2003 COMMERCIAL SPACE TRANSPORTATION FORECASTS

May 2003

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 (2003)

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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 2003 to 2012.

The *2003 Commercial Space Transportation Forecasts* report includes the following:

- The *COMSTAC 2003 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 *2003 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits*, which projects commercial launch demand for satellites in non-geosynchronous orbits (NGSO), such as low Earth orbit (LEO), medium Earth orbit (MEO), elliptical orbit (ELI), and external (EXT) orbit.

Together, the COMSTAC and FAA forecasts project that an average of nearly 24 commercial space launches worldwide will occur annually from 2003–2012. The combined forecasts are down 11.5 percent from those of last year, which projected an average of about 27 launches per year from 2002–2011. The reduction is attributed to global economic conditions and declines in customer demand and financial capital for some satellite service sectors.

In the GSO market, satellite demand averages 23.3 satellites per year, a decrease of 14.6 percent compared to the 2002 forecast. The resulting launch demand declined an average of about two launches per year, or nine percent, compared to last year's GSO forecast. Although NGSO satellite demand has stabilized and is essentially the same as last year's forecast of eight per year over 10 years, corresponding launch demand fell 19 percent because of an increase in multiple manifesting of small satellites. COMSTAC and FAA project an average annual demand as follows:

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

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

- 2.9 launches of small vehicles to NGSO.

Commercial launch demand is calculated by determining the number of primary payloads that are open to internationally competed launch services procurement and by estimating how many of those will ride as single-, dual-, or multiple-manifested payloads to determine the number of launches in the marketplace.

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 *2003 Commercial Space Transportation Forecasts* report covers the period from 2003 to 2012 and includes the following:

- The *COMSTAC 2003 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/AST's *2003 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits*, which projects commercial launch demand for all space systems in non-geosynchronous orbits (NGSO), such as low Earth orbit (LEO), medium Earth orbit (MEO), elliptical orbit (ELI), and external (EXT) orbit.

Growth of Commercial Space Transportation

Prior to the 1980s, the government was responsible for launching payloads to Earth orbit. Since then, commercial launch activity has steadily increased. From 1997–2001, commercial launches accounted for an average of about 42 percent of worldwide launches. During 2002, 24 out of 65 worldwide launches were commercial, accounting for 37 percent of global launch activity.

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

About the COMSTAC 2003 Commercial Geosynchronous Launch Demand Model

At the request of FAA/AST, COMSTAC (which is comprised of representatives from the U.S. launch and satellite industry) annually produces a model that forecasts worldwide demand for commercial launches of spacecraft that operate in GSO. First compiled in 1993, the 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 some launch vehicles.

About the FAA NGSO Commercial Space Transportation Forecast

Since 1994, FAA/AST has compiled an assessment of demand for commercial launch services to NGSO (i.e., those orbits not covered by the COMSTAC GSO forecast). The NGSO forecast is based on a worldwide satellite assessment of science, remote sensing, telecommunications, and other spacecraft using commercial launch services. It includes a baseline model for deployment of NGSO satellites that are considered the most likely to launch and an estimate of launch demand based on a review of multiple manifesting.

Combined Satellite and Launch Forecasts

This year's COMSTAC GSO and FAA/AST NGSO combined forecasts contain 313 satellites that are expected to be commercially launched between 2003 and

2012, as shown in Figures 1, 2, and 3. This is an 11 percent reduction in the total number of satellites included in last year's 10-year forecast. After calculating the number of satellites that could be launched two or more at a time on a single launch vehicle, a total demand of 237 commercial launches to GSO and NGSO destinations is forecast through 2012, as shown in Table 1 and Figures 3 and 4. The forecast for launch demand is an average of nearly 24 launches per year, a decrease of 11.5 percent compared to last year's forecast.

The projected satellite demand for GSO is significantly greater than NGSO for the third year in a row. There are 233 GSO satellites in the 10-year forecast, compared with 80 in NGSO. The GSO forecast contains a market demand of 23.3 satellites per year, with a high of 27 and a low of 18. This is a decrease of an average of four satellites per year compared last year's forecast. The number of NGSO satellites averages eight per year, virtually the same as from the 2002 forecast, which estimated 7.9 per year. The peak year in the NGSO forecast is 2006 with 15 satellites, while the low year is 2010 with five. All of the satellites in the GSO forecast are for telecommunications services, in contrast to the NGSO forecast where all are science and remote sensing satellites.

GSO launch demand averages 18.6 launches per year, a decrease of about two launches per year compared to last year's forecast of an average of 20.5 launches. Annual launch demand for NGSO consists of 2.2 launches for medium-to-heavy launch vehicles and 2.9 launches of small launch vehicles, for an average total of 5.1 launches. This total is down about 19 percent compared to the 2002 forecast average of 6.3 launches per year. Figure 4 shows historical forecasts from 1998–2003.

Table 1. Commercial Space Transportation Satellite and Launch Forecasts

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total	Average
Satellites												
GSO Forecast (COMSTAC)	22	18	18	22	24	25	26	27	25	26	233	23.3
NGSO Forecast (FAA)	10	7	8	15	7	7	7	5	6	8	80	8
Total Satellites	**32**	**25**	**26**	**37**	**31**	**32**	**33**	**32**	**31**	**34**	**313**	**31.3**
Launch Demand												
GSO Medium-to-Heavy	19	16	14	17	19	20	21	21	19	20	186	18.6
NGSO Medium-to-Heavy	2	2	3	5	2	2	1	1	1	3	22	2.2
NGSO Small	5	4	2	3	3	2	3	3	2	2	29	2.9
Total Launches	**26**	**22**	**19**	**25**	**24**	**24**	**25**	**25**	**22**	**25**	**237**	**23.7**

