lighter satellites.

There are several reasons for this shift, but the foremost reason is most likely the current economic environment. During uncertain times the ability and willingness of most commercial firms to assume risk is reduced. Larger satellites are typically more expensive and therefore require a longer period before this investment can be recouped. New satellite applications that require higher power levels and thus heavier satellites have been delayed due to concerns over the risk associated with these ventures.

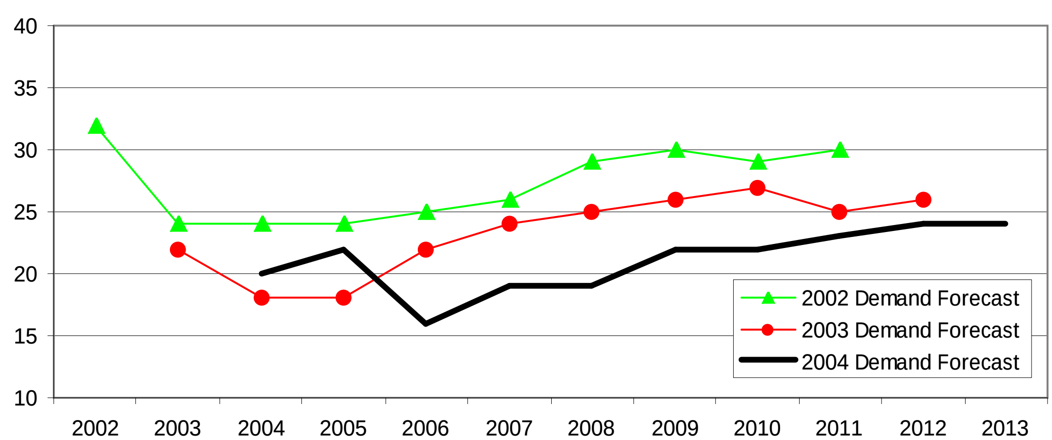
The ability to raise capital has been impacted by risk-averse financial markets forcing some operators to order smaller satellites than they might have otherwise purchased. Decreased insurance capacity for commercial satellites is also affecting demand for larger, more expensive satellites. These factors have come together to not only reduce the number of satellites launched but also mitigate the move towards heavier satellites. Consequently some satellite manufacturers have delayed the introduction of new higher-power, heavier satellite platforms.

Comparison with Previous COMSTAC Demand Forecasts

The 2002 and 2003 forecasts for commercial GSO satellites launched are compared to this year's 2004 forecast in Figure 11. The prior year forecasts are characterized by a near-term dip and long-term stabilization. This effect is particularly prominent in this year's forecast, as a low number of orders of new satellites in 2002 has depressed the number of launches expected in 2004 and 2005. Reports of the number of satellite orders in 2002 vary, but suggest that only six to seven commercial GSO satellite contracts were signed.[1]

The average satellite demand over the forecast period 2004 to 2013 is nine percent lower than last year's 10-year forecast average. This year's model has an average

Figure 11. 2002 and 2003 versus 2004 COMSTAC Mission Model Comparison



[1]"Satellite Manufacturers Look Hopefully Toward 2003," *Space News*, January 13, 2003; *Futron Satellite Manufacturing Report, 2002 Year-End Summary*.

demand of 21.1 GSO satellites per year for the period 2004 to 2013, with a modest increase in the last four years. All three years' forecasts show a general flatness in the 2007 to 2012 timeframe (with some year-to-year variations).

There are several factors that have reduced projected demand for satellites over the last few years. In the 2003 report, global and regional economic conditions and the availability of financing were again listed as two of these key factors. In this year's survey of operators, the Working Group included a supplemental questionnaire asking satellite service providers how certain factors are impacting their plans to purchase and launch satellites (the full results of this questionnaire are shown in Appendix B). The survey confirmed that operator concerns were consistent with the satellite manufacturing and launch industry's perspective, revealing that 69 percent of respondents felt that regional or global economic conditions caused "significant" or "some" reduction or delay in their procurement plans. In addition, 63 percent indicated that the ability to obtain export licenses and 56 percent indicated that the ability to obtain operating licenses had "significant" or "some" negative impact on their procurement plans.

There seems to be a more cautious view of proposed space-based programs due to financial problems of some current space-based businesses. New business concepts using satellites are undergoing more financial scrutiny, which has impacted the launch of new ventures. Many newer projects that require some form of financing to reach the operational phase have been delayed. This has manifested itself particularly in the struggling broadband market. Previous forecasts have included near-term and mid-term demand based on the expected deployment of several new broadband satellite systems. Although projects that were suspended in 2001, such as Wildblue, have been reactivated (but with fewer satellites than originally planned), many companies continue to defer any "broadband" projects because of the weak market and the lack of available financing.

Other factors contributing to reduced demand are rooted in specific operator requirements. There has also been a substantial shift in requirements for many of the major satellite operators. Several of these operators have recently completed long-term expansion and replacement projects, and are now focusing on reducing risk exposures and capital expenditures and on improving near-term financial results. A prime example of such a shift is evident in the activities of PanAmSat, which in May 2002 announced that the launch of Galaxy IIIC (in 2002) would complete a $2 billion "fleet modernization program," and that planned capital expenditures had been reduced by $1 billion over the next four years.[2]

Also affecting the mid-term decline in launch demand is the replacement cycle for existing geosynchronous satellites. Due to deployment timing and satellite lifetime designs, the expectation of required replacements for the 2004–2006 timeframe is below previous expectations. The effect of this trend is particularly evident in the 2004 forecast's projection for 2006 launches. The current generation of satellites is designed for longer on-orbit life than their predecessors. Longer on-orbit lifetimes cause orders for replacement satellites to shift further into the future, which flattens the demand curve. Increased on-orbit life reduces the magnitude and increases the period of the replacement cycle for newer spacecraft.

[2]PanAmSat Press Release, May 31, 2002.

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.

To date, 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 reduced its forecast of dual-manifest launches from an average of 4.7 per year to 2.8 per year. This means that even though the number of satellites demanded over the forecast period has dropped from 233 to 211, the number of launches has only been reduced by three, from 186 to 183.

Figure 12 and Table 10 present the 2004 satellite and launch demand forecast as well as actual values for 1993 through 2003.

Figure 12. 2004 COMSTAC Launch Demand Forecast

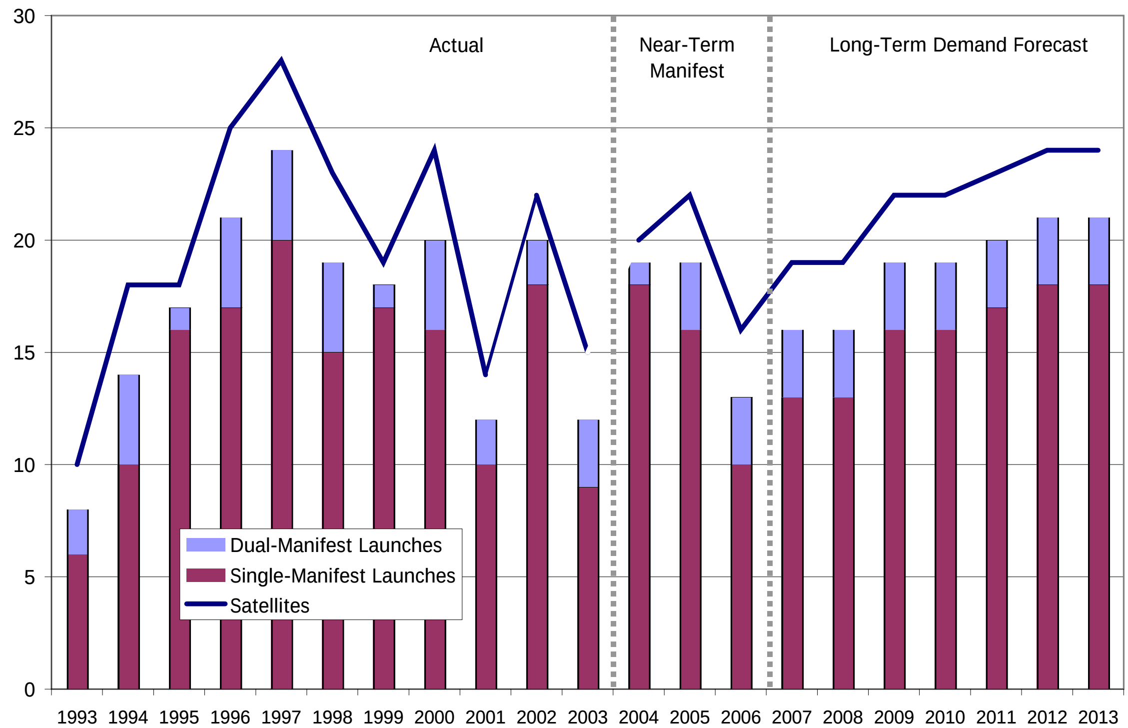


Table 10. COMSTAC Launch Demand Forecast Summary

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total	Average 2004 to 2013
Satellite Demand	20	22	16	19	19	22	22	23	24	24	211	21.1
Dual Launch Forecast	1	3	3	3	3	3	3	3	3	3	28	2.8
Launch Demand Forecast	19	19	13	16	16	19	19	20	21	21	183	18.3

Launch Assurance Agreements

As discussed earlier in the report, launches can be delayed by satellite issues, launch vehicle problems, or external factors such as regulatory delays. Occasionally, such delays will cause a customer's launch service provider to be 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 have been 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 companies have also developed different methods of offering customers schedule assurance.

