2002 COMMERCIAL SPACE TRANSPORTATION FORECASTS

May 2002

**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 the Commercial Space Launch Act of 1984, as amended. 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 during commercial launch operations. 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 (2002)

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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 2002 to 2011.

The *2002 Commercial Space Transportation Forecasts* report includes:

- The *COMSTAC 2002 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 *2002 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), and elliptical orbits (ELI).

Together, the COMSTAC and FAA forecasts project that an average of nearly 27 commercial space launches worldwide will occur annually from 2002 to 2011. The combined forecasts are down 16.5 percent from those of last year, which projected an average of 32 launches per year from 2001-2010. The decrease is a result of a lack of financing for satellite systems in some sectors, industry consolidations, global economic conditions and, in the NGSO market, a weakened position for telecommunications systems.

Specifically, GSO launch demand is down about 15 percent compared to last year's forecast and the launch demand for NGSO is down about 21 percent. COMSTAC and FAA project an average annual demand for:

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

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

- 4 launches of small vehicles to NGSO.

In general, commercial launch demand is calculated by determining the number of primary payloads that are open to internationally-competed launch services procurement.

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 *2002 Commercial Space Transportation Forecasts* report covers the period from 2002 to 2011 and includes:

- The *COMSTAC 2002 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 *2002 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), and elliptical orbit (ELI).

Growth of Commercial Space Transportation

Prior to the 1980s, the launching of payloads to Earth orbit was carried out as a government-run operation. Since then, commercial launch activity has steadily increased. During 1997-2001, commercial launches accounted for an average of about 42 percent of worldwide launches.

The commercial launch market is directly impacted by positive or negative activity in the satellite market ranging from global finance and customer demand to manufacturing timelines and industry consolidations.

About the COMSTAC 2002 Commercial Geosynchronous Launch Demand Model

At the request of the FAA, COMSTAC annually compiles a model that forecasts worldwide demand for commercial launches of spacecraft that operate in geosynchronous orbit. First compiled in 1993, the model is updated annually and 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, the FAA has compiled an assessment of demand for commercial launch services to non-geosynchronous orbits, i.e., those orbits not covered by the COMSTAC GSO forecast. The NGSO forecast is based on a worldwide satellite assessment of telecommunications, remote sensing, science and other spacecraft using commercial launch services.

The forecast develops two scenarios for deployment of NGSO satellite systems: a "baseline" scenario (considered the most likely to occur) and a "robust" scenario (considered likely to occur if demand for NGSO satellite services is sufficiently greater than expected).

Combined Payload and Launch Forecasts

This year's COMSTAC GSO and FAA NGSO combined forecasts show a 23 percent reduction in the total number of payloads that will generate worldwide commercial launch demand during the period from 2002-2011 in comparison to last year's ten-year forecast. Launch demand is down 16.5 percent compared to last year's forecast. Payload and launch demand are based on the COMSTAC GSO mission model and the baseline scenario of the FAA NGSO forecast

The combined GSO and NGSO forecasts project that 352 payloads will be deployed between 2002 and 2011, as shown in Figures 1, 2, and 3. The projected payload demand for GSO is significantly greater than NGSO for the second year in a row. There are 273 GSO payloads in the ten-year forecast, compared with 79 in NGSO. The GSO forecast averages 27.3 payloads per year with a low of 24 and a high of 32. With the exception of 2004 and 2005, deployment of NGSO payloads is relatively constant and overall averages about eight per year. For the first time since the FAA began forecasting, the majority of the satellites in NGSO are expected to be comprised of science and remote sensing satellites, not telecommunications satellites. The NGSO payload forecast is down 48 percent compared to last year's forecast.

After taking into account the dual manifesting of GSO payloads and the multiple manifesting of NGSO payloads, the forecasts together project 268 commercial launches will be conducted through 2011, as shown in Table 1 and Figures 1, 2, 3, and 4. The forecasted launch demand is an average of nearly 27 launches per year, consisting of:

- 20.5 launches of medium-to-heavy launch vehicles to GSO;
- 2.5 launches of medium-to-heavy launch vehicles to NGSO orbits; and
- 4 launches of small vehicles to NGSO.

GSO launch demand is down about 15 percent compared to last year's forecast of an average of 24 launches. NGSO launch demand is down about 21 percent compared to the 2001 forecast that had an average of eight launches per year. Figure 4 shows historical forecasts from 1998 to 2002.