Figure 1. GSO Satellite and Launch Demand

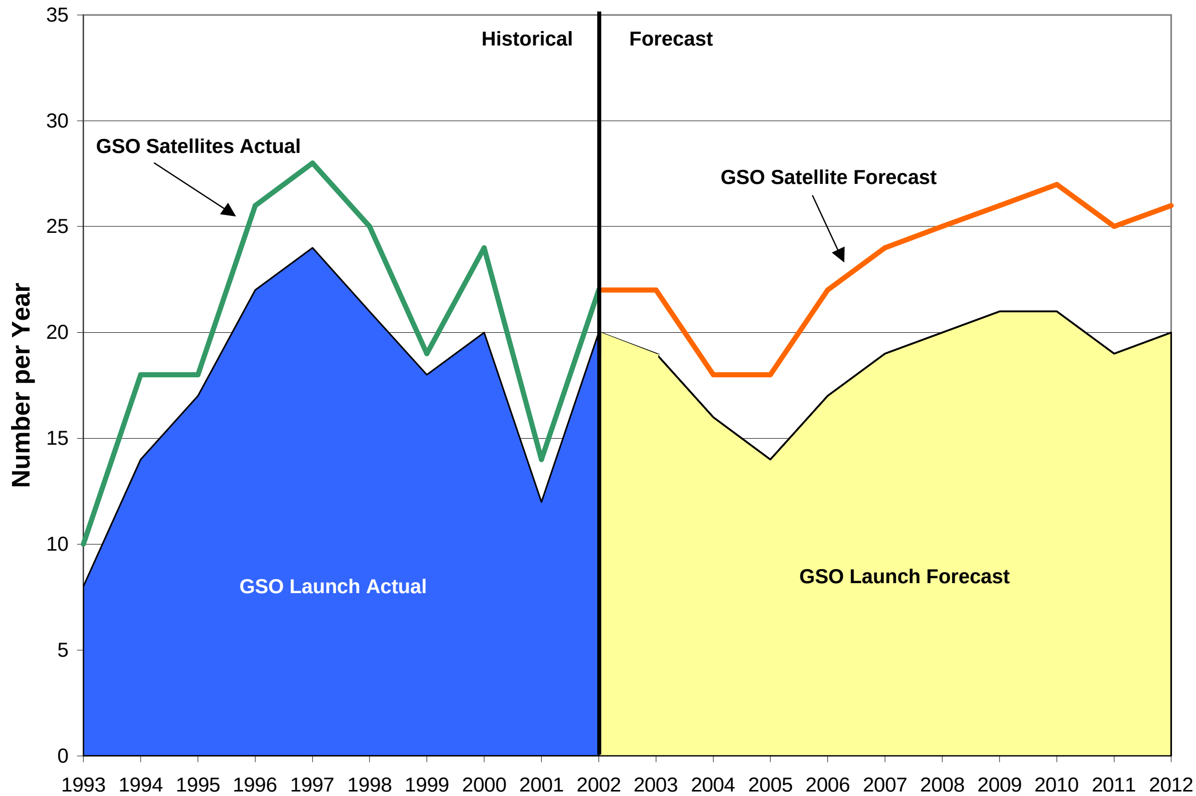


Figure 2. NGSO Satellite and Launch Demand

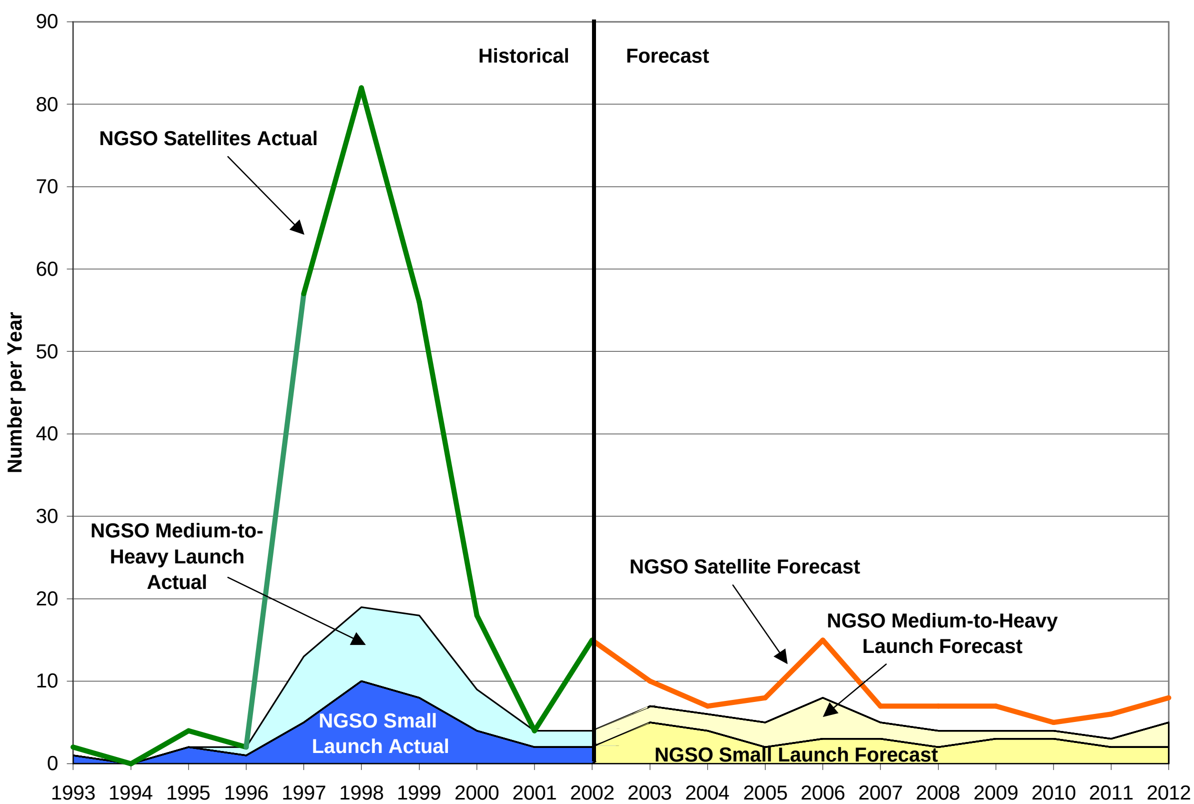


Figure 3. Combined GSO and NGSO Launch Forecasts

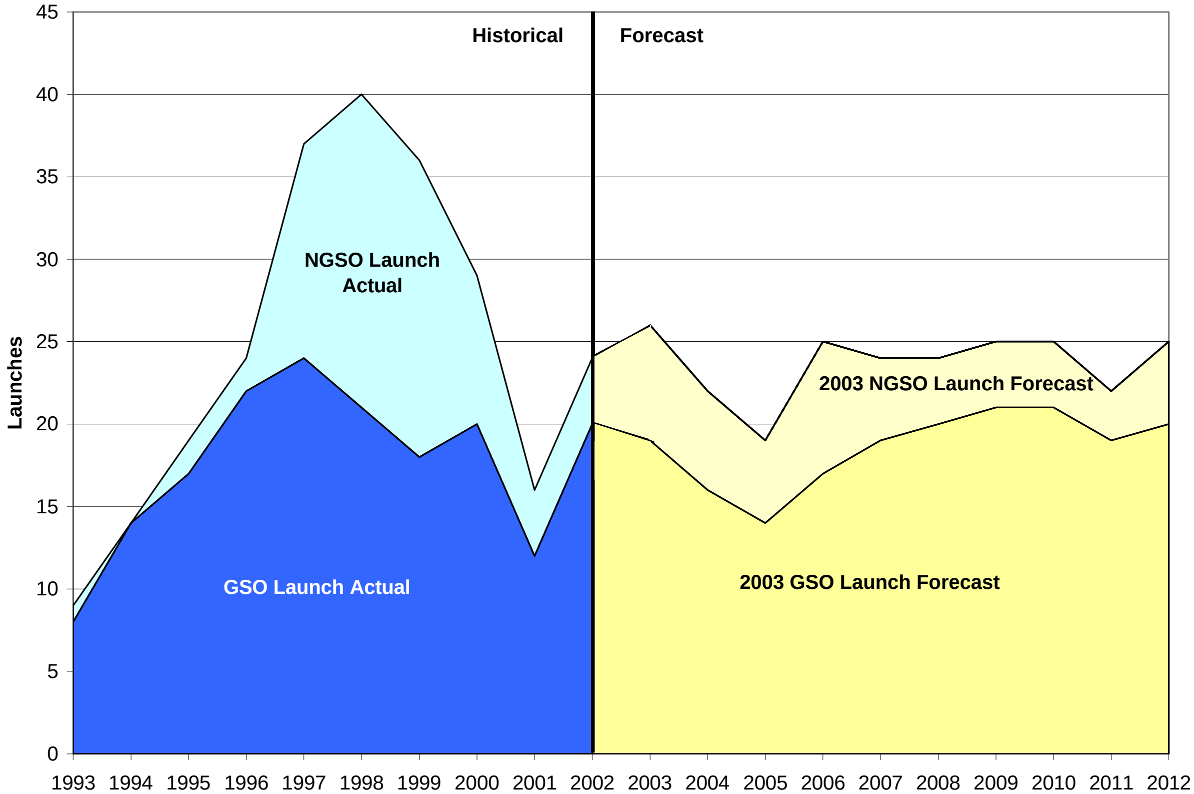
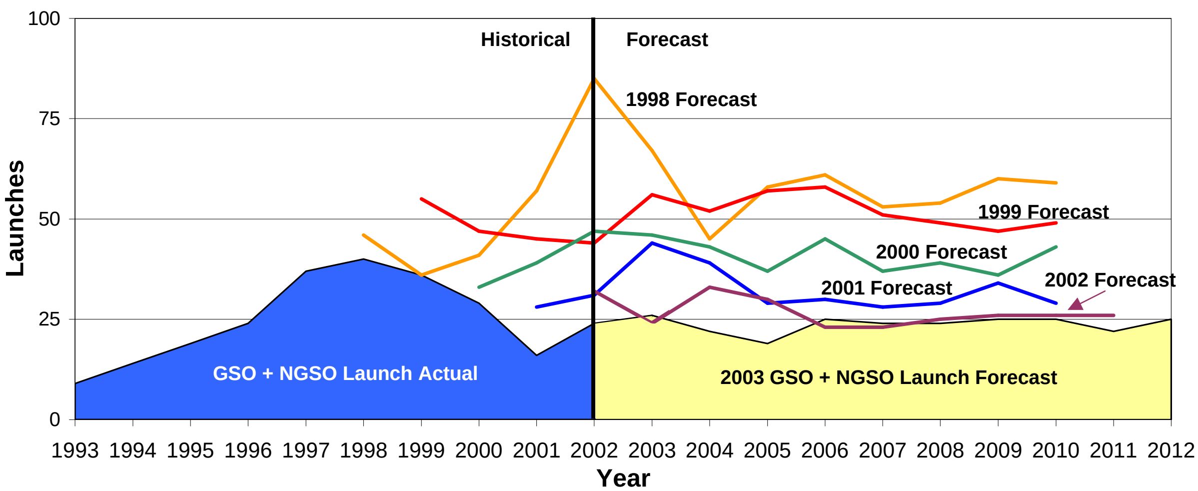


Figure 4. Historical Commercial Space Transportation Forecasts



COMSTAC 2003 Commercial Geosynchronous Orbit (GSO) Launch Demand Model

Executive Summary

This report was compiled by the Commercial Space Transportation Advisory Committee (COMSTAC) for the Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (FAA/AST). The *2003 Commercial Geosynchronous Orbit (GSO) Launch Demand Model* is the eleventh annual forecast of the worldwide demand for commercial GSO launches as seen 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 across the satellite and launch industries. In this report COMSTAC produces a satellite and launch demand forecast. One key content change has been introduced this year. The interpretation of the historical difference between demand forecasts and the actual number of satellites launched that was applied to the first year of the forecast in the 2002 report has been expanded to each of the first three years of the forecast. This change is expected to provide a more useful report in that the impacts of such events as launch failures, launch delays and satellite delays are taken into consideration. COMSTAC has also reordered some segments of the report to better explain these effects.

Satellite demand is derived by forecasting the number of satellites to be placed in GSO 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 a dual-launch configuration.

The near-term forecast, which is based on existing and anticipated satellite programs for 2003 through 2005, shows demand for 22 satellites to be launched in 2003, 18 in 2004, and 18 in 2005. The average annual COMSTAC demand forecasts published in the 2001 and 2002 reports were 30.5 and 27.3 satellites per year, respectively, over the 10-year forecast period. This year's mission model predicts an average demand of 23.3 satellites to be launched per year over the period from 2003 through 2012, a decrease of approximately 15 percent from the demand forecast of 27.3 satellites per year forecast in the 2002 report. Several factors are impacting 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.

The number of satellites launched is not the only relevant measure of activity in the commercial space industry. A new analysis of the number of transponders launched and the mass of satellites launched over time included in this year's report shows that although the number of satellites launched in 2002 and the number of satellites forecasted for 2003 and 2004 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.

In 2002, 22 commercial GSO satellites were launched, an increase of 57 percent

over the 2001 total of 14 satellites launched. The 2002 commercial model projected a demand of 32 satellites in 2002, with an expected actual launch realization of between 22 and 27 satellites. Eight of the 10 satellites that were included in the forecasted demand for 2002 that did not launch in 2002 are expected to launch in 2003 and are included in this year's near-term forecast.

Over the 10 years that this report has been published, forecasted demand for the first year of the forecast has consistently exceeded the actual number of satellites launched in that year. Using this historical variance as an indicator suggests that the 2003 demand of 22 satellites will be discounted to an actual number of satellites launched of somewhere between 13 and 19. The variance between that forecasted demand versus the actual number of satellites launched will be discussed in more detail.

The COMSTAC GSO Launch Demand Model is calculated to project the number of *satellites* to be launched 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. This report 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 shows the graphical representation of the COMSTAC Demand Forecast in terms of number of satellites and launches expected. The near-term launch demand forecast equates to 19 launches for 2003, 16 launches for 2004, and 14 launches for 2005.

Figure 5. COMSTAC Commercial GSO Launch Demand Forecast

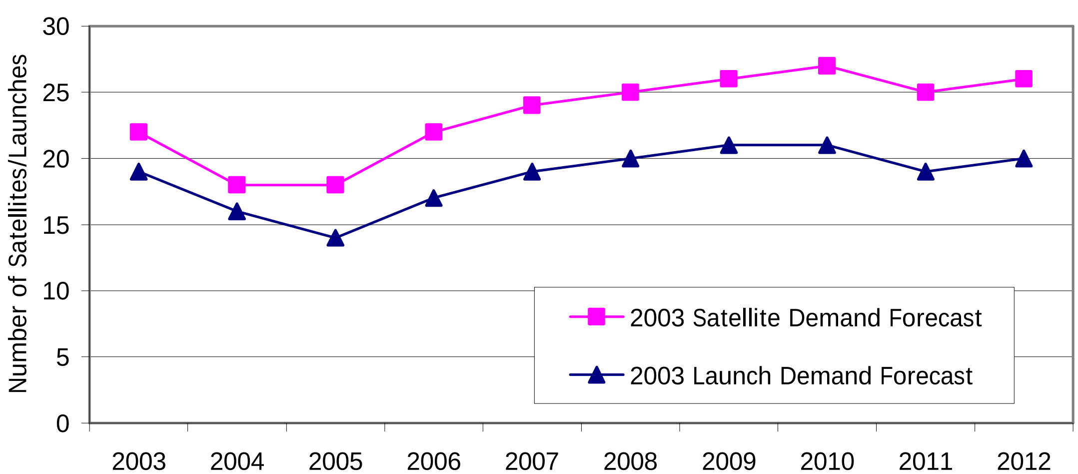


Table 2. Commercial GSO Launch Demand Forecast Data

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total	Average 2003 to 2012
Satellite Demand	22	18	18	22	24	25	26	27	25	26	233	23.3
Dual Launch Forecast	3	2	4	5	5	5	5	6	6	6	47	4.7
Launch Demand Forecast	19	16	14	17	19	20	21	21	19	20	186	18.6

Introduction

The Federal Aviation Administration's 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 satellite launch demand mission model and update it annually.

This report presents the 2003 update of the worldwide commercial geosynchronous orbit (GSO) satellite mission model for the period 2003 through 2012. It is based on market forecasts obtained in early 2003 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 delivery, launch failures, etc. 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.

Also included in the report is a discussion of the factors that could affect future launch demand and of trends in the commercial satellite industry. In a new addition to the analysis, the report examines data on the number of transponders per satellite and the mass of commercial GSO satellites over time. This analysis shows growth in satellite mass and the number of transponders per satellite from 1993 through 2004.

In October 2002, the FAA/AST asked the Technology and Innovation Working Group (Working Group) to examine the forecast methodology and report structure to ensure that the results provided the best available representation of demand for launch services, and that the report provided adequate guidance to the reader. To ensure that these goals are met, the Working Group undertook two key actions in updating the 2003 report. First, the "realization factor" that was first applied in the 2002 report to the first year of the forecast to show expected actual launches has been expanded to the first three years of the forecast. The intent of this change is to provide the reader not only with a projection of near-term demand, but also with an estimate of near-term actual satellites launched. Second, the methodology section has been enhanced and other segments of the report reorganized 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.

In this year's report, the Working Group has re-introduced a list of historical commercial GSO launches from 1993–2002 for the convenience of the reader in Appendix D. In completing this table, the Working Group has corrected a few minor inconsistencies that appeared in reports from previous years. Most notable among these corrections is the count of historical *launches* that appears later in Figure 7 and Figure 12, and the count of dual-manifested launches that appears in Figure 12. These corrections do not introduce any substantial changes to the report; rather, the changes merely standardize the accounting of dual-manifested launches. The reader should also note that the classification of satellites into mass class categories will appear slightly different than in previous years, as the mass class categories were updated in the 2002 report.

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 has broadened to provide the most realistic portrayal of space launch demand possible. Over the years, the COMSTAC mission model has been well received by industry, government agencies and international organizations.

The first report in 1993 was developed by the major launch service providers in the United States 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 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 28 inputs from satellite service providers, manufacturers, and launch service providers. COMSTAC would like to thank all of the participants in the 2003 mission model update.

Methodology

With the exception of 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 2003–2012) and to manufacturers and launch service providers (requesting comprehensive industry forecasts of addressable commercial GSO payloads per year for the period 2003–2012).

Addressable payloads in this context are satellites that are open for internationally competitive launch service procurement. 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, Chinese, or Indian government satellites that are captive to their own launch providers).

Note that the number of projected launches per year is a subset of this 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.

Respondents were asked to segregate their forecast into satellite mass classes based on the spacecraft's separated mass that is to be inserted into a nominal geosynchronous transfer orbit (GTO). In 2003, the Working Group continues to use the mass class categories as updated in the 2002 report. In previous years, the mass class categories used were representative of clusters of launch vehicles of similar capability. These categories, however, did not always accurately reflect the satellite models that would be competed by different manufacturers for a particular procurement. The goal of the Working Group in updating the mass categories was to create logical categories based on the 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.

The following organizations (noted with the country in which their headquarters is 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)
- KT Corporation (South Korea)
- Lockheed Martin Space Systems Co.* (U.S.)
- Loral Skynet (U.S.)
- Miraxis, LLC (U.S.)
- Mobile Broadcasting Corporation (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)
- Star One (Brazil)
- Space Systems/Loral* (U.S.)
- 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 2003 to 2012. 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 2006 through 2012. 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 include:

- 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

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

There is a certain amount of 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 may be 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 (2003–2005) 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 factors related to the launch vehicle and/or the satellite 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.

The 2002 report noted that an early failure of one or more of the new launch systems scheduled for inaugural flights in 2002 (Atlas V, Delta IV, and Ariane 5 ECA) would cause delays in, or migration of, scheduled launches. The December 11, 2002, failure of the Ariane 5 ECA has caused delays in the Ariane 5 manifest, and there may be additional impacts to the Ariane launch schedule. In the event of other failures, expected launches in a particular year are likely to be deferred into the next year unless an alternative launch service can be arranged. These expected impacts are reflected in the 2003 forecast, but it is difficult to predict the actual "ripple" effect of any one failure on the realization of launch demand.

Other factors influencing the mission model are regulatory issues, which affect the 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 cancellation of programs.

The customer 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.

2002 Space Industry Performance on Launch Demand

In the 2002 COMSTAC Commercial GSO Demand Model, the Working Group listed 32 satellites that were then manifested in that year. Of these 32 satellites, only 22 satellites were actually launched in 2002. And while there was a demand for 32 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 10 satellites that did not make their launch dates follows:

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

Projecting Actual Launches

As noted earlier, the three-year near-term mission model is based on input from each of the satellite manufacturers and launch service providers in the United States. 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 2003 is 22 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 2003 will also experience delays. In the 2002 Forecast report, the Working Group applied a “realization factor” to the first year of the forecast in an attempt to provide guidance to the reader on the potential number of actual launches. This factor was based on the variance between forecasted demand and actual launches for the first year of the forecast and resulted in a probable projection of actual satellites launched of between 22 and 27. In 2002, 22 commercial GSO satellites were launched, meaning that the variance in 2002 was similar to the last five years.

The variance between forecasted demand and actual launches for the first year of the forecast over the seven reports published from 1996 to 2002 was between 12 percent and 42 percent. In this year’s report, the Working Group attempts to provide an expanded look at potential actual launches for 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 26 percent for the first year, 31 percent for the second year, and 44 percent for the third year.

Applying this variance to this year’s 2003 demand forecast of 22 satellites, the probable number of satellites that will actually be launched in 2003 would be between 13 and 19 (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 12 and 18 in 2004, and between 10 and 18 in 2005.