A current trend in the commercial launch industry is to offer customers mutual launch back-up capability. This can provide an added level of mission assurance to protect against schedule delays (launch or spacecraft), satellite mass growth, insurance costs, etc. Such arrangements are offered by International Launch Services, which has been offering integrated schedule assurance with the Atlas and Proton vehicles since 1999, and by the Launch Services Alliance (LSA), formed in July 2003 by Arianespace, Boeing Launch Services and Mitsubishi Heavy Industries, which offers dual or triple integration on the Ariane 5, Zenit-3SL and H-IIA launch systems. ILS's schedule assurance was demonstrated in 2002, when the DirecTV 5 satellite was moved from the Atlas manifest to launch on Proton. An LSA schedule assurance option was invoked in October 2003, when the DirecTV 7S payload was transferred from an Ariane 5 to a Zenit-3SL.

During 2003 and early 2004, five satellites changed contracted launch vehicles, due largely to the impact of the Ariane 5 ECA failure in 2002. Operators of four satellites guaranteed their own schedule by switching providers independently. Eutelsat's W3A, SES Americom's AMC-15, and SES Global's Worldsat-3 (formerly AMC-13) all moved from Arianespace to ILS's Proton. Inmarsat changed its launch service provider for the Inmarsat 4F2 satellites from Arianespace to Sea Launch. The LSA backup option was invoked in October of 2003 when DirecTV 7S was transferred, as mentioned above.

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. 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; therefore, financing is difficult. Improved 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.

- **New market applications** may increase the demand for satellite services. Though there has been launch of hybrid satellites with Ka-band transponders, Ka-band satellites are becoming a reality with the future launch of Wildblue and Spaceway. Their success will determine the future demand of such satellite systems. New applications will be allowable once this capacity is available. The direct-tohome applications are driving current demand for capacity. With the deployment of the first dedicated high definition television system in 2003, interactive applications may be on the horizon. Time will tell what the future applications will be.

- **High-speed terrestrial services** may lower demand for satellite-based data transfer. There is currently an overcapacity of fiber optic assets. Use of these assets needs to reach peak before a stronger demand for space-based alternatives appears.

- **Data compression technology** already allows more data to cross terrestrial systems, decreasing the need for space-based systems.

- **Regulatory environment -** The U.S. Government regulatory environment continues to be a factor in the redistribution of market share from the domestic market.

- **New space hardware -** Providers not currently recognized as serious competitors may change pricing strategies and allow more affordable systems. The U.S. Government makes it difficult for satellite operators to consider the use of Chinese assets for launch. As more customers use foreign satellite manufacturers, there is a higher likelihood that these customers will use Long March as their launch provider. Russian satellite manufacturers are also seeking commercial customers. If the total price of a satellite system becomes low enough, the demand for such a system will grow and the market capture will be redistributed.

The reader must recognize that data in this report is prepared from comprehensive inputs from a number of satellite manufacturers and service providers. The individual inputs from the service providers indicate that the demand for larger satellites may be tailing off. This may be due to the fact that larger satellites generally require new technology and must be proven. This risk-averse bias has been tempered by comprehensive inputs from satellite manufacturers who are predicting continued demand for larger satellites.

Summary

This year's COMSTAC Commercial Mission Model forecast predicts a decrease in average annual demand for satellites compared to last year's projection. This change, from 23.3 satellites forecast to be launched per year, on average, to 21.1, is a reflection of the current weak environment for commercial satellite systems. A shift in operator focus from expansion to improving financial results, global economic conditions, and the availability of financing for satellite projects are among the factors that have led to this forecast decrease in demand. These factors, coupled with trends for longer satellite lifetimes and heavier satellites with increased transponder capacity, have caused forecasted near-term demand to return to levels experienced in the last half of the 1990s.

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 has averaged over 35 for the past five years compared to under 30 for the 1993–1996 period. The average transponders per satelite increases to 45 for the 2002–2004 period, 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. The Atlas V, Delta IV, and next generation Ariane 5 vehicles remain in the early stages of their flight experience. These vehicles represent a significant increase in the industry's capacity to launch heavy and extra-heavy payloads at competitive prices. Launch failures of these vehicles will likely 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 weak economic atmosphere, low availability of financing, and the regulatory environment appear to be the key factors affecting market demand at this time.

These factors introduce significant near-term uncertainty in the market, which is manifested in the lower levels of demand anticipated for the 2004-2006 period. Although lower than past forecasts, this year's projection indicates stabilization in the longer term.

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 2004 Mission Model Update named actual satellite programs that were currently manifested on each of the launch providers for 2004. Though 20 satellite programs were named for the year 2004, the industry probably will not execute all corresponding launches in this year. However, the demand on the launch industry for 2004 is for the launch of 20 satellites (19 launches, since two satellites are anticipated on a single dual launch).

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 2004 will likely fall in the range of 12 to 17. As described in the "Projecting Actual Launches" section, by examining the historical variance between predicted demand and actual launches, the Working Group predicts that the actual number of satellites launched will be between 16 and 20 in 2005, and between 12 and 14 in 2006.

As described earlier in this report, future years of the demand forecast beyond 2006 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 2004 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 16 satellite service providers:

- AirTV
- Mobile Broadcast
- Asiasat
- Mobile Satellite Ventures
- Broadcasting Satellite System Corp.
- New Skies
- DirecTV
- PanAmSat
- Inmarsat
- SatMex
- Intelsat
- Space Communications Corp.
- Korea Telecom
- Telesat Canada
- Loral Skynet
- 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 11. 2004 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	31%	38%	25%	6%	0%
Demand for satellite services	19%	31%	19%	25%	6%
Ability to compete with terrestrial services	6%	25%	50%	19%	0%
Availability of financing	19%	25%	50%	6%	0%
Availability of affordable insurance	19%	25%	56%	0%	0%
Consolidation of service providers	0%	6%	81%	12%	0%
Increasing satellite lifetimes	0%	12%	69%	12%	6%
Availability of satellite systems that meet your requirements	0%	6%	69%	6%	19%
Reliability of satellite systems	12%	19%	44%	19%	6%
Availability of launch vehicles that meet your requirements	0%	6%	62%	25%	6%
Reliability of launch systems	0%	12%	62%	19%	6%
Ability to obtain required export licenses	25%	38%	25%	12%	0%
Ability to obtain required operating licenses	6%	50%	31%	12%	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, 2004

Name
Title
Company
Address
City, Country

Subject: Request for 2004 Launch Demand Model Input

Dear ,

The Office of the Associate Administrator for Commercial Space Transportation (AST) of the 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 2003 demand forecast can be viewed on-line at http://ast.faa.gov/rep_study/forcasts_and_reports.htm.

To support the 2004 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.

Your response is needed by February 9, 2004, to ensure that the demand model update is ready for publication in May 2004. Please forward this request to the department most appropriate within your organization (e.g., market analysis, marketing, or contracts). Enclosed are input forms 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.

Thank you for your support of this activity.

Sincerely,

Patricia Grace Smith
Associate Administrator for Commercial Space Transportation

Enclosures:
(1) 2004 Commercial GSO Mission Model Update Instructions
(2) Satellite Demand Forecast by Payload Mass
(3) COMSTAC 2004 Commercial GSO Launch Demand Questionnaire
(4) COMSTAC Launch Demand Model Report Feedback Form

2004 Commercial GSO Mission Model Update Instructions

As with previous year efforts, the goal for the 2004 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.