Table 1: Commercial Space Transportation Payload and Launch Forecasts

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Average
Payloads												
GSO Forecast (COMSTAC)	32	24	24	24	25	26	29	30	29	30	273	27.3
NGSO Forecast (FAA)	10	6	22	12	5	7	4	4	5	4	79	7.9
Total Payloads	**42**	**30**	**46**	**36**	**30**	**33**	**33**	**34**	**34**	**34**	**352**	**35.2**
Launch Demand												
GSO Medium-to-Heavy	27	19	18	18	18	19	21	22	21	22	205	20.5
NGSO Medium-to-Heavy	1	1	11	8	1	1	0	0	0	1	24	2.4
NGSO Small	4	4	4	4	4	3	4	4	5	3	39	3.9
Total Launches	**32**	**24**	**33**	**30**	**23**	**23**	**25**	**26**	**26**	**26**	**268**	**26.8**

Figure 1: GSO Satellite and Launch Demand

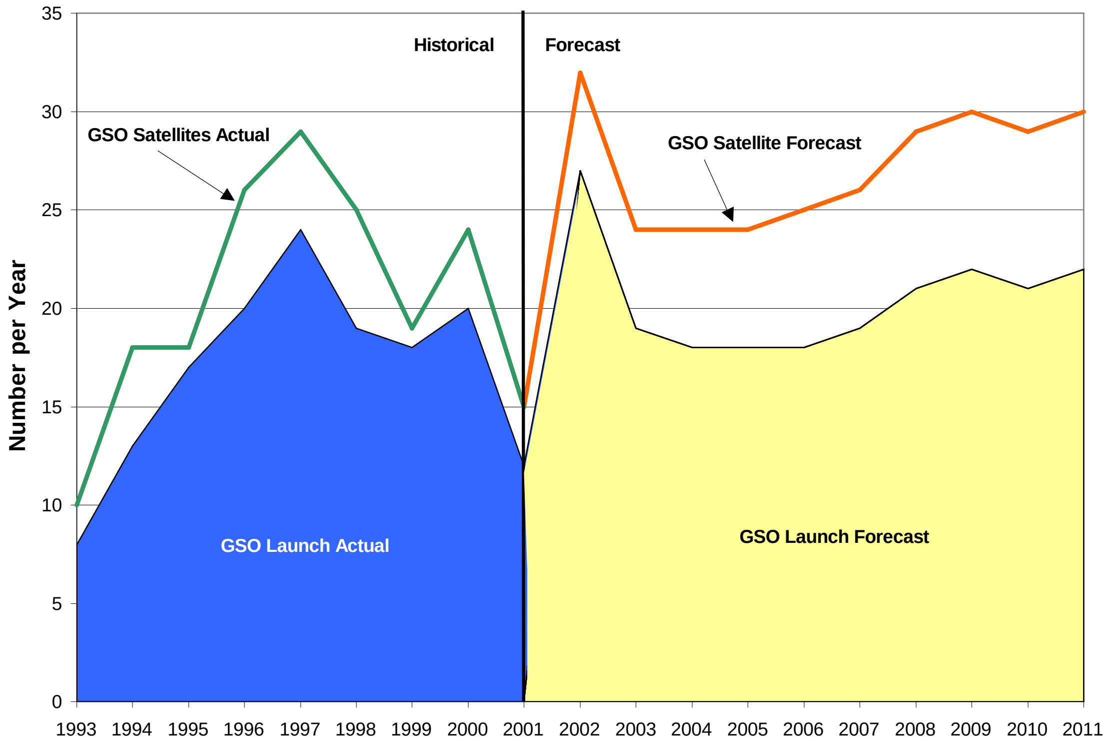


Figure 2: NGSO Satellite and Launch Demand

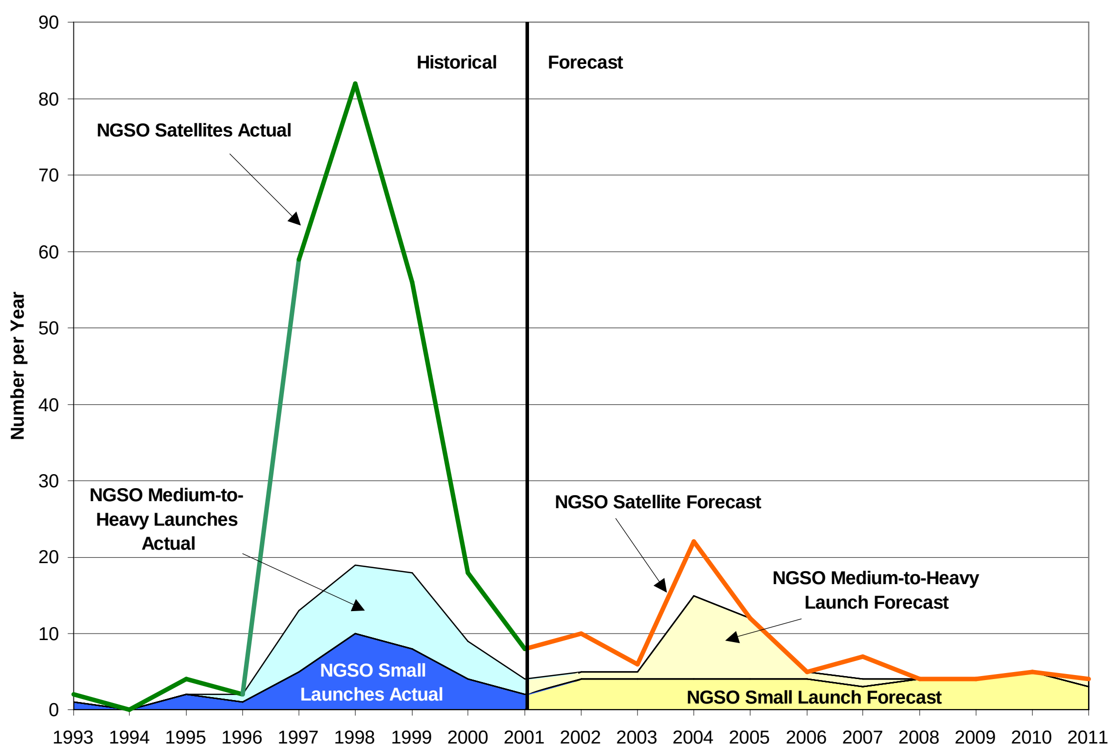


Figure 3: Combined GSO and NGSO Launch Forecasts

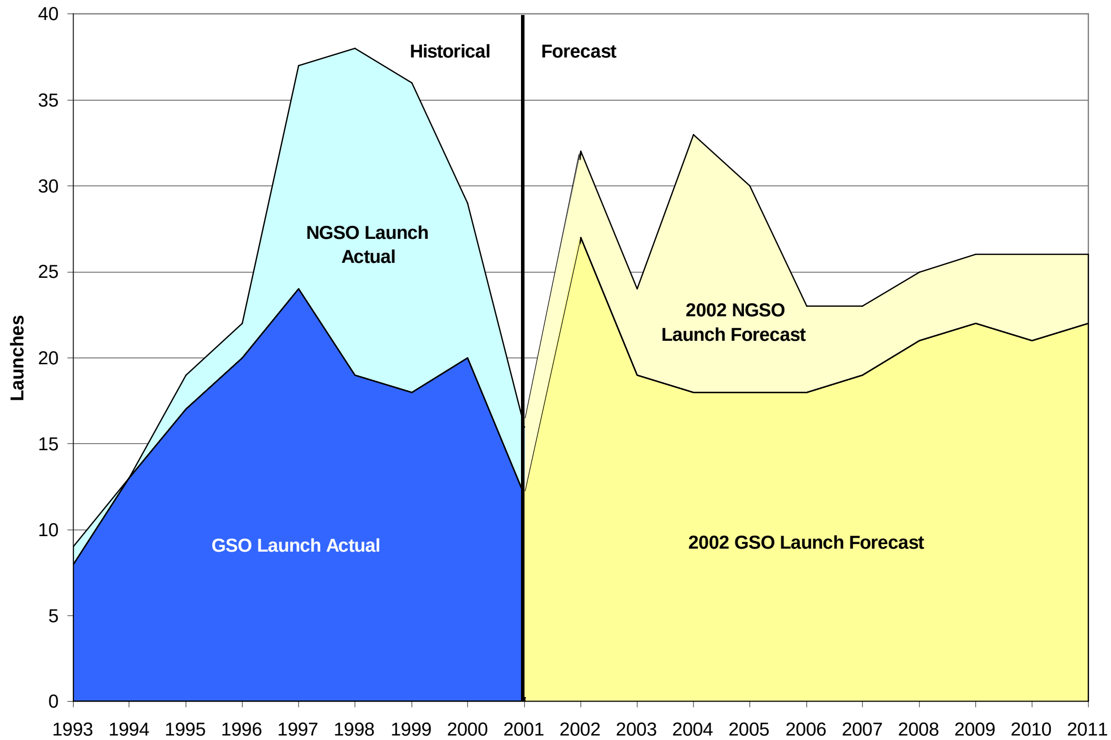
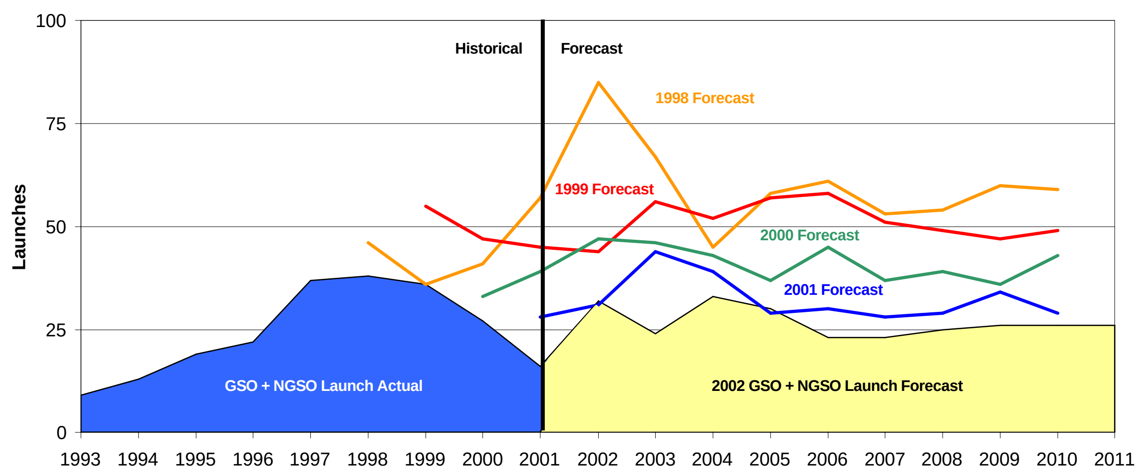


Figure 4: Historical Commercial Space Transportation Forecasts