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

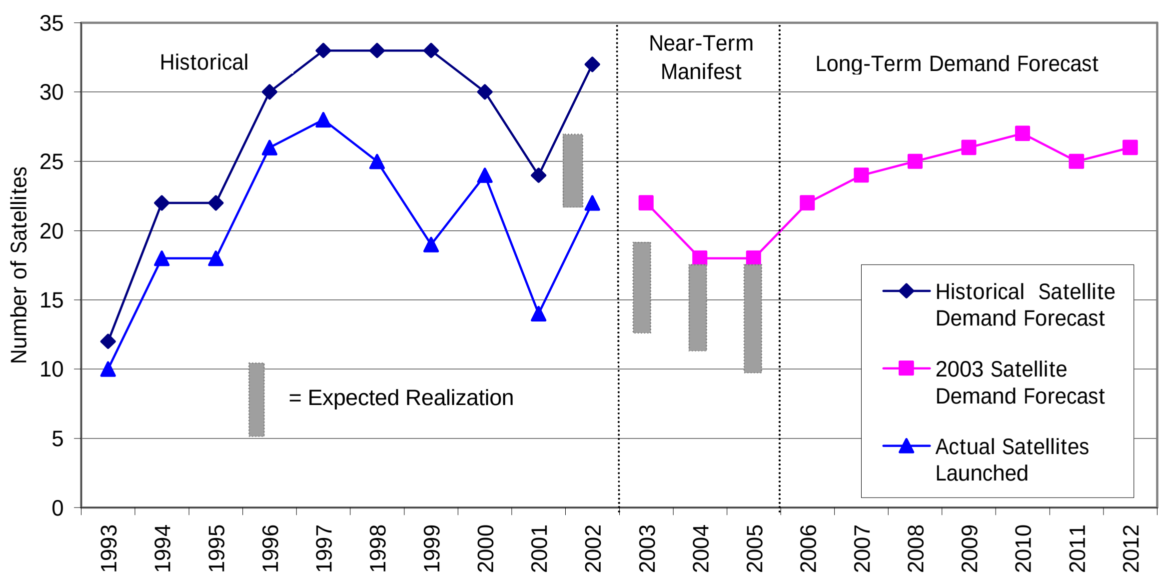
Figure 6 below shows the demand forecast that is produced using the methodology described. The figure indicates the difference between the near-term manifest and the longer-term forecast, and shows the expected launch realization as described above.

2003 Satellite Launch Demand Model

Figure 7 shows the Working Group's demand forecast for commercial satellite launches to GSO for the years 2003 through 2012. Also plotted in Figure 7 is the actual number of satellites launched for each year from 1993–2002, for reference. The range of individual estimates from the various comprehensive inputs is shown in Table 4. 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.

The near-term forecast shows 22 satellites to be launched in 2003, 18 in 2004, and 18 in 2005. This year's mission model predicts an average demand of 23.3 satellites to be launched per year over the period from 2003 through 2012. The COMSTAC average annual demand forecasts of 2001 and 2002 reports were 30.5 and 27.3 satellites per year, respectively. This year's average forecast of 23.3 satellites per year is 15

Figure 6. COMSTAC Commercial GSO Satellite Demand Forecast



percent lower than the average forecast of 27.3 satellites per year in the 2002 report. Several factors are impacting 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 on pages 22 and 23 of this report. Note that the average annual demand calculated in the 2001, 2002, and 2003 reports cover different spans of time, but that each covers a 10-year span. The 2001 report average annual demand is the average demand from 2001 to 2010, the 2002 report from 2002 to 2011, and the 2003 report from 2003 to 2012.

Table 5 shows the near term mission model for 2003 through 2005 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.

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.

Figure 7. COMSTAC Commercial GSO Satellite and Launch Demand Forecast

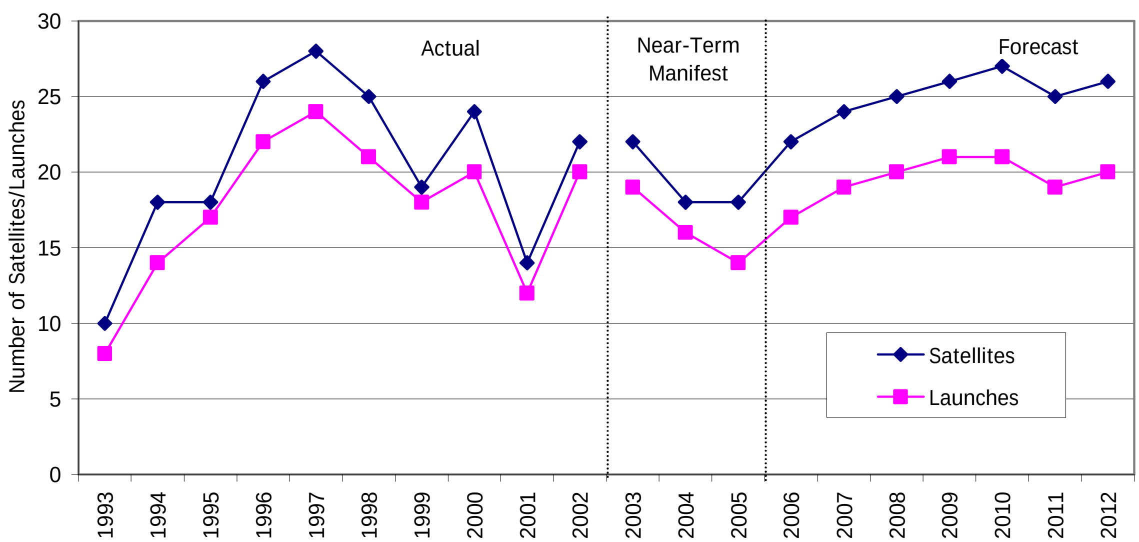


Table 4. COMSTAC Commercial GSO Satellite Forecast

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total	Average
High				33	33	33	33	33	33	33		
2003 Satellite Demand	**22**	**18**	**18**	**22**	**24**	**25**	**26**	**27**	**25**	**26**	**233**	**23.3**
Low				16	16	16	18	18	18	18		

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.

Figure 8 and Table 6 show the trends in annual GSO satellite mass distribution. Actual figures are presented for 1993 through 2002, followed by the distribution projected in this year's demand forecast.

Commercial GSO Satellite Trends

Industry Metrics

In the past, this report has analyzed specifically the number of satellites launched, the distribution of these satellites by mass class, and the number of launches associated with these satellites as metrics for the commercial space industry. This year the Working Group has expanded its analysis to examine some additional industry metrics: the number of transponders launched per year, the average number of transponders per satellite launched, the total mass

Table 5. Commercial GSO Near-term Mission Model, as of May 6, 2003

	2003	2004	2005
Total	22	18	18
Below 2,200 kg (<4,850 lbm)	4	4	1
	Amos 2 – Ariane 5 Bsat 2C – Ariane 5 e-Bird 1 – Ariane 5 Galaxy XII – Ariane 5	AMC-10 – Atlas IIAS AMC-11 – Atlas IIAS Galaxy VR – Ariane 5 Telkom 2 – Ariane 5	Galaxy IRR – Ariane 5
2,200–4,200 kg (4,850-9,260 lbm)	6	4	12
	AMC-9 – Proton Asiasat 4 – Atlas III Galaxy XIII – Sea Launch Hellas-sat – Atlas V Insat 3A – Ariane 5 Superbird 6 – Atlas IIAS	Insat 3E – Ariane 5 MBSat – Atlas III Spainsat – Ariane 5 XTAR EUR – TBD	Agrani 2 – Ariane 5 AMC 15 – Ariane 5 Anik F1R – Proton Arabsat 4A – TBD Astra 1KR – TBD Hot Bird 8 – TBD Insat 4A – Ariane 5 Insat 4B – Ariane 5 JCSat 9 – TBD Optus B1R – TBD StarOne C1 – TBD Telstar TBD – TBD
4,200–5,400 kg (9,260–11,905lbm)	8	4	2
	AMC-12 – Proton APStar V – Sea Launch EchoStar 9 – Sea Launch Estrela do Sul – Sea Launch INTELSAT 907 – Ariane 4 Optus C1 – Ariane 5 Rainbow 1 – Atlas V Thuraya 2 – Sea Launch	AMC-13 – Ariane 5 Amazonas – TBD Eutelsat W3A – Proton XM-3 – Sea Launch	Measat 3 – TBD Wildblue 1 – Ariane 5
Over 5,400 kg (>11,905 lbm)	4	6	3
	Anik F2 – Ariane 5 DirecTV 7S – Ariane 5 Intelsat 10 – Proton Satmex 6 – Ariane 5	Inmarsat 4 – Atlas V NSS 8 – Sea Launch Spaceway 1 – Sea Launch Spaceway 2 – Sea Launch Telstar 8 – Sea Launch iPSTAR – Ariane 5	Inmarsat 4 – Ariane 5 Miraxis – TBD Astrolink – TBD

of the satellites launched per year, and the average mass per satellite launched per year.

Figure 9 and Table 7 show the number of transponders launched per year and the average number of transponders per satellite launched. The total number of transponders launched shows a correlation to the number of satellites launched per year while the average number of transponders per satellite correlates with the trend to heavier higher power satellites. In 2002, the total number of transponders launched was more than 17 percent higher than in 1997 even though there were 27 percent more satellites launched in 1997. The average commercial GSO satellite carried almost 39 percent more transponders in 2002 that it did in 1997. Over the 10 year period shown the number of transponders carried per satellite has grown by more than 85 percent.

An analysis of the transponders carried on the satellites projected for launch in 2003 and 2004 indicates that growth in transponders per satellite is continuing. The number of transponders per satellite for 2002 through 2004 averages 49, while the average for the years prior to 2000 is only 30.

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

Figure 8. Forecast Trends in Annual GSO Satellite Mass Distribution

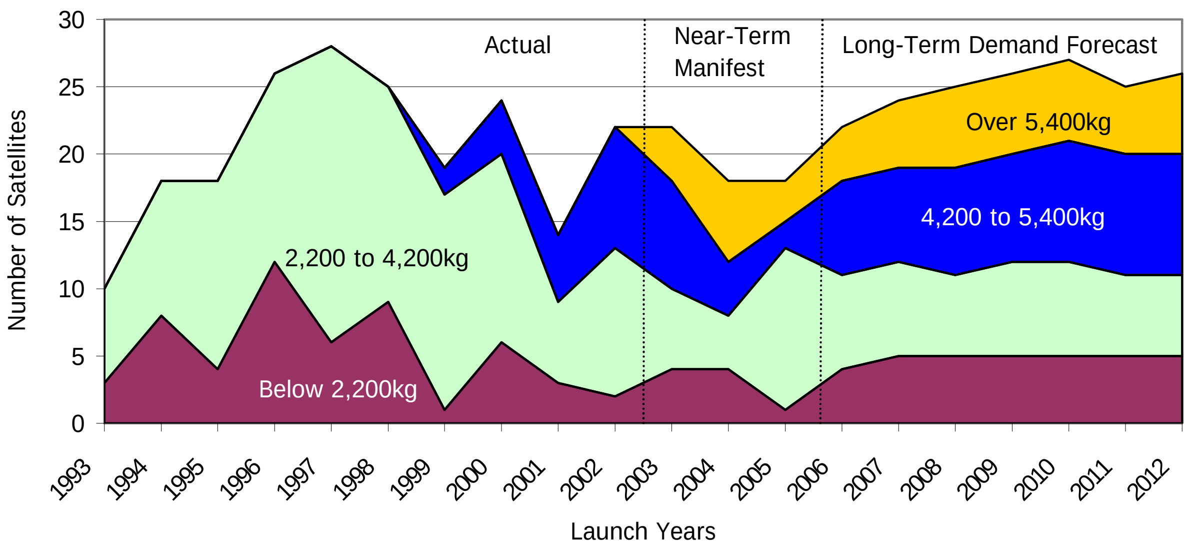


Table 6. Forecast Trends in Satellite Mass Distribution

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total 2003 to 2012	Avg 2003 to 2012	% of Total
Below 2,200 kg (<4,850 lbm)	3	8	4	12	6	9	1	6	3	2	4	4	1	4	5	5	5	5	5	5	43	4.3	18%
2,200 to 4,200 kg (4,850–9,260 lbm)	7	10	14	14	22	16	16	14	6	11	6	4	12	7	7	6	7	7	6	6	68	6.8	29%
4,200 to 5,400 kg (9,260–11,905 lbm)	0	0	0	0	0	0	2	4	5	9	8	4	2	7	7	8	8	9	9	9	71	7.1	30%
Above 5,400 kg (>11,905 lbm)	0	0	0	0	0	0	0	0	0	0	4	6	3	4	5	6	6	6	5	6	51	5.1	22%
Total	**10**	**18**	**18**	**26**	**28**	**25**	**19**	**24**	**14**	**22**	**22**	**18**	**18**	**22**	**24**	**25**	**26**	**27**	**25**	**26**	**233**	**23.3**	

mobile applications because their communication payloads are not easily analyzed in terms of typical C-band and Ku-band transponders. Examples include Inmarsat, Skynet (belonging to the British Ministry of Defence), Thuraya, and XM satellites.

Figure 10 and Table 8 show the total mass launched per year and the average mass per satellite launched. The total mass launched per year also shows a correlation to the number of satellites launched per year while the average mass per satellite again correlates with the trend to heavier higher power satellites. In 2002, the total mass launched was slightly larger than was launched in 1997 even though there were 27 percent more satellites launched in 1997. The average commercial GSO satellite was nearly 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 exceeded 4,000 kilograms.