The forecast will be of the “addressable” commercial geosynchronous satellite launches through 2013. “Addressable” payloads in this context are those payloads that are open for internationally competitive launch service procurement. Please do not include in your forecast those payloads that are captive to national flag launch service providers (i.e., USAF or NASA satellites, or similar European, Russian, Japanese, or Chinese government satellites that are captive to their own launch providers). 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 2013. The individual inputs that you provide will be kept confidential by the COMSTAC Technology and Innovation Working Group; only the composite results are released. We ask you to forecast the part of the market that your company knows best. It may be a forecast of your company’s needs and/or a regional market view. 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 9, 2004,** in order to support our update schedule. Your responses should be sent directly to Mr. David Pollock at the following address:

David Pollock
The Boeing Company
6633 Canoga Avenue
P.O. Box 7922, MC GB-07
Canoga Park, CA 91309-7922

Phone: 818-586-1297
Fax: 818-586-1330
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If you have any questions, please contact Mr. Pollock directly.

COMSTAC Launch Demand Model Report Feedback Form

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.

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. Does your company obtain a copy of this report (either through downloading the report from the AST website or by other means)?

______ Yes ______ No

If your company does review a copy of the report each year, how does your organization use the report and the data it contains (e.g. for general market trend data; for specific near-term manifest information, etc.)?

Does your organization has any specific recommendations that would make the *COMSTAC Commercial Geosynchronous Orbit Launch Demand Model* report more useful for your company or any other comments?

Appendix D. Historical Launches

Figure 13 plots the total number of GSO satellites launched during the past ten years, 1993 through 2003. Shown first is the annual number of satellites that have been included in previous COMSTAC reports and comprise the spacecraft launched using commercially competed launch services ("addressable" satellites). Also shown on the chart is the total number of GSO satellites launched in each year, which includes both the addressable satellites and all remaining GSO spacecraft (what COMSTAC considers to be "non-addressable spacecraft": those that use domestic launch services or for which launch services were not commercially competed). The non-addressable missions are comprised of ~50 percent national military spacecraft (e.g. communications, data relay, early warning), ~25 percent civil spacecraft (e.g. meteorology, tracking, advance communications experiments), and ~25 percent national telecommunications services spacecraft (e.g. domestic TV broadcasting, banking, government services communications).

Tables 12 through 14 present the historical addressable commercial spacecraft launched from 1993 through 2003. 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.

Figure 13. GSO Satellites Launched per Year

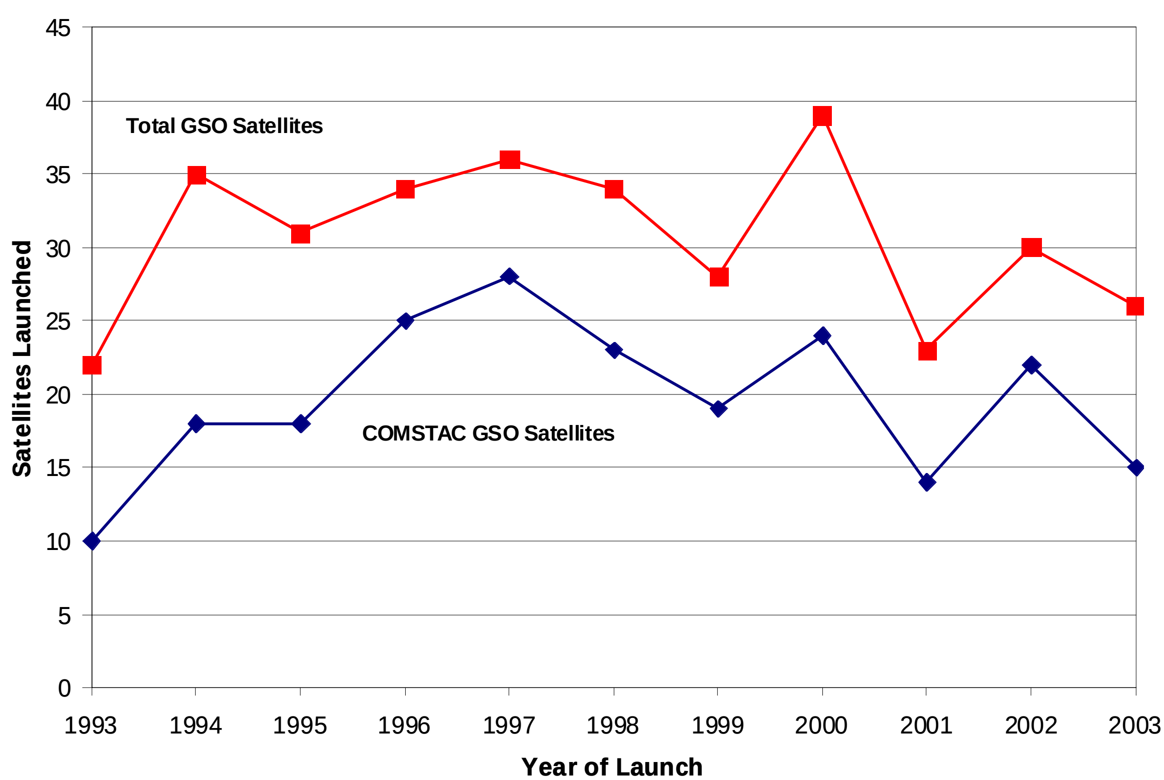

Table 12. 1993–1997 COMSTAC GSO Commercial Satellites

	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

1993

2,200 - 4,200 kg (4,850 - 9,260 lbm)		Astra 1C	Ariane 42L
	DM2	DBS 1	Ariane 44L
		Galaxy 4	Ariane 42P
	DM1	Hispasat 1B	Ariane 44L
		Intelsat 701	Ariane 44LP
	DMN	Solidaridad 1	Ariane 44LP
		Telstar 401	Atlas IIAS
Below 2,200 kg (<4,850 lbm)	DM1	Insat 2B	Ariane 44L
	DM2	Thaicom 1	Ariane 44L
		NATO 4B	Delta II

1994

2,200 - 4,200 kg (4,850 - 9,260 lbm)		Astra 1D	Ariane 42P
		Intelsat 702	Ariane 44LP
	DM2	PAS 2	Ariane 44L
		PAS 3	Ariane 42P
	DM4	Solidaridad 2	Ariane 44L
		Telstar 402	Ariane 42L
		DBS 2	Atlas IIA
		Intelsat 703	Atlas IIAS
		Orion 1	Atlas IIA
		Optus B3	Long March 2E
Below 2,200 kg (<4,850 lbm)	DM3	Brazilsat B1	Ariane 44LP
	DM2	BS-3N	Ariane 44L
	DM1	**Eutelsat II F5**	Ariane 44LP
	DM4	Thaicom 2	Ariane 44L
	DM1	**TurkSat 1A**	Ariane 44LP
	DM3	TurkSat 1B	Ariane 44LP
		Galaxy 1RS	Delta II
		APStar 1	Long March 3

1995

2,200 - 4,200 kg (4,850 - 9,260 lbm)		Astra 1E	Ariane 42L
		DBS 3	Ariane 42P
		Intelsat 706A	Ariane 44LP
		N-Star a	Ariane 44P
		PAS 4	Ariane 42L
		Telstar 402R	Ariane 42L
		AMSC 1	Atlas IIA
		Galaxy 3R	Atlas IIA
		Intelsat 704	Atlas IIAS
		Intelsat 705	Atlas IIAS
		JCSat 3	Atlas IIAS
		APStar 2	Long March 2E
		ASIASAT 2	Long March 2E
		EchoStar 1	Long March 2E
Below 2,200 kg (<4,850 lbm)	DM1	Brazilsat B2	Ariane 44LP
	DM1	Hot Bird 1	Ariane 44LP
	DMN	Insat 2C	Ariane 44L
		Koreasat 1	Delta II

1996

2,200 - 4,200 kg (4,850 - 9,260 lbm)	DM3	Arabsat 2A	Ariane 44L
	DM4	Arabsat 2B	Ariane 44L
		EchoStar 2	Ariane 42P
		Intelsat 707A	Ariane 44LP
		Intelsat 709	Ariane 44P
		MSAT 1	Ariane 42P
		N-Star b	Ariane 44P
	DM2	Palapa C2	Ariane 44L
	DM1	PAS 3R	Ariane 44L
		AMC 1	Atlas IIA
		Hot Bird 2	Atlas IIA
		Palapa C1	Atlas IIAS
		Intelsat 708A	Long March 3B
		Astra 1F	Proton K/DM
Below 2,200 kg (<4,850 lbm)	DM2	Amos 1	Ariane 44L
	DMN	Italsat 2	Ariane 44L
	DM1	Measat 1	Ariane 44L
	DM4	Measat 2	Ariane 44L
	DM3	TurkSat 1C	Ariane 44L
		Inmarsat 3F1	Atlas IIA
		Inmarsat 3F3	Atlas IIA
		Galaxy 9	Delta II
		Koreasat 2	Delta II
		APStar 1A	Long March 3
		Inmarsat 3F2	Proton K/DM