COMSTAC 2002 Commercial Geosynchronous Orbit Launch Demand Model

Executive Summary

This report was compiled by the Commercial Space Transportation Advisory Committee (COMSTAC) for the Office of the Associate Administrator for Commercial Space Transportation of the Federal Aviation Administration (FAA/AST). The *COMSTAC 2002 Commercial Geosynchronous Orbit Launch Demand Model* is the tenth annual forecast of the worldwide demand for commercial geosynchronous (GSO) launches as seen by the U.S. commercial space industry. It is intended to assist the 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. Two content changes have been introduced this year, viz., (1) new mass class categories are introduced in order to better align with actual satellite models being offered, and (2) an interpretation of the historical difference between demand forecasts and the actual number of satellites launched is applied to this year's forecast. The latter change is expected to provide a more useful report in that the impacts of such unforeseeable events as launch failures, launch delays and satellite delays are taken into consideration.

The 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, the satellite demand is adjusted by the number of satellites forecasted to be launched in a dual-launch configuration.

2001 yielded the lowest number of commercial GSO satellites launched since 1993; just 14 satellites were launched, down from 24 in 2000, a decrease of 42 percent. The 2001 commercial model forecasts a launch demand of 24 satellites in 2001. Nearly all of the 10 satellites that were included in the forecasted demand for 2001 that did not launch in 2001 are expected to launch in 2002 and are included in this year's near-term forecast.

The near-term forecast, which is based on existing and anticipated satellite programs for 2002 through 2004, shows demand for 32 satellites to be launched in 2002, 24 in 2003, and 24 in 2004.