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

Figure 9. Total C/Ku Transponders Launched and Average C/Ku Transponders per Satellite

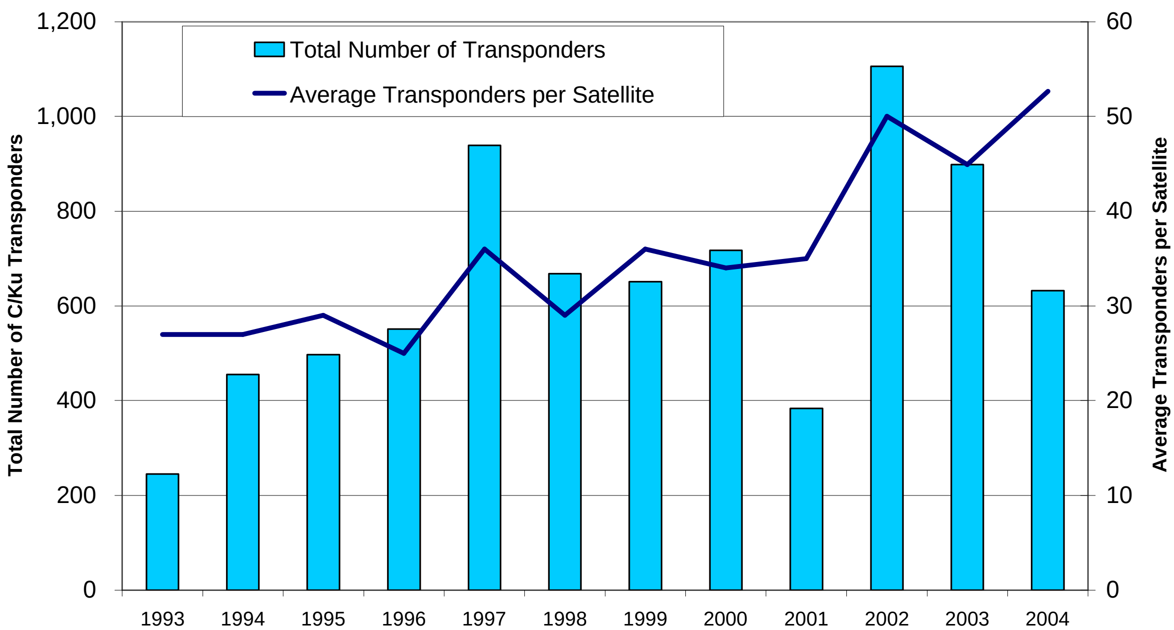


Table 7. Total C/Ku Transponders Launched and Average C/Ku Transponders per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total Number of Transponders	245	455	497	551	939	668	651	717	384	1,106	898	632
Average Transponders per Satellite	27	27	29	25	36	29	36	34	35	50	45	53

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 appears to be slowing. Last year the report forecast that 134 satellites would be launched in the two heaviest mass categories over the period 2003–2011. In this year's forecast, that number has dropped to 107 for the same period, a reduction of more than 20 percent, compared with an overall forecast reduction of 15 percent. In contrast, the number of satellites forecast to be launched in the two lightest mass categories has dropped less than 7 percent, from 107 to 100 over this period.

There are several reasons for this shift, but the most prevalent 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 unsure financial markets and this has forced some operators to scale back capital expenditures and order smaller satellites than they might have otherwise purchased. Limitations on the insurance capacity for commercial satellites are also affecting demand for larger satellites. As the amount of coverage required for a single launch event nears available capacity each additional dollar of coverage costs more on a relative basis. These factors have come together to not only reduce the

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

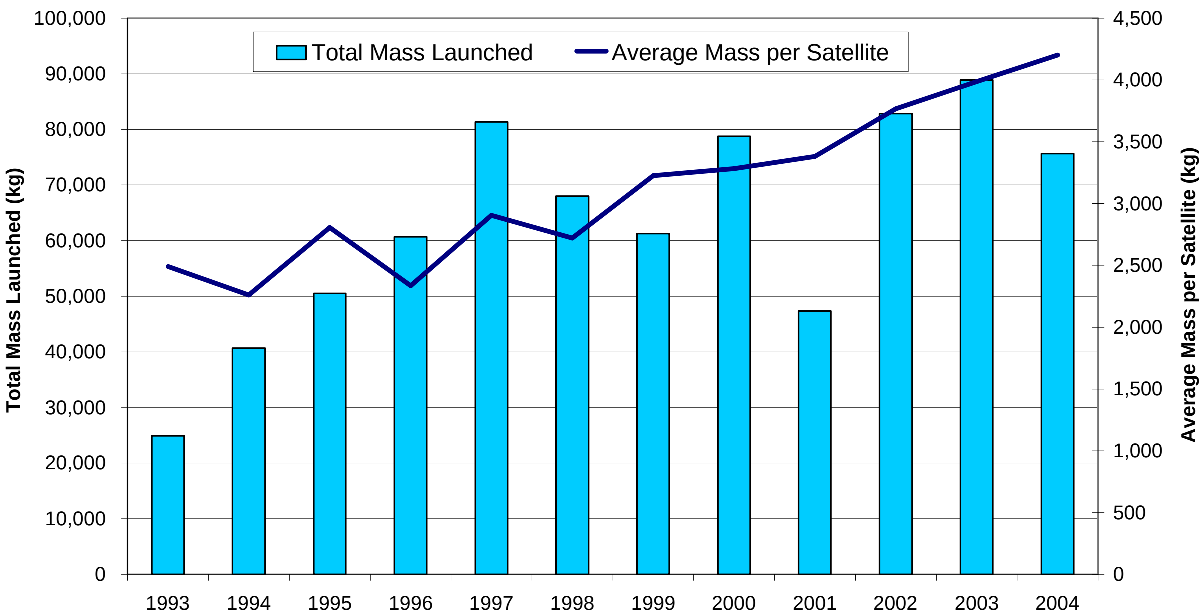


Table 8. Total Satellite Mass Launched and Average Mass per Satellite

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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

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

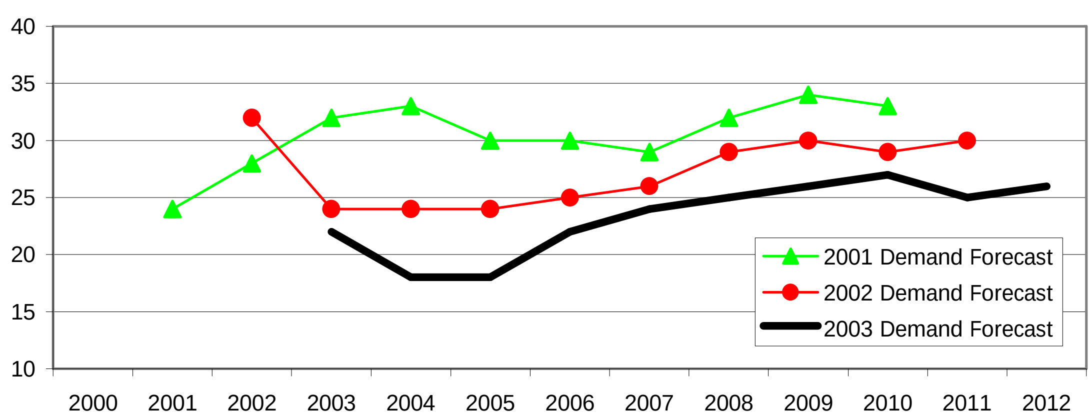
The forecasts of the prior two years are compared to this year's forecast in Figure 11. The 2002 and 2003 forecasts are characterized by a near-term well and long-term stabilization. This effect is particularly prominent in this year's forecast, as a low number of orders of new satellites in 2002 has 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 2003–2012 is 15 percent lower than last year's 10-year forecast average. This year's model has an average demand of 23.3 GSO satellites per year for the period 2003–2012, with a modest increase in the last four years. All three years' forecasts show a general flatness in the 2007–2012 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 2002 report, global and regional economic conditions, and the availability of financing were 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 of this report). The survey confirmed that operator concerns were consistent with the satellite manufacturing and launch industry's perspective, revealing that 66 percent of respondents felts that regional or global economic conditions caused "significant" or "some" reduction or delay in their procurement plans. In addition, 54 percent indicated that the availability of financing 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 expect-

Figure 11. 2001 and 2002 Versus 2003 COMSTAC Mission Model Comparison



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

ed deployment of several new broadband satellite systems. Although projects that were suspended in 2001 such as Astrolink and WildBlue have been reactivated (but with a number of satellites lower 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]

The effects of this strategy can be seen in the orders placed by major operators in recent years. From 1998–2001, PanAmSat ordered 12 satellites, eight of which have already been launched.[3] Another of the world's largest satellite operators, Intelsat, completed the deployment of seven Intelsat IX series satellites in early 2003. Neither Intelsat nor PanAmSat placed any satellite orders in 2002, with Intelsat having placed no orders since 2000. Also, both Intelsat (Intelsat 10-01) and PanAmSat (Galaxy VIIIiR) each cancelled a satellite order in 2002.

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 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.

Launch Vehicle Demand

Since its inception, the COMSTAC mission model has provided commercial launch demand forecasts in terms of the number of GSO satellites to be launched. However, the number of commercial GSO launches is lower than the number of satellites launched due to dual manifesting on launch vehicles. In the fall of 1997, the Working Group decided to estimate the demand for launch vehicles based on the satellite launch forecast because of the dual manifesting of a portion of the satellites. Figure 12 presents the satellite demand forecast described earlier as well as actual values for 1993 through 2002.

To date, only Arianespace has been capable of dual manifesting commercial GSO satellites, and its highest publicly announced launch capability is approximately six flights per year. Historically, some portion of Arianespace's commercial GSO manifest has been launched on a dedicated or single manifest basis. Arianespace will also launch payloads other than commercial GSO satellites that must fit within this launch capacity.

Other launchers capable of dual manifesting may become commercially available in a few years. This would increase oppor-

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

[3]Satellites include: PanAmSat 9 (launched), Galaxy XI (launched), Galaxy XR (launched), PanAmSat 6B (launched), Galaxy IVR (launched), PanAmSat 10 (launched); Galaxy IIIC (launched), Galaxy VIIIiR (cancelled), Galaxy XII (launched), Galaxy VR, Galaxy 1RR, Galaxy XIII.

tunities for customers to fly dual launches, and the Working Group feels that customers may elect to utilize dual manifest services more often as these service become proven, causing the annual number of dual manifested satellites to increase gradually. The predicted number of dual launches takes this into consideration, as well as the mass of available satellites in a given year. Table 9 shows the forecasted number of dual launches and the total launch demand. Figure 12 depicts this information and shows the historical number of single and dual launches.

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 primary issues that will impact satellite demand in the future:

- **Economic conditions**—As noted earlier in the report, poor economic conditions have had a negative effect on the current forecast. Depressed demand for some satellite services and the lack of readily available financing for new ventures have reduced demand for satellites. Improved economic conditions could increase the availability of funding for satellite projects (especially new applications), but it is unlikely that the environment would again support the number

Figure 12. 2003 COMSTAC Launch Demand Forecast

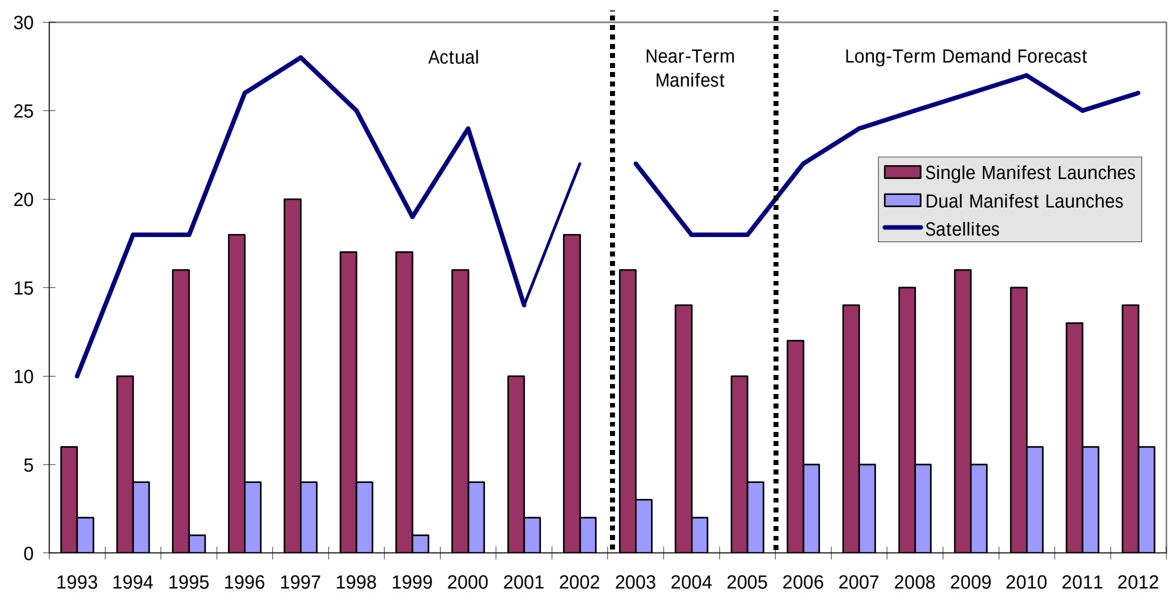


Table 9. COMSTAC Launch Demand Forecast Summary

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total	Average 2003 to 2012
Satellite Demand	22	18	18	22	24	25	26	27	25	26	233	23.3
Dual Launch Forecast	3	2	4	5	5	5	5	6	6	6	47	4.7
Launch Demand Forecast	19	16	14	17	19	20	21	21	19	20	186	18.6

of speculative projects proposed in the late 1990s period. As noted earlier in this report, demand for Ka-band/broadband satellite applications has become impaired by "time to market" concerns versus terrestrial alternatives. Additionally, some of the initiatives as well as future initiatives are potentially threatened by the poor results of various satellite projects. Further or sustained poor economic conditions could produce additional negative pressures on the forecast of satellite demand. The Working Group reminds the reader that projections of future economic conditions have been taken into account in the development of the long-term forecast presented in this report.