1997

2,200 - 4,200 kg (4,850 - 9,260 lbm)	DM1	AMC 2	Ariane 44L
	DMN	Hot Bird 3	Ariane 44LP
		Intelsat 801	Ariane 44P
		Intelsat 802	Ariane 44P
		Intelsat 803	Ariane 42L
		Intelsat 804	Ariane 42L
		JCSat 5	Ariane 44P
		PAS 6	Ariane 44P
	DM4	Sirius 2	Ariane 44L
	DM2	Thaicom 3	Ariane 44LP
		AMC 3	Atlas IIAS
		DirecTV 6	Atlas IIA
		EchoStar 3	Atlas IIAS
		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)	DM2	BSat 1A	Ariane 44LP
	DM4	Cakrawarta 1	Ariane 44L
	DM3	Inmarsat 3F4	Ariane 44LP
	DM3	Insat 2D	Ariane 44LP
	DM1	Nahuel 1A	Ariane 44L
		Thor II	Delta II

(boxed entries, shown in bold) = 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 13. 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)		0			2			4			5			9	
					Galaxy 11	Ariane 44L		Anik F1	Ariane 44L		DirecTV 4S	Ariane 44LP		Intelsat 904	Ariane 44L
					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
														Astra 1K	Proton K/DM
														Echostar 8	Proton K/DM
														Intelsat 903	Proton K/DM
														Galaxy IIIC	Sea Launch
2,200 - 4,200 kg (4,850 - 9,260 lbm)		14			16			14			6			11	
	DM4	Afristar	Ariane 44L		AMC 4	Ariane 44L	DM1	Asiastar 1	Ariane 5G	DM2	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	Hotbird 7	Ariane 5ECA
		Hot Bird 4	Ariane 42P		Insat 2E	Ariane 42P		Europe*Star1	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
		Galaxy 10	Delta III		Asiasat 3S	Proton K/DM		Hispasat 1C	Atlas IIAS					Nimiq 2	Proton M/M
		Astra 2A	Proton K/DM		Astra 1H	Proton K/DM		AAP 1	Proton K/DM						
		EchoStar 4	Proton K/DM		LMI 1	Proton K/DM		AMC 6	Proton K/DM						
		PAS 8	Proton K/DM		Nimiq	Proton K/DM		PAS 9	Sea Launch						
					Telstar 6	Proton K/DM									
					DirecTV 1R	Sea Launch									
Below 2,200 kg (<4,850 lbm)		9			1			6			3			2	
	DM4	AMC 5	Ariane 44L	DM1	Skynet 4E	Ariane 44L	DM3	AMC 7	Ariane 5G	DM1	BSat 2A	Ariane 5G	DM1	Astra 3A	Ariane 44L
	DM1	Brazilsat B3	Ariane 44LP				DM4	AMC 8	Ariane 5G	DM2	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												

☐ = 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 14. 2003 COMSTAC GSO Commercial Satellites

	2003	2004	2005	2006	2007
Total Launches	12				
Total Satellites	15	0	0	0	0
Over 5,400 kg (>11,905 lbm)	0	0	0	0	0
4,200 - 5,400 kg (9,260 - 11,905 lbm)	5	0	0	0	0
	EchoStar 9 – Sea Launch Intelsat 907 – Ariane 44L DM2 Optus C1 – Ariane 5 Rainbow 1 – Atlax V Thuraya 2 – Sea Launch				
2,200 - 4,200 kg (4,850 - 9,260 lbm)	6	0	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				
Below 2,200 kg (<4,850 lbm)	4	0	0	0	0
	Amos 2 – Ariane 5 DM2 Bsat 2C – Ariane 5 DM3 e-Bird 1 – Ariane 5 DM1 Galaxy XII – Ariane 5				

[ ] = Launch Failure

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

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

2004 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits

Executive Summary

The Federal Aviation Administration's forecast for 2004 projects 106 satellites worldwide during the next ten years will seek commercial launch services to non-geosynchronous orbits (NGSO), a 32.5 percent increase from last year's forecast.

However, because many of the new satellites added to the forecast can be launched in groups on one individual launch vehicle, the resulting demand for commercial launches has not increased but remains at 51 launches over the next ten years, the same amount in the 2003 forecast.

The 2004 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits is an annual report prepared by the FAA's Associate Administrator for Commercial Space Transportation (AST) that assesses the worldwide market for satellites that are expected to be available for commercial launch services or are sponsored commercially.

This year's report, covering the period 2004–2013, includes the return of two previously bankrupt mobile satellite services operators to the launch market after favorable combinations of steady customer growth, debt-free operations, and new private investors. Thirty-two new telecommunications satellites are in this year's forecast, including complete replacement of the only operating Little LEO constellation.

Although business conditions and the general economy show signs of improvement in the satellite telecommunications sector, it is too early to forecast second-generation satellites for Big LEO systems.

2004 Launch Forecast: FAA/AST is forecasting an average demand of five worldwide commercial launches per year during 2004–2013 with more activity in the near-term, including six launches each in 2004 and 2005 and nine in 2006. This is an increase from 2001–2003, when the NGSO market produced four actual commercial launches each year.

Demand is split into two vehicle size classes with an average of 2.3 medium-to-heavy launch vehicles per year and 2.8 small launch vehicles per year over the next ten years. Many satellites in the near-term have already been assigned to a specific launch vehicle, while others are expected to be available for launch services bidding on the international market.

About 55 percent of the 106 satellites in the market are comprised of international science satellites. Thirty percent of the market is made up of telecommunications satellites operated by two U.S. companies, while the remaining 15 percent of the market is commercial remote sensing satellites.

Introduction

With only four commercial launches in each of the past three years, the non-geosynchronous market has been experiencing a lull in activity only slightly better than the early 1990s when an occasional science satellite was available for commercial launch services. The last few years is in stark contrast to an intense period from 1997–1999 when 195 satellites were orbited, including two mobile satellite telephony systems and a mobile messaging service; the number of launches soared to 19 in 1998 and 18 in 1999. The FAA forecast in 1998 predicted a vibrant future market with around 30 launches per year from 2001 through 2010, mostly from the telecommunications sector.

However, during the 1990s, competing cellular technologies advanced as satellite operators designed and launched their systems. After launch, NGSO satellite operators failed to attract sufficient customers to pay back their initial investments. All of these factors, coupled with the the end of U.S. economic expansion, caused bankruptcies of Iridium, ICO Global, Globalstar, and ORBCOMM. Investors lost confidence in future low Earth orbit (LEO) telecommunications ventures. High data-rate or broadband satellite constellations did not emerge as the next wave. Plans for broadband shifted to geosynchronous orbit. The future NGSO telecommunications market collapsed, as did the demand for launch services.

After 18 satellites were orbited on nine launches in 2000, the market fell to just four satellites launched in 2001. During 2001-2003, NGSO satellites were a mixture of 15 small science satellites, 10 telecommunciations satellites and three commercial remote sensing satellites.

Table 15. 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 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 market for the next four years described in this forecast is a similar mixture with some growth to six to nine launches per year. The 2004 forecast is the first to show a significant increase in total number of satellites from the previous year since the 1998 FAA forecast.

International science satellites have a steady rate of activity, although the market is hard to predict because it is not based necessarily on the need to replace existing satellites. With a few exceptions, the science market is largely made up of nations with fledgling space programs without a domestic launch provider or satellite operators seeking less expensive launch options not available domestically. This market includes commercially competed launches to the Moon or Mars. The number of international science or other satellites (such a technology demonstrations) in the 2004 forecast is about the same as the 2003 forecast.

The commercial remote sensing industry is maturing and preparing to launch second-generation satellites with the support of government customers serving as anchor tenants. The number of remote sensing satellites in the forecast is down slightly compared to last year's forecast (from 20 to 16 through 2013).

Somewhat forgotten by the marketplace is the fact that three mobile satellite constellations, Iridium, Globalstar and ORBCOMM, are still up and running. These companies, reborn from bankrupt predecessors, are adding customers and are poised for profitability.