- **Future industry consolidation—** Consolidation among satellite operators may also affect future demand for satellites and launch services. In 2001, the combination of SES Astra and GE Americom into SES Global led to the cancellation of at least one satellite that the new combined company found to be redundant. Many in the satellite industry believe that further consolidation is likely. This will potentially affect near-term demand (as any redundancies in the production pipeline are eliminated), and long-term demand (as consolidated companies seek efficiencies in their orbital deployments).

- **Increased satellite lifetimes—**As noted in last year's report, customer preference for 15 years or more of usable lifetime on orbit is now routine. Satellite lifetime requirements are expected to remain at this level, slowing the pace of replenishment, thereby delaying demand.

- **Regulatory environment—**Many observers cite the U.S. Government regulatory environment as the probable cause of a redistribution of market share from domestic to non-U.S. suppliers. The impact is not limited to the actual capture of business, but also to delays in the initiation and execution of programs. The results from this year's survey associated with this report indicate that 33 percent of respondents believed that their "ability to obtain required export licenses" had "some" or "significant" negative impact on their plans to purchase a new satellite. U.S. satellite manufacturers and launch vehicle providers continue to be hampered in meeting the expectations of their international customers due to this environment. In 2000, one satellite contract was cancelled and another satellite was (and remains) in storage pending receipt of a license in order to deliver (APMT and Chinasat 8). In 2002, APT Satellite Company renegotiated the terms of its contract for the APStar V satellite with Loral such that Loral agreed to additional investment in the satellite in exchange for control of 50 percent of the capacity. As part of this agreement, Loral and APT would select a new launch vehicle to replace the Long March vehicle originally selected if an export license could not be obtained by September 30, 2002.[4] In addition, APT ordered an additional satellite from a non-U.S. supplier (Alcatel) to guard against the possibility that APStar V would be delayed.[5]

- **New satellite markets and applications—**Over time, new applications for satellite services may be developed, leading to increased demand for the construction and launch of GSO satellites. Although a prediction of new demand from new satellite applications is included in the development of long-term forecast, additional unpredicted new markets for satellite services may emerge, driving increased demand for satellites and launches. A recent example of a new

[4]Loral Space and Communications Press Release, September 23, 2002.

[5]APT Satellite Holdings Ltd. Press Release, December 11, 2001.

emerging application is the satellite radio market, for which Worldspace and XM Satellite Radio have launched two GSO satellites each.

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 27.3 satellites forecast to be launched per year, on average, to 23.3 is a reflection of the current 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 decrease in forecasted 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.

While the forecasted demand for 2003 is projected to be about the same as actual satellites launched for 2002, a significant number of these satellites and launches were forecasted to have occurred last year. The forecasted demand for 2003 through 2007 averages 21 satellites per year, which is the same as the actual average for the period 1998–2002.

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 1993–1997 period. The average transponders per satellite increases to 49 for the 2002 through 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 a stabilization in the longer term.

Appendix A. Use of the COMSTAC GSO Launch Demand Model

Demand Model Defined

The COMSTAC GSO Launch 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 2003 Mission Model Update named actual satellite programs that were currently manifested on each of the launch providers for 2003. Though 22 satellite programs were named for the year 2003, the industry probably will not execute all corresponding launches in this year. However, the demand on the launch industry for 2003 is for the launch of 22 satellites (19 launches after discounting for dual manifesting).

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 2003 will likely fall in the range of 13 to 18. As described in the "Projecting Actual Launches" section, by examining the historical variance between prediucted demand and actual launches, the Working Group predicts that the actual number of satellites launched will be between 12 and 18 in 2004, and between 10 and 18 in 2005.

As described earlier in this report, future years of the demand forecast beyond 2005 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 2003 survey of industry participants, the Working Group included a supplemental questionnaire for satellite service providers. The questionnaire that follows asked service providers how certain factors are impacting their plans to purchase and launch satellites. The Working Group felt that additional input from the companies who buy and operate commercial satellites was important given the current environment. The Working Group received inputs from the following 15 satellite service providers:

- AirTV
- Asiasat
- Broadcasting Satellite System Corp.
- Eurasiasat
- Loral Skynet
- Mobile Broadcasting Corp.
- Miraxis
- Mobile Satellite Ventures
- PanAmSat
- SingTel Optus
- Satmex
- Space Communications Corp.
- Shin Satellite
- Telesat Canada
- Thuraya Telecommunications

The Working group would like to offer special thanks to these 15 organizations for providing this additional input. While this questionnaire is by no means a scientific instrument from which concrete conclusions can be reached, it does provide some anecdotal insight into factors that are impacting the demand for launching commercial GSO satellites. A summary of the results of this questionnaire is provided on the following page.

Table 10. 2003 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	33%	33%	27%	7%	0%
Demand for satellite services	13%	20%	33%	27%	7%
Ability to compete with terrestrial services	0%	13%	60%	27%	0%
Availability of financing	27%	27%	33%	13%	0%
Availability of affordable insurance	13%	27%	53%	7%	0%
Consolidation of service providers	0%	13%	73%	13%	0%
Increasing satellite life times	0%	27%	67%	7%	0%
Availability of satellite systems that meet your requirements	0%	7%	67%	7%	20%
Reliability of satellite systems	7%	20%	47%	20%	7%
Availability of launch vehicles that meet your requirements	0%	13%	73%	13%	0%
Reliability of launch systems	0%	13%	87%	0%	0%
Ability to obtain required export licenses	20%	13%	53%	13%	0%
Ability to obtain required operating licenses	7%	7%	73%	13%	0%

Appendix C. Letter from the Associate Administrator

U.S. Department of Transportation

Commercial Space Transportation

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

Federal Aviation Administration

Ms./Mr. President
President
XYZ Space Company
1234 Street Address
Anytown, State, Country 12345

Subject: Request for 2003 Launch Demand Model Input

Dear ,

The Office of the Associate Administrator for Commercial Space Transportation (AST) of the Federal Aviation Administration (FAA) commissions an annual update to the Commercial Geosynchronous Orbit Launch Demand Model for geosynchronous satellites. The demand model is developed for the FAA by the Commercial Space Transportation Advisory Committee (COMSTAC). COMSTAC is a chartered industry advisory body that provides recommendations to the FAA on issues that affect the U.S. commercial launch industry. The 2002 demand forecast can be viewed on-line at http://ast.faa.gov/rep_study/forcasts_and_reports.htm.

To support the 2003 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 7, 2003, to ensure that the demand model update is ready for publication in May 2003. 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 at your convenience.

Thank you for your support of this activity.

Sincerely,

Patricia G. Smith
Associate Administrator for Commercial Space Transportation

Enclosures:
(1) 2003 Commercial GSO Mission Model Update Instructions
(2) Satellite Demand Forecast by Payload Mass
(3) COMSTAC 2003 Commercial GSO Launch Demand Questionnaire
(4) COMSTAC Launch Demand Model Report Feedback Form

2003 Commercial GSO Mission Model Update Instructions

As with previous year efforts, the goal for the 2003 COMSTAC Geosynchronous Orbit Launch Demand Model 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 2012. "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, along with those of other satellite services providers, satellite manufacturers, and launch vehicle suppliers will be combined to form a composite view of the demand for launch services through 2012. 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 7, 2003, in order to support our update schedule. Your responses should be sent directly to Mr. Ethan Haase at the following address:

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

Phone: 571-633-7445
Fax: 571-633-7535
Email: ethan.e.haase@lmco.com

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

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					
Demand for satellite services					
Ability to compete with terrestrial services					
Availability of financing					
Availability of affordable insurance					
Consolidation of service providers					
Increasing satellite life times					
Availability of satellite systems that meet your requirements					
Reliability of satellite systems					
Availability of launch vehicles that meet your requirements					
Reliability of launch systems					
Ability to obtain required export licenses					
Ability to obtain required operating licenses					

Additional factors which have impacted your company's plans:

Any other comments you would like to include:

Appendix D. Historical Launches

Figure 13 plots the total number of GSO satellites launched during the past ten years, 1993 through 2002. 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 approximately 50 percent national military spacecraft (e.g., communications, data relay, early warning), approximately 25 percent civil spacecraft (e.g., meteorology, tracking, advance communications experiments), and approximately 25 percent national telecommunications services spacecraft (e.g., domestic TV broadcasting, banking, government services' communications).

Tables 11 and 12 presents the historical addressable commercial spacecraft launched during the past 10 years, 1993 through 2002. The chart also notes which missions were flown on a dual-manifested launch and the resulting total number of launches in each year. Please note that the 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

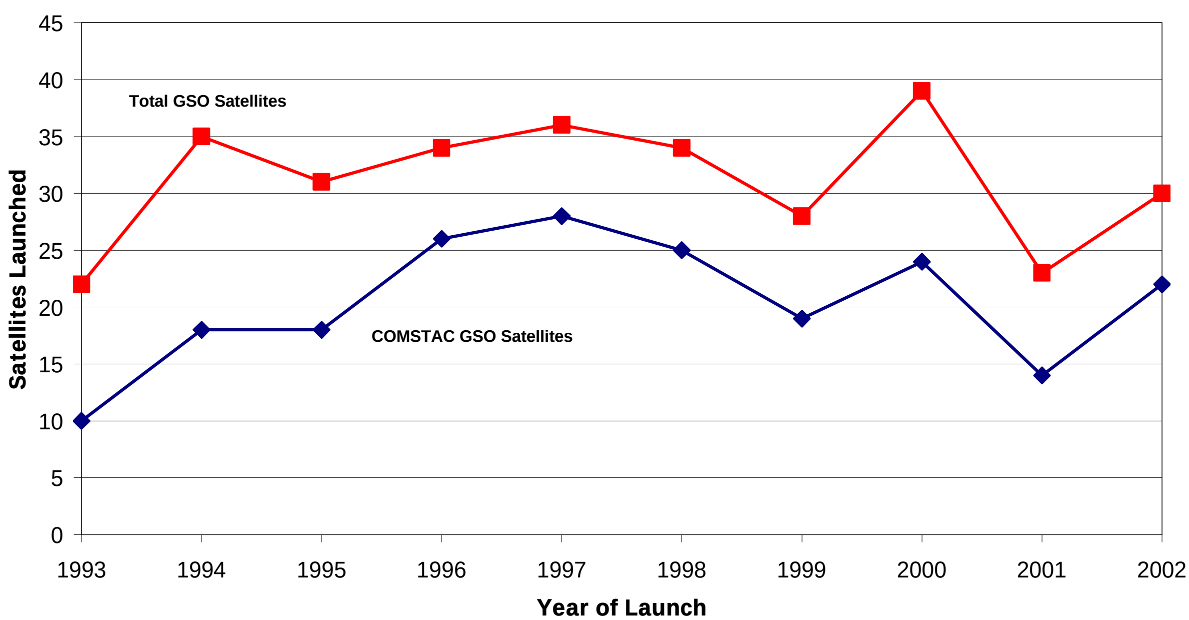


Table 11. 1993–1997 COMSTAC GSO Commercial Satellites

	1993	1994	1995	1996	1997
Total Launches	8	14	17	22	24
Total Satellites	10	18	18	26	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	12	6

1993

Mass Class	DM	Satellite	Launch Vehicle
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

Mass Class	DM	Satellite	Launch Vehicle
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 (Launch Failure)	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 (Launch Failure)	Ariane 44LP
	DM4	Thaicom 2	Ariane 44L
	DM1	TurkSat 1A (Launch Failure)	Ariane 44LP
	DM3	TurkSat 1B	Ariane 44LP
		Galaxy 1RS	Delta II
		APStar 1	Long March 3

1995

Mass Class	DM	Satellite	Launch Vehicle
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 (Launch Failure)	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

Mass Class	DM	Satellite	Launch Vehicle
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 (Launch Failure)	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
		Chinasat 7 (Launch Failure)	Long March 3
		Inmarsat 3F2	Proton K/DM

1997

Mass Class	DM	Satellite	Launch Vehicle
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 (Launch Failure)	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

☐ = Launch Failure

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

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

Table 12. 1998–2002 COMSTAC GSO Commercial Satellites

	1998	1999	2000	2001	2002
Total Launches	21	18	20	12	20
Total Satellites	25	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
2,200 - 4,200 kg (4,850 - 9,260 lbm)	16	16	14	6	11
Below 2,200 kg (<4,850 lbm)	9	1	6	3	2

1998

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

1999

Class	DM	Satellite	Launch Vehicle
4,200 - 5,400 kg (9,260 - 11,905 lbm)		Galaxy 11	Ariane 44L
		☐ Orion 3	Delta III
2,200 - 4,200 kg (4,850 - 9,260 lbm)		AMC 4	Ariane 44L
	DM1	Arabsat 3A	Ariane 44L
		Insat 2E	Ariane 42P
		Koreasat 3	Ariane 42P
		Orion 2	Ariane 44LP
		Telkom	Ariane 42P
		Telstar 7	Ariane 44LP
		Echostar V	Atlas IIAS
		Eutelsat W3	Atlas IIAS
		JCSat 6	Atlas IIAS
		Asiasat 3S	Proton K/DM
		Astra 1H	Proton K/DM
		LMI 1	Proton K/DM
		Nimiq	Proton K/DM
		Telstar 6	Proton K/DM
		DirecTV 1R	Sea Launch
Below 2,200 kg (<4,850 lbm)	DM1	Skynet 4E	Ariane 44L