After growing steadily and emerging from bankruptcy, ORBCOMM attracted significant investor capital during 2003–2004 and is currently making arrangements to replace its orbiting satellite system with an estimated 24 satellites beginning with incremental launches in 2006. Meanwhile, Globalstar emerged from bankruptcy in April 2004 with new investors and is preparing to expand operations and launch at least four replacement satellites that were constructed prior to Chapter 11 proceedings.

It is too early to predict the complete replacement (or second generation) of Iridium and Globalstar systems since satellite lifespans are currently expected to last beyond 2011 and investment and design decisions are still several years away.

Any new telecommunications entrants must compete with existing systems (both on the ground and from geosynchronous orbit, or GSO) and decreasing user prices already offered by debt-free NGSO operating companies.

There are still applicants for Federal Communications Commission (FCC) licenses in Ku-, Ka-, and V-bands for fixed services although they currently are not developed enough to include in the FAA forecast. In 2003, the FCC issued new guidelines intended to accelerate the process for awarding licenses for new satellite systems. The goal of the new process is to award NGSO licenses in less than 270 days. Some critics contend that the requirement of a $7.5 million bond for NGSO systems 30 days after receiving an FCC license will discourage entrepreneurs from developing new applications.

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 LEO, medium Earth orbit (MEO), elliptical orbit (ELI), and external orbit (EXT).

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.

This year's forecast includes a single "baseline" forecast without a more "robust" projection that was used in NGSO forecasts prior to 2003 for expanded market conditions.

The following sections review each market segment.

NGSO Satellite Systems

International Science and Other Payloads

As more countries establish civil space science programs, the demand for commercial launch services has increased since many of these nations lack domestic launch services. Most of these missions are on modest budgets, so the demand leans toward low-cost, small launch vehicles. The availability of inexpensive launches on refurbished Russian ballistic missiles, some capable of carrying multiple satellites, has allowed the market for international science payloads to grow in recent years. In the past three years, science or demonstration payloads have been launched commercially for operators in a number of countries, including Germany, Nigeria, Saudi Arabia, South Korea, Sweden, and Turkey. The 1994 U.S. National Space Transportation Policy generally restricts U.S. government payloads from launching on non-U.S.-built vehicles, so demand for these payloads is not included in this report.

International science satellites can be classified into three groups. The first are remote sensing satellites that are operated non-commercially, typically by government agencies. 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 launch in the first half of 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. First launch could be in 2005 or 2006 on vehicles yet to be 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. Another example is the Detection of Electro-Magnetic Emissions Transmitted from Earthquake Regions (DEMETER) mission by the French space agency CNES, scheduled for launch in mid-2004 on a Dnepr.

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 is scheduled for launch in late 2004 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 the first half of 2005 on the same Cosmos booster that will launch China DMC+4.

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 and said in 2004 it expects the current constellation to last until at least 2014. Its main U.S. rival, XM Satellite, operates two satellites in GSO, launched in 2001. 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 two million combined for Sirius and XM in April 2004 and is growing rapidly, this has not translated into new systems either to compete with Sirius and XM or to provide service in other countries. One company that proposed bringing radio to Europe went bankrupt in 2003. In addition, given the uncertainty over whether future systems would use NGSO or GSO satellites, no DARS systems are included in the 2004 forecast.

MARKET DEMAND SCENARIOS

FAA/AST projects that approximately 58 satellites of the international science or other category will be launched during the forecast period. These payloads will be deployed on 33 launches, including 11 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 $2.5 billion in 2003, according to the American Society for Photogrammetry and Remote Sensing. Other sales estimates for satellite imagery providers only were just over $300 million worldwide in 2003, and are expected to grow to about $800 million by 2010.

The commercial market for satellite-based, high-resolution imagery has been slow to pick up. 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. For government customers, commercial satellite imagery has proven useful for intelligence and military mapping. 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 a NextView contract with DigitalGlobe to enable the development and launch of a next-generation commercial remote sensing satellite. A second NextView contract will be awarded by the end of September 2004 through a competitive bid. 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. Landsat satellites have amassed over 30 years of archival imagery, and studies using Landsat data often require comparing changes over time. The Landsat Data Continuity Mission (LDCM) is intended to provide continued coverage of Landsat-like data. LDCM was structured as a public-private partnership in which the government would buy data from a commercial provider. However, the government declined to accept the proposal from the sole bidder to LDCM, Resource21, in September 2003. To date, there has been no announcement as to how the LDCM partnership between NASA and the U.S. Geological Survey (USGS) plans to continue Landsat coverage. The issue has become all the more urgent since Landsat 7 is producing degraded imagery due to a failure of the scan line corrector, the mechanism that compensates for the forward motion of the satellite as the image is acquired. The spacecraft is also past its five-year design life.

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 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 in late 2005 on a Delta 2.

ImageSat International

ImageSat, founded as West Indian Space in 1997, provides commercial imagery through its Earth Resources Observation Systems (EROS) remote sensing satellite. Headquartered in Cyprus, its strategic partners include Israel Aircraft Industries Ltd.

Table 16. 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 2005 2007	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 2007	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	74 (163) 372 (819) 304 (670) 368 (811)	10,000 1,000 1 1	1995 1997 2003 2001	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 2005	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 TBD	Radarsat 1 continues to operate.
Development and Proposed							
RapidEye	RapidEye AG	Surrey Satellite Technology Ltd.	RapidEye 1-5	380 (837)	6.5	2006	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	2004	TrailBlazer will conduct remote sensing of the Moon in 1-meter resolution, but requires NOAA license to image the Earth from a distance.

Table 17. 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.

and Electro Optics Industries. ImageSat currently operates one high-resolution satellite, EROS A, which was launched from Russia in the winter of 2000. By the first quarter of 2006, the company plans to launch EROS B, a satellite similar to EROS A but with an improved camera capable of providing imagery with a panchromatic resolution of 0.7 meters. In 2008, ImageSat plans to launch EROS C, which will provide 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 Astrium, is developing the TerraSAR commercial radar imagery system. Deutschen Zentrum für Luft- und Raumfahrt (DLR, the German Aerospace Center) selected Astrium to jointly develop the TerraSAR X satellite, which is an X-band synthetic aperture radar (SAR) observation spacecraft. DLR plans to invest $89.8 million, with Astrium investing $24.6 million, toward the development of the satellite. TerraSAR X will launch on a Dnepr sometime in 2006, while the larger TerraSAR L, with an L-band radar payload, is tentatively scheduled for launch in 2008. InfoTerra GmbH will be responsible for commercial operations, while DLR will oversee science operations.

Northrop Grumman

In February 2004 NOAA granted Northrop Grumman a commercial remote sensing license for a system called Continuum. The system employs 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. The company has not disclosed specific plans to build and launch the Continuum spacecraft.

ORBIMAGE

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. In addition, the company is expected to compete for the second NGA NextView satellite contract later this year.

Radarsat International

Radarsat International, formed in 1989 to market and distribute Radarsat 1 data, is now a fully-owned subsidiary of MacDonald Dettwiler and Associates (MDA). Both companies are based in Canada. Radarsat 1, launched in 1995 aboard a Delta 2 rocket, has gathered synthetic aperture radar (SAR) data over nearly all of the Earth's surface, and provides radar data with resolutions between 8 and 100 meters. Radarsat 2, planned for launch in 2006, will continue the mission of its predecessor. MDA had considered building a third satellite, Radarsat 3, to operate in tandem with Radarsat 2 later in the decade, but the company now plans to build Radarsat 3 as a follow-on to Radarsat 2 near the end of Radarsat 2's planned seven-year lifetime. The Canadian government has supported the Radarsat 1 program through the Canadian Space Agency (CSA). However, the next generation of Radarsat satellites and their ground support infrastructures, will be operated commercially by MDA.

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). 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, are expected to be launched together at the end of 2006.

Space Imaging

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 mid-2003, the company had more than 160-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.

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. The company is bidding on an NGA NextView contract to partially fund its follow-on satellite. The contract award is expected by the end of September 2004.

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 poised to launch its flagship, TrailBlazer.

TrailBlazer, which is scheduled for launch in late 2004 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 16 payloads throughout the forecast period, with a peak in 2006 due to replacement cycles and the launch of five RapidEye satellites. Those satellites will be deployed on 12 launches, including 10 medium-to-heavy vehicles.