2000

Class	DM	Satellite	Launch Vehicle
4,200 - 5,400 kg (9,260 - 11,905 lbm)		Anik F1	Ariane 44L
		PAS 1R	Ariane 5G
		Garuda 1	Proton K/DM
		Thuraya 1	Sea Launch
2,200 - 4,200 kg (4,850 - 9,260 lbm)	DM1	Asiastar 1	Ariane 5G
	DM3	Astra 2B	Ariane 5G
		Europe*Star 1	Ariane 44LP
		Eutelsat W1R	Ariane 44P
		Galaxy 10R	Ariane 42L
		Galaxy IVR	Ariane 42L
		N-Sat-110	Ariane 42L
		Superbird 4	Ariane 44LP
		Echostar VI	Atlas IIAS
		Eutelsat W4	Atlas IIIA
		Hispasat 1C	Atlas IIAS
		AAP 1	Proton K/DM
		AMC 6	Proton K/DM
		PAS 9	Sea Launch
Below 2,200 kg (<4,850 lbm)	DM3	AMC 7	Ariane 5G
	DM4	AMC 8	Ariane 5G
	DM4	Astra 2D	Ariane 5G
	DM2	Brazilsat B4	Ariane 44LP
	DM1	Insat 3B	Ariane 5G
	DM2	Nilesat 102	Ariane 44LP

2001

Class	DM	Satellite	Launch Vehicle
4,200 - 5,400 kg (9,260 - 11,905 lbm)		DirecTV 4S	Ariane 44LP
		Intelsat 901	Ariane 44L
		Intelsat 902	Ariane 44L
		XM Rock	Sea Launch
		XM Roll	Sea Launch
2,200 - 4,200 kg (4,850 - 9,260 lbm)	DM2	☐ Artemis	Ariane 5G
		Atlantic Bird 2	Ariane 44P
	DM1	Eurobird	Ariane 5G
		Turksat 2A	Ariane 44P
		Astra 2C	Proton K/DM
		PAS 10	Proton K/DM
Below 2,200 kg (<4,850 lbm)	DM1	BSat 2A	Ariane 5G
	DM2	☐ BSat 2B	Ariane 5G
	DMN	Skynet 4F	Ariane 44L

2002

Class	DM	Satellite	Launch Vehicle
4,200 - 5,400 kg (9,260 - 11,905 lbm)		Intelsat 904	Ariane 44L
		Intelsat 905	Ariane 44L
		Intelsat 906	Ariane 44L
		NSS-6	Ariane 44L
		NSS-7	Ariane 44L
		☐ Astra 1K	Proton K/DM
		Echostar 8	Proton K/DM
		Intelsat 903	Proton K/DM
		Galaxy IIIC	Sea Launch
2,200 - 4,200 kg (4,850 - 9,260 lbm)	DMN	Atlantic Bird 1	Ariane 5G
	DMN	☐ Hotbird 7	Ariane 5ECA
		Insat 3C	Ariane 42L
	DM1	JCSat 8	Ariane 44L
	DM2	Stellat 5	Ariane 5G
		Echostar 7	Atlas IIIB
		Hispasat 1D	Atlas IIAS
		Hotbird 6	Atlas V 401
		Eutelsat W5	Delta IV M+ (4,2)
		DirecTV 5	Proton K/DM
		Nimiq 2	Proton M/M
Below 2,200 kg (<4,850 lbm)	DM1	Astra 3A	Ariane 44L
	DM2	N-Star c	Ariane 5G

☐ = Launch Failure

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

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

2003 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits

Executive Summary

Each year, the Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (FAA/AST) prepares an assessment of the non-geosynchronous commercial satellite launch market for the purpose of projecting demand for future commercial launches. The *2003 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits* projects a total of 51 launches during the next 10 years. This is a 19 percent decrease in demand for commercial launches compared to last year's forecast.

The non-geosynchronous orbit (NGSO) market has shifted away from the telecommunications sector to a smaller market comprised of international science and commercial remote sensing satellites. Several of these are small payloads that are launching in groups aboard low-priced Russian launch vehicles. As a result, while the number of satellites in the 2003 forecast is about the same as the 2002 forecast, launch demand has decreased.

In previous years, the NGSO forecast has presented "baseline" and "robust" market scenarios. With the indefinite postponement or cancellation of many of the proposed NGSO telecommunications constellations, the remaining market can best be characterized using a single forecast scenario. Therefore, this year's report only presents a baseline scenario.

Baseline Scenario: FAA/AST is forecasting an average of 5 launches per year during 2003–2012. This includes about two launches per year for medium-to-heavy launch vehicles and about three launches per year for small vehicles.

Launches throughout the forecast are divided into the following sectors:

- 35 launches for international science and other satellites and
- 16 launches for commercial remote sensing satellites.

For those 51 launches, there are a total of 80 satellites forecast during 2003–2012. This total is virtually unchanged from last year's forecast of 79 satellites. Within the satellite demand total, the decrease in the number of telecommunications satellites this year was offset by an increase in science satellites scheduled for launch later in the forecast. 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. Seventy percent of the satellites scheduled to launch during 2003–2006 weigh less than 600 kilograms (1,322 pounds).

About 75 percent of the payload market is comprised of international science and other satellites (such as technology demonstrations) while the remaining 25 percent are satellites that will provide commercial remote sensing services. There are no telecommunications satellites in the forecast period for the first time since FAA/AST began forecasting in 1994. However, market conditions could change and telecommunications could return to the forecast next year.

During 2002, there were four commercial launches to NGSO worldwide, the same amount as in 2001. FAA/AST is estimating an increase to seven commercial launches in 2003. The NGSO market peaked in 1998 and 1999 when the number of commercial launches reached 19 and 18, respectively.

Introduction

Following a remarkable surge of launch activity during 1997–1999, the NGSO market collapsed with the business failures of new mobile satellite systems. These failures were mainly attributed to significant shortfalls in the number of customers needed to generate sufficient revenues to pay back initial investments. Bankruptcies of Iridium, ICO Global, Globalstar, and ORBCOMM, coupled with the end of U.S. economic expansion, have caused many investors to lose confidence in future low Earth orbit (LEO) telecommunications ventures. Contrary to popular expectations, no high data-rate or “broadband” satellite constellations materialized. The current market is made up of international science and commercial remote sensing satellites, with about 75 percent of the payload owners/operators located outside the United States. The majority of payloads owned or operated in the United States are for commercial remote sensing. The average of five launches per year projected during 2003–2012 is higher than the one to two launches per year during 1993–1996, prior to the telecommunications surge.

International science satellites continue to have a steady rate of activity. The science market is largely made up of nations with fledgling space programs without a domestic launch provider or satellite owners seeking lower launch prices unavailable in their home countries. The first two interplanetary missions (to the Moon and Mars) for which launch services were competed internationally are scheduled to launch during 2003. Growing interest in commercial remote sensing capabilities from government, natural resources, and agricultural customers continues to enable the development of new and follow-on systems for remote sensing satellites.

Although second-generation telecommunications systems are not included in the forecast at this time due to uncertainties that current revenues will be sufficient to make a business case for future deployments, the new owners of Iridium and ORBCOMM continue to operate their existing satellite constellations successfully. Globalstar also continues operations and plans to emerge from bankruptcy by the end of 2003. Any new telecommunications entrants must compete with existing systems (both on the ground and from geosynchronous orbit, or GSO) and decreasing user prices already being offered by debt-free NGSO operating companies. Considering the health of orbiting systems and their constellation lifespan, it may be four to six years before follow-on systems enter design phases leading to possible replacement launches.

Regardless of the difficulties experienced by deployed NGSO systems thus far, companies are still seeking financial support to deploy new telecommunications systems. New Federal Communications Commission (FCC) guidelines released in 2003 are intended to accelerate the process for awarding licenses for new satellite systems. For example, some companies waited 10 years from when they first approached the FCC until they received a license for a 2-GHz satellite system. The goal of the new process is to award NGSO licenses in less than 270 days. On the other hand, some critics contend that the new FCC process, which now requires a $5- to $7.5-million bond, will discourage entrepreneurs from developing new applications.

Table 13. Commercially Competed Launches

	NGSO	GSO	**Total**
1996	2	22	**24**
1997	13	24	**37**
1998	19	21	**40**
1999	18	18	**36**
2000	9	20	**29**
2001	4	12	**16**
2002	4	20	**24**
2003 est.	7	19	**26**

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

To assess demand for international commercial launch services resulting from 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/AST'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 would 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.

Previous FAA/AST forecasts included a robust market scenario representing expanded conditions for more systems beyond the baseline. Because of delays or cancellation of many of the proposed telecommunications systems, this year's forecast does not include a robust scenario.

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. International governments and research organizations typically launch small spacecraft to conduct scientific research and technology demonstration missions, primarily in LEO. 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 Germany, Italy, Malaysia, Saudi Arabia, and Sweden. 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. These satellites are similar to commercial remote sensing satellites in terms of technology, but generally operate at lower resolutions. Also, the imagery products generated from these satellites are usually offered for free or at cost. An example of these 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, 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, are scheduled to be launched commercially on a Russian Cosmos in 2003.

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. Examples of these missions include the Detection of Electro-Magnetic Emissions

Transmitted from Earthquake Regions (DEMETER) mission by the French space agency CNES, scheduled for launch in 2004 on a Dnepr booster; and the European Space Agency's Mars Express orbiter and British Beagle 2 Mars lander, which will be launched commercially on a Soyuz booster provided by Starsem in June 2003.

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 2003 on a submarine-launched Volna booster. The Space Environment Reliability Verification Integrated System-1 (SERVIS-1) satellite, built by Japan's Institute for Unmanned Space Experiment Free Flyer, will test the ability of commercial off-the-shelf electronics and other technologies to operate in the space environment. SERVIS-1 is scheduled for launch in 2003 on a Rockot, provided by Eurockot Launch Services.

DIGITAL AUDIO RADIO SERVICES

Sirius Satellite Radio (formerly CD Radio) launched three satellites to ELI in 2000 and rolled out service in 2002. Its main U.S. rival, XM Satellite, operates two satellites in GSO. Strong subscriber growth in these services has generated interest in DARS in other regions, most notably Europe. In 2002, Global Radio, based in Luxembourg, announced that it planned to begin service in Europe in 2005 using satellites in ELI. However, the company filed for bankruptcy in 2003 before it started to build its system. While it is possible that future ventures may attempt to provide DARS service in Europe or elsewhere, no systems have been announced, and given the uncertainty over whether future systems would use NGSO or GSO satellites, no DARS systems are included in the 2003 forecast.

MARKET DEMAND SCENARIOS

FAA/AST projects that approximately 60 satellites of the international science or other category will be launched under the baseline scenario. These payloads will be deployed on 35 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

The remote sensing industry consists of four parts: aerial imagery, ground systems, value-added products (often called geographic information services, or GIS), and commercial satellite remote sensing—a small part of the industry—addressed here. Total sales for all sectors of the U.S. remote sensing industry were estimated by the American Society for Photogrammetry and Remote Sensing to be around $2 billion in 2001. Worldwide sales of raw satellite remote sensing imagery generated an estimated $200 million in revenues for 2001, with a projected revenue total approaching $550 million by 2010.

Commercial remote sensing operators have recognized higher customer demand for integrated information systems, so operators have negotiated partnerships in an effort to provide, through product cross-fertilization, customized GIS tools for a variety of applications. Because of this trend, the market is evolving to become more about customized value-added services and less about how the images are acquired, a largely irrelevant issue from the customer's point of view.

Demand for commercial satellite imagery is difficult to forecast because, unlike telecommunications, demand for services cannot be directly linked to the number of satellites. This is due to the resale of imagery, the wide variety of imagery types requiring different suites of sensors, and the difficulty in defining the market for value-added products. The following companies are developing commercial remote sensing satellites.

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. While DigitalGlobe has not announced plans for follow-on satellites, it is assumed that a replacement for QuickBird will be launched in 2006, shortly before the end of QuickBird's design life.

In January 2003, the National Imagery and Mapping Agency (NIMA) 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. The contract enables NIMA to use commercial satellite imagery across a broad spectrum of value-added applications. Space Imaging was also awarded a similar contract. The contract is for three years and is dependent on availability of funds.

In March 2002, DigitalGlobe won one of two study contracts under the Landsat Data Continuity Mission (LDCM), a program established by the National Aeronautics and Space Administration (NASA) to identify and enable a commercial remote satellite system to operate in lieu of a government-funded Landsat-8 program. However, in March 2003, DigitalGlobe concluded that the structure of the NASA contract contained too much risk and decided not to pursue the project any further, leaving Resource21 as the sole potential bidder for a Landsat Follow-On. Instead, DigitalGlobe is studying potential markets and technical requirements for a commercial high-resolution follow-on satellite to QuickBird.

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 three shareholders are Israel Aircraft Industries, Electro Optics Industries, and Core Software Technology. ImageSat currently operates only one satellite, EROS A1, which was launched from Russia in the winter of 2000. It is to be followed by the EROS-B series, consisting of four satellites, with the initial launch of EROS B1 expected in 2004. All the satellites have a standard resolution of 1.8 meters, but can be programmed to obtain images with resolution less than a meter.

InfoTerra GmbH

InfoTerra GmbH, a subsidiary of Astrium, recently entered the commercial satellite remote sensing industry with the introduction of the TerraSAR program. Deutschen Zentrum für Luft- und Raumfahrt (DLR, the German Aerospace Center) selected Astrium to jointly develop the 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. Both TerraSAR X and TerraSAR L will launch on a Dnepr sometime in 2005. InfoTerra GmbH will be responsible for commercial operations, while DLR will oversee science operations.

ORBIMAGE

ORBIMAGE, the first company to operate a commercial remote sensing satellite (OrbView 1, launched in 1995), filed for bankruptcy in April 2002. In January 2003, ORBIMAGE signed a non-binding

Table 14. 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 B1-B4	280 (617) 350 (771)	1.5 1.5	2000 2004	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 2006	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 and 2 continue to operate. OrbView 4 lost due to launch vehicle failure.
QuickBird	DigitalGlobe	Ball Aerospace	QuickBird 1 QuickBird QuickBird Follow-On	815 (1797) 909 (2004) TBA	1 0.6 0.5	2000 2001 2006	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 2005 2007	Radarsat 1 continues to operate. Radarsat 3 will launch "a few years after Radarsat 2" and will work in tandem.
Development and Proposed							
RapidEye	RapidEye AG	MacDonald, Dettwiler and Associates	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) TBA	1	2005	TerraSAR X will provide commercial imagery, TerraSAR L appears largely restricted to government applications.
RS	Resource21	Boeing	RS 1	1,200 (2,646)	10	2006	Will proceed with program regardless of LDCM status.
Landsat Follow On	TBD	TBD	TBD	TBD	TBD	TBD	Phase One Landsat Data Continuity Mission contract awarded to DigitalGlobe and Resource21. DigitalGlobe has concluded it will not pursue LDCM.
TrailBlazer	TransOrbital	TransOrbital	TrailBlazer	420 (926)	1	2003	TrailBlazer will conduct remote sensing of the Moon in 1-meter resolution, but requires NOAA license to image the Earth from a distance.

Table 15. Commercial Satellite Remote Sensing Licenses

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

*Source: NOAA

agreement with an official committee of its unsecured creditors and Orbital Sciences Corporation (OSC) to facilitate ORBIMAGE's emergence from Chapter 11. Under the agreement, ORBIMAGE will end its pending litigation with OSC in exchange for additional working capital. However, the settlement is contingent on the successful launch of OrbView 3, scheduled for launch on a Pegasus XL in June 2003.

OrbView 1, launched in 1995, and OrbView 2, launched in 1997, continue to operate, providing images with 10-kilometer and 1.1-kilometer resolution, respectively. OrbView 3, delayed due to technical problems, will provide 1-meter resolution panchromatic and 4-meter resolution multispectral imagery. ORBIMAGE is also the exclusive U.S. distributor of worldwide imagery from the Canadian RADARSAT-2 satellite, planned for launch in 2004. OrbView 4 was lost due to a launch failure in 2001. It is unclear what ORBIMAGE plans as a follow-on system.

Radarsat International

Radarsat International, formed in 1989 to operate Radarsat 1, is now a subsidiary of MacDonald, Dettwiler and Associates (MDA). Both companies are based in Canada. Radarsat 1, launched in 1995 aboard a Delta 2, has gathered radar data covering most of Earth and provides radar imagery with resolutions between 8 and 100 meters. Radarsat 2, planned for launch in 2005, will continue the mission of its predecessor, and may work in tandem with Radarsat 3, which is currently in development. Despite substantial support from the Canadian Space Agency (CSA) in the beginning, Radarsat and its ground support infrastructure are now 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. MDA's Radarsat International and U.S.-based EarthSat will provide much of the product development and customer service. The satellites, each with a resolution of 6.5 meters, are expected to be launched together in 2006.

Resource21

Resource21 was established by Boeing, BAE Systems, Farmland, and the Institute for Technology Development. It intends to provide information services to customers in the agriculture, national security, and science application sectors. Like DigitalGlobe, Resource21 was awarded a $5-million study contract under the LDCM in March 2002. Resource21 has not yet announced the results of its work. Resource21 has always focused on providing imagery to support the agricultural industry, so the LDCM requirements may complement the company's business plan. While its satellite plans apparently remain in the conceptual stage, Resource21 has announced that it will develop and launch at least one LEO satellite with 10-meter resolution, regardless of how the LDCM program unfolds.

Space Imaging

Space Imaging, founded in 1994 and based near Denver, Colorado, provides high-resolution satellite imagery from its IKONOS satellite to government and commercial customers around the globe. 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, and in October 2002, the company applied for a license to own and operate a commercial imaging satellite that would have a ground resolution of 0.25 meters. The company's next-generation satellite, currently referred to as Block 2, is tentatively planned for launch in 2006. 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 60-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.

NIMA awarded Space Imaging with a multi-year satellite-imagery capacity contract in January 2003. Under the terms of the contract, NIMA would acquire 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.

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 Winter 2002, TransOrbital is now poised to launch its flagship, TrailBlazer.

TrailBlazer, which is planned for launch in late 2003 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 1 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 20 payloads throughout the forecast period, with a peak in 2006 due to replacement cycles and the launch of five RapidEye satellites.

"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 16.

Recent Developments

ORBCOMM is actively pursuing a follow-on constellation and could award a satellite construction contract in the first half of 2004. The physical characteristics of the satellites will depend on the vendor awarded the contract. The current plan is to begin replenishment launches in 2006. As of Spring 2003, the worldwide messaging system had approximately 50,000 subscribers active on their network. The ORBCOMM constellation is comprised of 35 satellites 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, currently operates ORBCOMM. Most of the satellites were launched between 1997 and 1999. Whether or not ORBCOMM will be able to fund a follow-on system is unclear at this time.

Other potential providers of low-data-rate satellite services have struggled to gain necessary funding and face FCC milestones to retain their licenses initially granted in 1998. These companies include Final Analysis (the company has restructured after filing for Chapter 7 bankruptcy in September 2001), Leo One, and E-SAT (the FCC declared its license null and void in April 2003).

Some Little LEO satellite systems are so small that they do not necessarily generate launch demand. One such system is being deployed by Aprize Satellite, Inc. 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 on Dnepr in May 2004 and two more in October 2004. A constellation with 48 satellites is planned by Aprize, depending on customer demand for additional data-communication capacity and frequency of contact.

COMPETITION

Proponents believe that the data messaging market is big enough for several providers with specialized niches and different data rates and/or real versus delay timing. However, competition comes from many providers on the ground and from existing Big LEO systems as well as GSO satellites.

"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 a few years yet before they would require replacement satellites. Big LEO systems are detailed in Table 17.

GLOBALSTAR

In April 2003, U.S. bankruptcy court approved the sale of Globalstar's assets to a new company controlled by ICO Global Communications. ICO paid $55 million in exchange for a 54 percent majority equity interest of Globalstar and gains access to more than 77,000 subscribers. Globalstar hopes to emerge from bankruptcy by the end of 2003. The move gives ICO an existing system where it could enhance

Table 16. FCC-Licensed Little LEO Systems

System	Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
			Number + Spares	Mass kg (lbm)			
Operational							
ORBCOMM	ORBCOMM Global LP	Orbital	48	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							
FAISat	Final Analysis	Final Analysis	26 + 6	151 (332)	LEO	TBD	FCC licensed, March 1998. Two test satellites launched in 1995 and 1997. Company filed a petition for a waiver of its FCC-mandated deployment milestones in March 2002.
Leo One Worldwide	LEO One USA	Dornier	48	125 (275)	LEO	TBD	FCC licensed, February 1998. Company filed a petition for a two-year extension of its FCC-mandated deployment milestones in February 2002.
E-Sat	E-Sat, Inc.	Alcatel	6	113 (250)	LEO	TBD	FCC licensed, March 1998. Company filed a petition for a two-year extension of its FCC-mandated deployment milestones in March 2002. FCC denied petition and revoked license in April 2003.

service by installing ground signal repeaters (also known as ancillary terrestrial component, or ATC).

Globalstar declared Chapter 11 bankruptcy in February 2002 after $4 billion was spent and customer growth did not meet expectations after operations began in September 1999. Globalstar has reported three satellite failures (out of 48 satellites) in the operational constellation as of April 2002. Eight completed satellites are in ground storage. A contract to launch those satellites, if necessary, on Delta II launch vehicles was canceled in Fall 2002, forcing Globalstar to lose its deposit. 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 10 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 continues to express commitment to proceed with its own network. A controlling interest in Globalstar allows the company to explore the voice and data market further. ICO plans to offer medium-rate wireless Internet access (up to 144 kilobits per second) in addition to voice service. This is higher than the speeds available through Globalstar.

The first ICO satellite was lost in a Sea Launch vehicle failure in March 2000. Another satellite launch on an Atlas IIAS 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 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 net-

Table 17. FCC-Licensed Big LEO Systems

System	Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
			Number + Spares	Mass kg (lbm)			
Operational							
Globalstar	Globalstar LP	Alenia Spazio	48 + 8	447 (985)	LEO	1998	Constellation on-orbit and operational; FCC licensed, January 1995. Company filed for Chapter 11 bankruptcy protection in February 2002; ICO acquired a majority interest in the company in April 2003.
Iridium	Iridium Satellite LLC	Motorola	66 + 14	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	10 + 2	2,744 (6,050)	MEO	2000	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.
Proposed							
2.0 GHz							
ECCO II	Constellation Communications	TBD	46 + TBD	585 (1,290)	LEO	TBD	FCC license granted July 17, 2001. FCC revoked license in January 2003 when company failed to meet satellite construction contract milestone; company is appealing the decision.
Ellipso 2G	Mobile Comm. Holdings (MCHI)	TBD	26 + TBD	1,315 (2,900)	LEO & ELI	TBD	FCC license granted July 17, 2001. FCC revoked license in January 2003 when company failed to meet satellite construction contract milestone; company is appealing the decision.
Globalstar GS-2	Globalstar LP	TBD	64 + 4	830 (1,830)	LEO[1]	TBD	FCC license granted July 17, 2001. FCC revoked license in January 2003 when company failed to meet satellite construction contract milestone; company is appealing the decision.
Iridium/Macrocell	Iridium Satellite LLC	TBD	96 + TBD	1,712 (3,775)	LEO	TBD	FCC license granted July 17, 2001. Valid satellite construction contract submitted in July 2002.

(1) Globalstar GS-2 also requested authority to operate 4 GEO satellites in conjunction with the LEO.

work owner. A similar group also invested in Teledesic. The FCC license for 2 GHz requires the first two satellites to be launched by January 2005. There are two completed satellites in storage and construction on an additional eight is nearly complete.

IRIDIUM

In 2002, Iridium Satellite successfully launched seven spare satellites: five by Delta 2 and two by Russia's Rockot. The system could last until 2014, much longer than initially advertised. As a result, Iridium Satellite may not have to begin planning for a follow-on system until 2007 or 2008, assuming it could obtain funding to design, build, and launch a new system. In the meantime, the company could break even during 2003 and show a profit in 2004. 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 80 satellites (14 satellites are orbiting spares). A total of 95 satellites have been launched. Two partially assembled satellites are available for launch if needed although buyers have been sought for these satellites.

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.

"Broadband LEO" Systems

While satellites do not have sufficient bandwidth to service the entire broadband user population, they are playing a growing role in the delivery of high data-rate information. Satellites can provide service to unwired urban areas and can also reach remote customers that conventional landline services may not even attempt to access. In some cases, satellites and landlines are complementary, using each other as conduits to reach end users.

Currently there are no NGSO systems delivering broadband services. There are several GSO transponders serving data roles between gateways and internet service providers (ISPs) and more operators plan to include broadband capabilities in future plans with the first of a few new, dedicated GSO broadband satellites scheduled to launch in 2004.

High start-up costs of $4–10 billion or more have slowed NGSO broadband development. Another challenge faced by NGSO systems (and not just broadband) is rapid change of communications technology; by the time a space system is designed

Table 18. FCC-Licensed Broadband LEO Systems

System	Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
			Number + Spares	Mass kg (lbm)			
Under Development							
Ka-Band							
Teledesic	Teledesic LLC	Alenia Spazio[1]	30 + 3	1,000 (2,205) and 3,455 (7,617)	MEO	TBD[2]	FCC licensed, March 1997; license amended January 1999 for 288-sat system; firm milestones assigned by FCC in January 2001. Application to amend system to 30 sats filed with FCC February 2002. Teledesic suspended initial satellite construction contract with Alena Spazio in September 2002.

(1) Alenia Spazio was only contracted for the first two satellites in constellation.

(2) Teledesic launched the T-1 experimental satellite in February 1998.

and orbited, it may be obsolete or the consumer/business market may have shifted away from it. More than 20 applications involving broadband satellites in NGSO and GSO systems have been submitted to the FCC.

Recent Developments

Teledesic announced in September 2002 that it had suspended work on satellite construction and had reduced its staff significantly. The company stated it could not envision returns to shareholders that were commensurate with the risk. Teledesic was first formed in 1990 and went from systems of 840 satellites, to 288, and then to 30 satellites. The company spent hundreds of millions of dollars on developing broadband systems and retains a significant allocation of spectrum. There is a September 2004 "bring into use" deadline for its ITU spectrum.

Future Markets

The sharp decline of the telecommunications market in recent years has raised the question of what new markets, if any, will stimulate demand for 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. Other paying passengers are negotiating for rides, and studies have shown that enough of a business market exists, even at high prices. In the wake of the Columbia accident, future space tourist flights on Soyuz missions have been suspended and are not expected to resume until after the Space Shuttle returns to flight.

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. A viable public space travel market may require the right space vehicle. The next few years could see new vehicles emerge as attempts to win the $10 million X Prize, a contest to launch a reusable vehicle carrying up to three passengers to 100 kilometers (62 miles) altitude—a suborbital trajectory—twice within 14 days. Since this report only includes commercial missions to NGSO, new vehicles associated with the X Prize would likely not be included in the forecast. Several other small firms are developing vehicles for LEO markets. At this time, the public space travel market is still maturing but could be included in future NGSO reports. It is uncertain if other markets, such as space-based manufacturing, on-orbit resupply, or orbiting hotels, will emerge with associated launch demand by 2012.

Risk Factors That Affect 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. These situations are no longer present. 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.