"Little LEO" Telecommunications Systems

Little LEO satellite systems were dubbed "little" by the FCC because they are at comparatively lower frequencies than those considered "Big LEO" systems. The Little LEO systems provide narrowband data communications such as e-mail, two-way paging, and simple messaging using frequencies below 1 GHz. Target markets include automated meter reading, vehicle fleet tracking and other kinds of remote data monitoring. Only ORBCOMM has fully deployed its system. Little LEO systems are listed in Table 18.

Recent Developments

ORBCOMM is moving ahead with plans to deploy replacement satellites in the near future. The company is currently soliciting bids for the construction of an estimated 24 replacement satellites, which would be launched four to ten at a time on about four

Table 18. FCC-Licensed Little LEO Systems

System	Operator	Prime Contractor	Satellites: Number	Satellites: Mass kg (lbm)	Orbit Type	First Launch	Status
Operational							
ORBCOMM	ORBCOMM Global LP	Orbital	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.
Under Development							
AprizeStar (LatinSat)	Aprize Satellite	SpaceQuest	2/2 (in orbit/ operational)	10 (22)	LEO	2002	Planned 48-satellite system. Received experimental FCC license in 2004. Licensed by Argentine CNC in 1995 and ITU in 2000.

launches. The company plans to select one company later this year to provide both the satellites and launch services. The first launch of replacement satellites is planned for late 2006, with future launches to take place as required. The new satellites are designed to be larger and more robust than the existing spacecraft, with a design life of at least ten years.

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 Technology AG, 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. As of early 2004 the company was near cash-flow breakeven and approaching 100,000 subscribers.

The ORBCOMM constellation is currently comprised of 35 satellites (30 of which are operational) in orbits of 825 kilometers (513 miles) in altitude. 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. Most of the satellites were launched between 1997 and 1999.

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.

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. Two additional AprizeStar satellites are scheduled for launch on a Dnepr in June 2004. More satellites are scheduled for launch on Dnepr in either November 2004 or April 2005. Construction of two satellites for launch in Fall 2005 is underway. 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 scheduled for launch this year. The system also received a license in 1995 from the Argentine National Communications Commission (CNC) and an ITU license in 2000.

Market Demand Scenarios

FAA/AST projects that 24 Little LEO satellites will be launched during the coming decade and generate a demand for four 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 19.

GLOBALSTAR

In April 2004 Globalstar completed a long-awaited restructuring of the company; it had entered Chapter 11 bankruptcy protection in February 2002 after $4 billion was spent and customer growth did not meet expectations. Under an agreement finalized in December 2003, investment firm Thermo Capital Partners LLC acquired an 81.25% stake in a new Globalstar operating company for $43 million, with the remainder of the company going to its creditors, including Qualcomm and Loral. The company plans to construct new gateways to serve the North Pacific and Caribbean markets, and to expand its fax and data services. The agreement with Thermo Capital Partners came after ICO backed out of an April 2003 agreement to acquire a controlling interest in the company after concluding in October 2003 that an unspecified condition of the agreement would not be met. As of April 2004 the company reports having 110,000 subscribers, three times the number from two years earlier. It had $55 million in revenue in 2003 and plans to reach $85 million in 2004.

One issue the company has faced is on-orbit failures of its satellites: 16 have experienced problems with their S-band converters, with at least four of those satellites having been declared failures. Globalstar has eight completed satellites in ground storage, which the company acquired during restructuring negotiations with Loral. The company is currently planning to launch at least four satellites in late 2006 with an additional launch date to be determined. In mid-2003 Globalstar filed an application with the FCC to alter the size of its constellation from 48 to 40 satellites, which is the size of the operational

Table 19. FCC-Licensed Big LEO Systems

System	Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
			Number	Mass kg (lbm)			
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.
Under Development							
2.0 GHz							
ICO	New ICO Global Communications (Holdings), Inc.	Boeing	1/1 (in orbit/ operational)	2,744 (6,050)	MEO	2000	Planned 12-satellite system. FCC license granted July 17, 2001. Company emerged from bankruptcy in May 2000 after $1.2 billion investment by Eagle River Investments, LLC. Company now focused on packet-switched data delivery. ICO F-2, the first satellite in system, was launched in 2001. ICO Z-1 was lost when launch vehicle failed in 2000.

constellation as of April 2004, although some orbiting satellites could be recovered and brought back into service. In January 2003, the FCC rescinded Globalstar's 2-GHz license for an additional follow-on constellation; however, Globalstar is appealing this decision.

ICO

Despite a favorable FCC finding in 2003 to grant 2-GHz MSS operators' approval to use an ancillary terrestrial component, it is unclear if ICO will launch its medium-data-rate mobile satellite system of ten operational satellites and two spares. The company appears to be waiting for improvements in customer market prices and capital finance conditions. ICO has stated it is committed to proceed with its own network. ICO plans to offer medium-rate wireless Internet access (up to 144 kilobits per second) in addition to voice service.

The first ICO satellite was lost in a Sea Launch vehicle failure in March 2000. Another satellite launch on an Atlas 2AS in June 2001 was successful. The satellite is operating in a circular orbit at an altitude of 10,390 kilometers (6,450 miles) and has been used to test signal quality. The remaining ten satellites are being assembled by Boeing Satellite Systems; the contract between ICO and BSS was renewed in mid-2003, although the terms of the deal were not announced. The FCC license for 2 GHz requires the first two satellites to be launched by January 2005. The FCC has also assigned ICO only 5 MHz of bandwidth out of its system capacity of 30 MHz.

The company's name, ICO, is taken from the acronym for intermediate circular orbit. After raising some $3.1 billion, the original ICO filed 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 in the company by a group of investors led by Craig McCaw, a successful wireless cellular-telephone network owner. A similar group also invested in Teledesic.

Iridium

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 replacement system. The current system could last until 2014, much longer than initially advertised. As a result, Iridium Satellite does not expect to begin planning for a follow-on system until late this decade, assuming it can obtain funding to design, build, and launch a new system. Iridium Satellite 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. The current constellation consists of 79 satellites, 13 of which are orbiting spares. A total of 95 satellites have been launched.

Originally conceived by Motorola in 1991, Iridium's system of 66 operational satellites, spares, and an extensive ground network was developed and deployed at a cost around $5 billion. In December 2002 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. DoD also agreed to indemnify Iridium from any potential future damages caused by satellite reentry. During spring 2003, Iridium reported a 50 percent increase in usage because of the war in Iraq, maritime use, and other commercial activity. The company has also introduced short messaging and fax services in 2003 and 2004, respectively.

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.

"Broadband LEO" Systems

Broadband satellite systems had been expected to provide an answer to the "last mile" problem of high-speed Internet access, offering services to consumers and businesses to unwired urban areas as well as remote customers that conventional landline services may not even attempt to access. However, the high costs of such satellite systems—$4–10 billion for NGSO satellite constellations—and the growth of affordable terrestrial alternatives have hindered their development. While several GSO broadband systems are in development and scheduled for launch as soon as this year, there are no broadband NGSO systems currently under active development nor foreseen to launch in the next decade. The only company with an FCC license for an NGSO broadband system, Teledesic, surrendered its license in June 2003, effectively ending that company's efforts to deploy a Ka-band satellite constellation. A number of applications for broadband NGSO licenses still remain before the FCC.

Future Markets

The sharp decline of the telecommunications market has raised the question of what new markets, if any, will stimulate demand for commercial NGSO launches in the future. Space tourism, or public space travel, appears to be a promising new market sector on the horizon. The question is when public space travel will emerge. In April 2001, the first paying space tourist, Dennis Tito, launched to the International Space Station (ISS) for a one-week visit. A second tourist, Mark Shuttleworth, was launched in April 2002. In March 2004 space tourism company Space Adventures announced that American businessman Gregory Olsen would be the third such private space traveler, scheduled to fly to the station in April 2005. Other paying passengers are negotiating for rides, and studies have shown that enough of a business market exists, even at high prices. With regards to the NGSO forecast, Soyuz tourist flights involve selling the third seat on regularly-scheduled return vehicle exchange missions that would have been launched with or without a paying passenger. Thus these missions did not generate launch demand.

Since this report only includes commercial orbital missions, the outlook for suborbital vehicles is not currently included in this forecast. However, new suborbital vehicles capable of carrying passengers have arrived. During April 2004, FAA/AST issued suborbital reusable launch vehicle mission licenses to Scaled Composites and XCOR Aerospace. Scaled Composites flew one licensed mission to an altitude of 32 kilometers in April 2004 and plans additional missions to compete for the $10-million Ansari X Prize. XCOR plans to conduct test flights with its license with ultimate goal of carrying passengers in the near future. Other companies are also pursuing suborbital and orbital licenses.