- **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. Or there could 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 systems 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, security concerns with the export of space technology, and political relations between countries can all affect demand. For example, in April 2003, the FCC adopted a new licensing process to speed things up and put pressure on companies that are not making progress towards launching satellites. The new process includes shorter waiting periods to receive a license (270 days or less turnaround for NGSO applicants) and a requirement for companies to post a $5- to $7.5-million bond within 30 days of receiving a license.

- **Terrestrial competition**—As seen with Big LEO mobile communications, the customer market for long-developing space systems may be overtaken by more effective technology (e.g., cellular telephones) on the ground. Broadband satellites face fiber-optic competition, much of it installed in urban areas over the past five years. 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, in some cases, 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.

- **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, DoD has funded the continuation of Iridium service, purchased commercial remote sensing data, and purchased excess capacity on communications satellites. NASA has also purchased science data such as with OrbView 2.

- **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 (see Table 19) were used in the model while future years were estimated based on historical activity.

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 orbits between LEO and GSO; and
- Elliptical orbits (ELI, also known as highly-elliptical orbits (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.
- 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

Table 19. Near-Term NGSO Satellite Manifest

Service Type	2003	2004	2005	2006
Commercial Remote Sensing	OrbView 3 - Pegasus XL TrailBlazer - Dnepr	EROS B1 - START 1	TerraSar X - Dnepr Radarsat 2 - Delta 2	Ikonos Follow On - TBD QuickBird Follow On - TBD Landsat Follow On - TBD EROS B2 - START 1 RapidEye 1 - TBD RapidEye 2 - TBD RapidEye 3 - TBD RapidEye 4 - TBD RapidEye 5 - TBD
International Science	Mars Express - Soyuz Beagle 2 - Soyuz Nigeriasat - Cosmos BNSCSat - Cosmos BilSat - Cosmos Rocsat 2 - Taurus Cosmos 1 - Volna SERVIS 1 - Rockot	China TBD - Cosmos Topsat - Cosmos Cryosat - Rockot Kompsat 2 - Rockot Egyptsat - Dnepr Demeter - Dnepr	VNSat - Cosmos Thai-Paht 2 - Cosmos	
Other				
Total Satellites	10	7	4	9
Total Launches	7	6	3	5

Note: This manifest includes only those satellites announced as of May 14, 2003.

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 satellite projection is slightly higher while the launch projection is lower than in the 2002 forecast. These numbers reflect reduced expectations in the telecommunications sector balanced by a similar expected increase in international science and other activities. The forecast for the remote sensing sector has remained steady from last year to the present.

Baseline Scenario

The baseline scenario anticipates the following satellite market characteristics from 2003–2012:

- International science and other satellites will comprise about 75 percent of the payload market, up from 43 percent of the satellite market forecast in 2002.

- Remote sensing will encompass about 25 percent of the market with about 20 satellites; both numbers are the same as those forecast in 2002.

- NGSO communications systems will drop to zero percent of the satellite market. Details include:
  - No new Little LEO systems in addition to the already-deployed ORBCOMM. This is the same number as the 2002 forecast;
  - No new Big LEO systems to join the already-deployed Iridium and Globalstar systems. This is one less than the number of systems projected in 2002; and
  - No new Broadband LEO systems.

Table 20 and Figures 14 and 15 show the baseline forecast in which 80 satellites will be deployed between 2003 and 2012. In comparison to last year's forecast of 79 total satellites (2002–2011), this year's projections are up one percent. By contrast, the 2001 baseline forecast (2001–2010) contained 151 satellites. Table 21 shows the mass distributions of manifested satellites over the next four years. The predominance of the smaller satellites is evident, with 70 percent of all satellites going to NGSO in the next four years expected to be less than 600 kilograms. In reality, this percentage can be expected to be even higher, as some of the smallest satellites can appear quickly when budgets allow and have a short development phase from design to launch. This makes them difficult to forecast.

The 80-satellite total forecast over the next 10 years, accounting for multiple manifesting on launch vehicles, yields a commercial launch demand of about 51 launches over the forecast period. This demand

Table 20. Baseline Market Scenario Satellite and Launch Forecast

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL	Avg
Satellites												
Big LEO	0	0	0	0	0	0	0	0	0	0	0	0.0
Little LEO	0	0	0	0	0	0	0	0	0	0	0	0.0
Broadband	0	0	0	0	0	0	0	0	0	0	0	0.0
International Scientific/Other	8	6	6	6	5	6	6	5	6	6	60	6.0
Commercial Remote Sensing	2	1	2	9	2	1	1	0	0	2	20	2.0
Total Satellites	**10**	**7**	**8**	**15**	**7**	**7**	**7**	**5**	**6**	**8**	80	8.0
Launch Demand												
Medium-to-Heavy Vehicles	2	2	3	5	2	2	1	1	1	3	22	2.2
Small Vehicles	5	4	2	3	3	2	3	3	2	2	29	2.9
Total Launches	**7**	**6**	**5**	**8**	**5**	**4**	**4**	**4**	**3**	**5**	51	5.1

breaks down into about three launches annually on small launch vehicles and two launches annually on medium-to-heavy launch vehicles. Overall, the current launch count of 51 launches is down 19 percent from last year's prediction of 63 launches over 10 years. With 35 launches projected, international science and other payloads such as technology demonstrators account for about 69 percent of the launch demand through 2012, up from about 52 percent of the launch demand forecast last year. Similar to remote sensing payloads and payload market share, remote sensing launches have remained the same in 2002 and 2003, forecast at 16 launches both years. However, the market share of remote sensing launches within the entire 10-year launch forecast has increased from about 25 percent in 2002 to about 31 percent in the 2003 forecast. The combined telecommunications sectors (Little, Big, and Broadband LEO) together account for zero percent of the total payload market, a dramatic decrease from previous forecasts.

Figure 14. Baseline Market Scenario Satellite Forecast

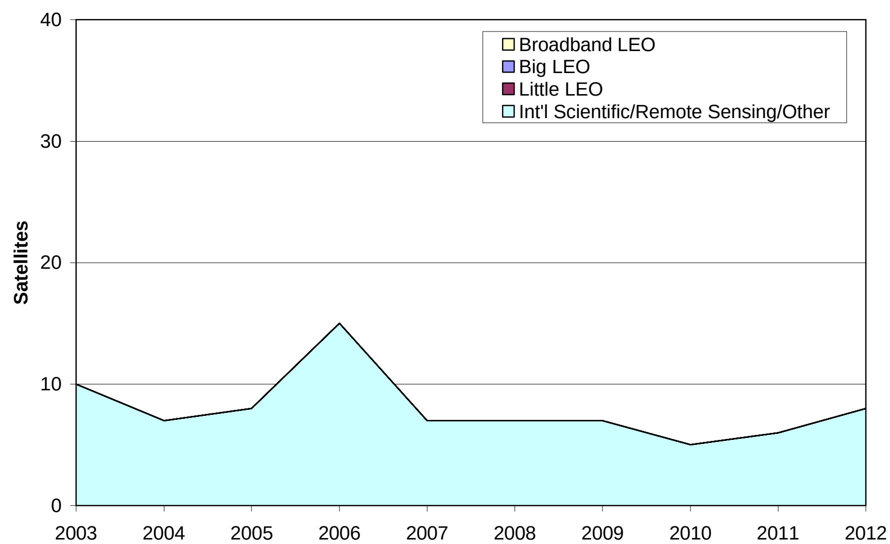
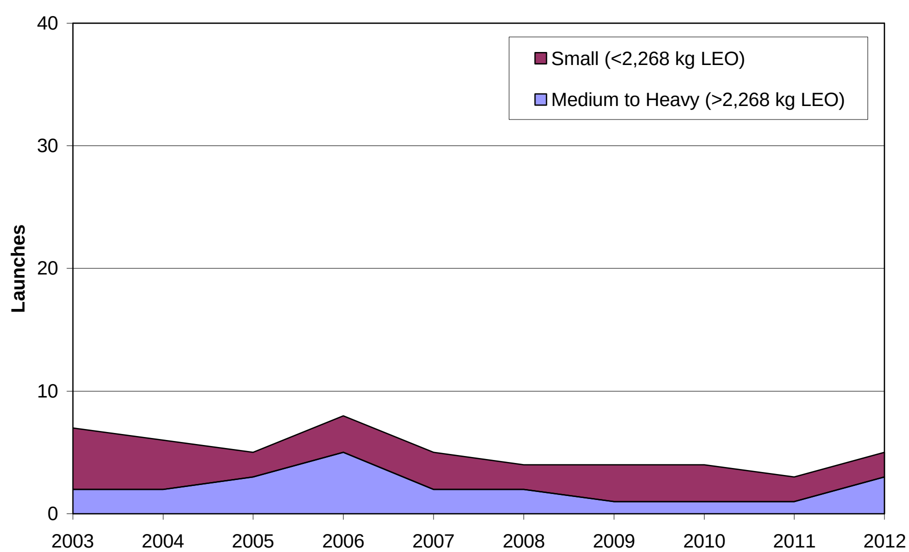


Figure 15. Baseline Market Scenario Launch Demand Forecast



This year's report does not include a robust market scenario, because the robust model of scientific and commercial remote sensing payloads did not yield a significant increase. Furthermore, market uncertainties preclude an accurate forecast of new telecommunications systems or replacements of existing telecommunications systems within the 2003–2012 time period. However, space markets can change relatively rapidly and the robust scenario could return in future forecasts.

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 is the first forecast since 1998 in which the number of payloads has increased from the previous forecast, though the number of launches have continued to decrease. The 2003 forecast estimates only seven launches during the 2003 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 second time since FAA/AST began forecasting, 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 22 lists actual payloads launched by market sector and total commercial launches that were internationally-competed from 1994–2002. Medium-to-heavy vehicles had 39 launches during this period while small vehicles had 32. The 2003 forecast estimates launch demand for more small vehicle launches (29) than medium-to-heavy vehicle launches (22) from 2003–2012.

Historical satellite and launch data for the period 1993–2002 are shown in Table 23. Secondary and piggyback payloads on launches with larger primary payloads were not included in the payload or launch tabulations.

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

	2003	2004	2005	2006	Total	Percent of Total
< 200 kg (< 441 lbm)	5	4	2	0	11	37%
200-600 kg (441-1323 lbm)	3	1	0	6	10	33%
600-1200 kg (1323-2646 lbm)	2	2	1	2	7	23%
> 1200 kg (> 2646 lbm)	0	0	1	1	2	7%
Total	10	7	4	9	30	100%

Table 22. Historical Commercial NGSO Activity*

	1994	1995	1996	1997	1998	1999	2000	2001	2002
Satellites									
Big LEO	0	0	0	46	60	42	5	1	7
Little LEO	0	3	0	8	18	7	0	0	2
International Science/Other	0	0	2	1	4	5	11	1	6
Commercial Remote Sensing	0	1	0	2	0	2	2	2	0
Total Satellites	**0**	**4**	**2**	**57**	**82**	**56**	**18**	**4**	**15**
Launches									
Medium to Heavy vehicles	0	0	1	8	9	11	6	2	2
Small vehicles	0	2	1	5	10	7	3	2	2
Total Launches	**0**	**2**	**2**	**13**	**19**	**18**	**9**	**4**	**4**

*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 a launch are included unless combined secondaries generate the demand.

Figure 16. Comparison of Past Baseline Launch Demand Forecasts

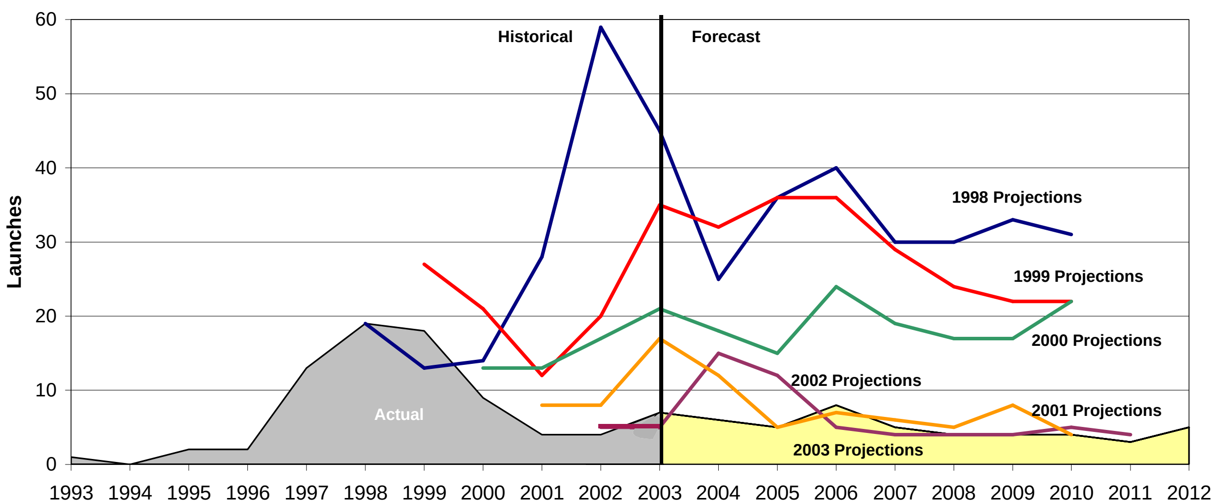


Table 23. Historical NGSO Satellite and Launch Activities (1993-2002)*

Summary	Market Segment	Date	Satellite	Launch Vehicle	
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
4 Launches	**International Science**	3/17/02	GRACE (2 sats)	Rockot	Small
2 Medium-to-Heavy		12/20/02	SaudiSat 2	Dnepr	Medium-to-Heavy
2 Small			Unisat 2		
			RUBIN 2		
			Trailblazer Structural 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
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

*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.

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