NASA is currently developing a "Centennial Challenges" prize program as part of President Bush's space exploration vision to explore the solar system and return humans to the Moon and Mars. Centennial Challenges may include future prizes for "micromissions" to the Moon, Mars, and asteroids that could stimulate commercial launch demand. NASA is also evaluating cargo missions to and from ISS that could be provided commercially and issued a $227 million data services contract to Kistler Aerospace if the company can fund and fly the K-1 vehicle to ISS and back by the end of 2006 and return flight data to NASA.

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. Some investors may be waiting for examples of success in the GSO broadband market. Although satellite radio is steadily growing in the United States, it has not reached high confidence levels for investors in Europe or Asia.

- **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 U.S. Department of Defense (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, 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.*

Methodology

This report is based on FAA/AST research and discussions with industry, including satellite service providers, satellite manufacturers, launch service providers, and independent analysts.

The forecast considers progress in financing, design maturity, licensing, partnerships, target market development, spacecraft development, launch services contracts, and deployment plans for publicly-announced satellites. Equally important considerations include investor confidence in service markets, competition from terrestrial and space sectors (including GSO satellites and currently operating NGSO systems), and national and global economic conditions. In addition, the status of orbiting systems and their business histories were evaluated. Interviews with system operators and the FCC were conducted for this report.

Traditionally, very small satellites—those with masses of under 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.

The 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.

Follow-on systems and replacement satellites for existing systems are evaluated on a case-by-case basis. In some cases, expected future activity was beyond the timeframe of the forecast.

Finally, international launch providers were surveyed for the latest available near-term manifests. For the remote sensing and international science markets, near-term primary payloads that generated individual commercial launches were used in the model while future years were estimated based on historical activity. Table 20 shows the announced near-term manifests for these markets utilized in this report.

Table 20. Near-Term Identified NGSO Satellite Manifest

Service Type	2004	2005	2006	2007
Commercial Remote Sensing	TrailBlazer - Dnepr	WorldView - Delta 2	Radarsat 2 - Delta 2	NextView 2 - TBA
			RapidEye (5) - TBA	
			EROS B - START 1	
			TerraSAR X - Dnepr	
International Science	Rocsat 2 - Taurus	Kompsat 2 - Rockot	GOCE - Rockot	
	Demeter - Dnepr	China DMC+4 - Cosmos	Corot - TBA	
	Cryosat - Rockot	Topsat - Cosmos	COSMO Skymed 2 - TBA	
	Cosmos 1 - Volna	SSETI Express - Cosmos		
	EgyptSat 1 - Dnepr	TBA - Falcon 1		
		COSMO Skymed 1 - TBA		
Telecom/Other		Genesis Pathfinder - Falcon 5	ORBCOMM (6) - TBA	ORBCOMM (6) - TBA
			Globalstar (4) - TBA	Globalstar (4) - TBA
Total Payloads	**6**	**8**	**21**	**11**
Total Launches	**6**	**6**	**9**	**3**

Note: This manifest includes only those satellites announced as of May 12, 2004.

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 to allow for global coverage using fewer higher-powered satellites. However, MEO is often a term applied to any orbit between LEO and GSO;
- Elliptical orbits (ELI, also known as highly-elliptical orbits, or HEO) have apogees ranging from 7,600 kilometers (4,725 miles) to 35,497 kilometers (22,000 miles) in altitude and up to 116.5° inclination, allowing satellites to "hang" over certain regions on Earth, such as North America; and
- External or non-geocentric orbits (EXT) are centered on a celestial body other than the Earth. They differ from highly-elliptical orbits (ELI) in that they are not closed loops around Earth and a spacecraft in EXT will not return to an Earth orbit. In some cases, this term is used for payloads intended to reach another celestial body (e.g., the Moon) even though part of the journey is spent in a free-return orbit that would result in an Earth return if not altered at the appropriate time to reach its destination orbit.

Satellite and Launch Forecast

In this forecast, the number of satellites seeking future commercial launch services has increased by 26 satellites compared to the 2003 forecast. This is the first significant satellite increase from a previous year's forecast since 1998. The addition of a second-generation Little LEO system and a series of replacement satellites for a Big LEO system are the primary reasons for the increase. The resulting launch demand, however, is the same as last year's ten-year forecast because of an increased number of satellites in the forecast that will be multi-manifested.

Baseline Forecast

The baseline forecast anticipates the following satellite market characteristics from 2004-2013:

- International science and other satellites (such as technology demonstrations) will comprise about 55 percent of the NGSO satellite market with 58 satellites, similar to 60 in the 2003 forecast and well above the 34 satellites in the 2002 forecast.
- Telecommunications satellites account for 30 percent of the market with 32 satellites, a significant increase from last year's forecast, which had zero.
- Remote sensing satellites that serve commercial missions will encompass 15 percent of the market with 16 satellites, similar to 20 in both the 2002 and 2003 forecasts.

Table 21 and Figures 14 and 15 show the baseline forecast in which 106 satellites will

Figure 14. Baseline Satellite Forecast

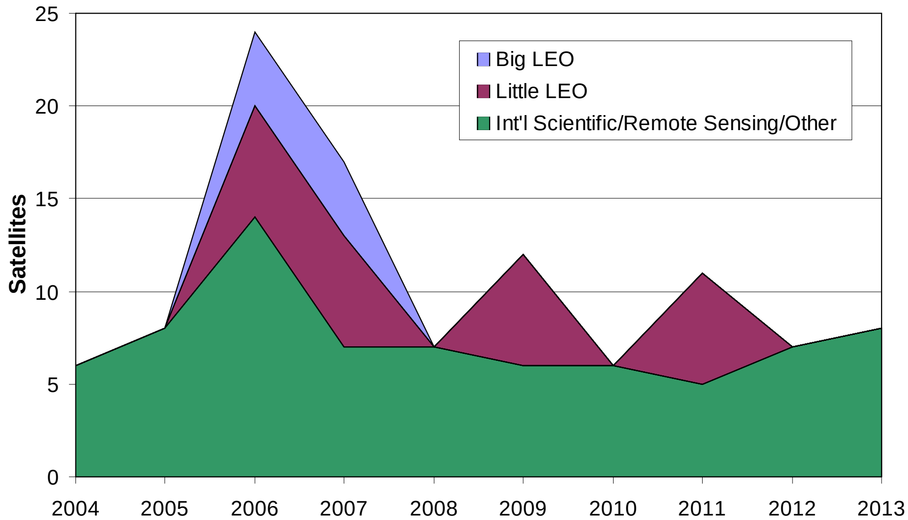

Figure 15. Baseline Launch Demand Forecast

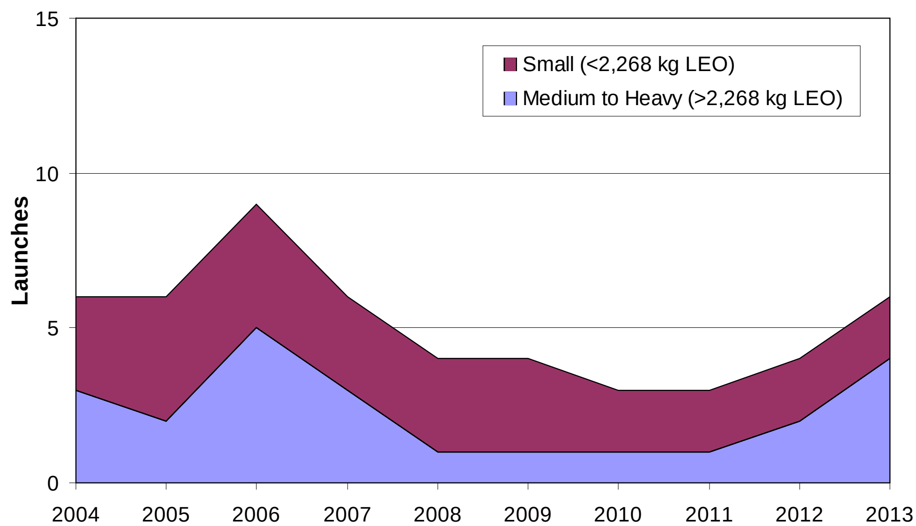

Table 21. Baseline Satellite and Launch Forecast

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	TOTAL	Avg
Satellites												
Big LEO	0	0	4	4	0	0	0	0	0	0	8	0.8
Little LEO	0	0	6	6	0	6	0	6	0	0	24	2.4
International Scientific/Other	5	7	6	6	5	6	6	5	6	6	58	5.8
Commercial Remote Sensing	1	1	8	1	2	0	0	0	1	2	16	1.6
Total Satellites	**6**	**8**	**24**	**17**	**7**	**12**	**6**	**11**	**7**	**8**	106	10.6
Launch Demand												
Medium-to-Heavy Vehicles	3	2	5	3	1	1	1	1	2	4	23	2.3
Small Vehicles	3	4	4	3	3	3	2	2	2	2	28	2.8
Total Launches	**6**	**6**	**9**	**6**	**4**	**4**	**3**	**3**	**4**	**6**	51	5.1

be deployed between 2004 and 2013. In comparison to last year's forecast of 80 total satellites (2003–2012), this year's projections are up 32.5 percent. Table 22 shows the mass distributions of known manifested satellites over the next four years. The predominance of the smaller satellites is evident, with 79 percent of all satellites going to NGSO in the next four years expected to be less than 600 kilograms.

After accounting for multiple manifesting, the 106 satellites in the forecast yields a commercial launch demand of 51 launches over the forecast period. This demand breaks down into about three launches annually on small launch vehicles and two launches annually on medium-to-heavy launch vehicles. Fifty-one was also the total in the 2003 forecast. The near-term launch forecast projects launch activity above the ten-year average of five per year: six launches each in 2004, 2005, and 2007, and nine launches in 2006.

Of the 51 total launches, 33 are projected to have international science and other satellites onboard. Twelve launches are forecast to carry commercial remote sensing satellites while six launches will carry the 32 telecommunications satellites in the forecast. Most commercial remote sensing satellites will be launched on medium-to-heavy launch vehicles because of their relatively larger mass compared to two-thirds of the international science satellites, which are projected to launch on small launch vehicles. While actual vehicle selections have not been made for the 32 telecommunications satellites when this forecast report was published, the FAA estimates four will go on small launch vehicles and two on medium-to-heavy vehicles.

As in last year's forecast, this year's report also 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 past 2011. However, space markets can change relatively rapidly and the robust scenario could return in future forecasts.

Table 22. Distribution of Satellite Masses in Near-Term Manifest

	2004	2005	2006	2007	Total	Percent of Total
< 200 kg (< 441 lbm)	3	4	7	6	20	43%
200-600 kg (441-1323 lbm)	2	0	10	4	16	35%
600-1200 kg (1323-2646 lbm)	1	2	3	1	7	15%
> 1200 kg (> 2646 lbm)	0	2	1	0	3	7%
Total	6	8	21	11	46	100%

Historical NGSO Market Assessments

A historical comparison of FAA/AST baseline forecasts from 1998 to the present is in Figure 16. Actual launches to date are also displayed. Since publication of the first projections for NGSO/LEO launches in 1994, there has been tremendous growth in the number of proposed NGSO systems. 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, since 1999, FAA/AST has reduced its annual forecasts as demand in the marketplace fell. This year's forecast, however, is the second consecutive forecast in which the number of payloads has increased from the previous forecast. The 51 launches in this year's forecast are exactly the same as the number from the 2003 forecast, marking the first time since 1998 that the total number of launches forecast did not decrease from one year to the next.

The 2004 forecast estimates six launches during the 2004 calendar year. NGSO activity peaked with 19 launches in 1998 when Iridium, Globalstar, and ORBCOMM were active. It should be pointed out that the 1998 projections were reasonable at that time based on demand and that market conditions in NGSO change rapidly.

For the third 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 from 1994–2003. Medium-to-heavy vehicles had 40 launches during this period while small vehicles had 35. The 2004 forecast estimates launch demand for more small vehicle launches (28) than medium-to-heavy vehicle launches (23) from 2004–2013.

Historical satellite and launch data for the period 1993–2003 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	Total
Satellites											
Big LEO	0	0	0	46	60	42	5	1	7	0	161
Little LEO	0	3	0	8	18	7	0	0	2	0	38
International Science/Other	0	0	2	1	4	5	11	1	6	1	31
Commercial Remote Sensing	0	1	0	2	0	2	2	2	0	8	17
Total Satellites	**0**	**4**	**2**	**57**	**82**	**56**	**18**	**4**	**15**	**9**	**247**
Launches											
Medium-to-Heavy Vehicles	0	0	1	8	9	11	6	2	2	1	40
Small Vehicles	0	2	1	5	10	7	3	2	2	3	35
Total Launches	**0**	**2**	**2**	**13**	**19**	**18**	**9**	**4**	**4**	**4**	**75**

* 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 16. Comparison of Past Baseline Launch Demand Forecasts

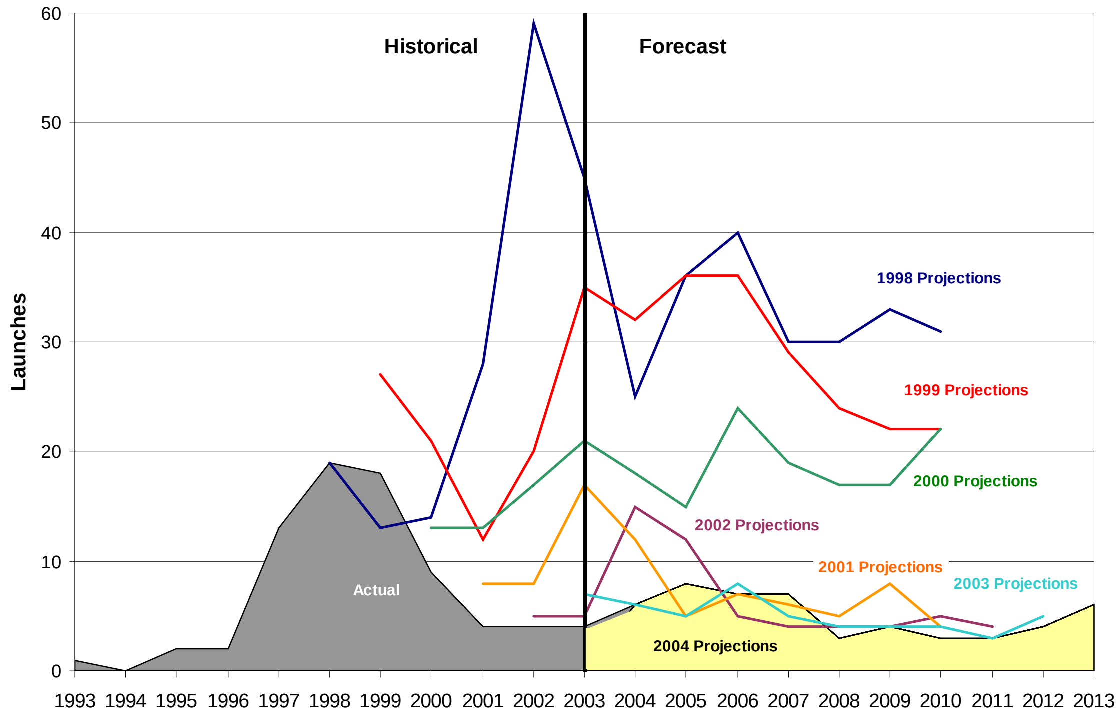

Table 24. Historical NGSO Satellite and Launch Activities (1993–2003)†

Summary	Market Segment	Date	Satellite	Launch Vehicle	
2003					
9 Satellites	**Remote Sensing**	6/26/03	OrbView 3	Pegasus XL	Small
1 Remote Sensing					
8 Int'l Science	**International Science**	6/2/03	Mars Express	Soyuz	Medium-to-Heavy
			Beagle 2		
		9/27/03	BilSat 1	Cosmos	Small
			BNSCSat		
			KaistSat 4		
4 Launches			NigeriaSat 1		
1 Medium-to-Heavy			Rubin 4-DSI		
3 Small		10/30/03	SERVIS 1	Rockot	Small
2002					
15 Satellites	**Big LEO**	2/11/02	Iridium (5 sats)	Delta 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		
2 Small			Test Article		
2001					
4 Satellites	**Big LEO**	6/19/01	ICO F-2	Atlas 2AS	Medium-to-Heavy
1 Big LEO					
2 Remote Sensing	**Remote Sensing**	9/21/01	OrbView 4	Taurus	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					
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

† 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 SaudiSat 2 et al.

Table 24. Historical NGSO Satellite and Launch Activities (1993–2003) [Continued]

Summary	Market Segment	Date	Satellite	Launch Vehicle	
1999					
56 Satellites	**Big LEO**	2/9/99	Globalstar (4 sats)	Soyuz	Medium-to-Heavy
42 Big LEO		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 (1993–2003) [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					