The average annual COMSTAC demand forecasts published in the 2000 and 2001 reports were 30.6 and 30.5 satellites per year, respectively, over the forecast period. This year's mission model predicts an average demand of 27.3 satellites to be launched per year over the period from 2002 through 2011, a decrease of approximately 11 percent from the demand forecast of 30.5 satellites per year forecast in the 2001 report. Several factors are impacting the demand for commercial GSO satellites, including economic conditions, availability of financing for satellite projects, and industry consolidation. The influence of these factors is addressed in more detail in this report.

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. Over the nine 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 2002 demand of 32 satellites will be discounted to an actual number of satellites launched of somewhere between 22 and 27. The variance between that forecasted demand in the first year of the forecast vs. the actual number of satellites launched will be discussed in more detail.

Figure 5 shows the graphical representation of the COMSTAC Demand Forecast in terms of number of satellites and launches demanded. The near-term launch demand forecast equates to 27 launches for 2002, 19 launches for 2003, and 18 launches for 2004. As in the last two forecasts, the near-term demand has declined in this year's forecast. Table 2 shows the projected number of dual payloads to be launched.

Figure 5: COMSTAC Commercial GSO Launch Demand Forecast

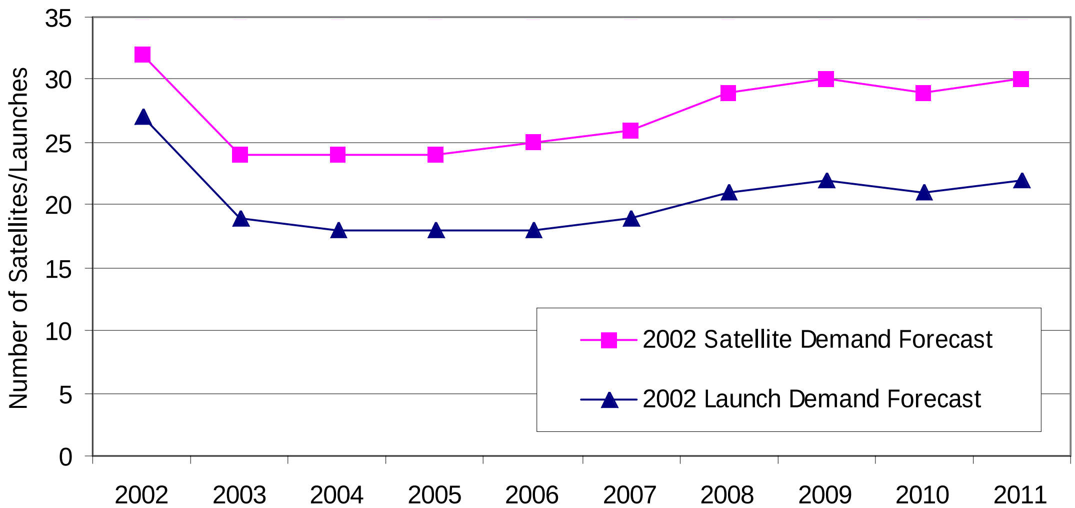


Table 2: Commercial GSO Launch Demand Forecast Data

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Average
Satellite Demand	32	24	24	24	25	26	29	30	29	30	273	27.3
Dual Launch Forecast	5	5	6	6	7	7	8	8	8	8	68	6.8
Launch Demand Forecast	27	19	18	18	18	19	21	22	21	22	205	20.5

Introduction

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

This report presents the 2002 update of the worldwide commercial geosynchronous orbit (GSO) satellite mission model for the period 2002 through 2011. It is based on market forecasts obtained in early 2002 from major satellite manufacturers, satellite service providers, and launch service providers.

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 for that year will then depend 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 Appendix A of this 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 U.S. and covered the period 1992-2010. In the next few years, the major U.S. satellite manufacturers and the satellite service providers began to contribute to the market demand database. In 1995, the Technology and Innovation Working Group (the Working Group) was formally chartered to prepare the annual Commercial Payload Mission Model Update. Since then, the participation in the preparation of this report has grown. This year the committee received 27 inputs from U.S. and non-U.S. satellite service providers, manufacturers, and launch vehicle providers. COMSTAC would like to thank all of the participants in the 2002 mission model update.

Methodology

With the exception of minor adjustments, the Working Group's launch demand forecast methodology has remained consistent. As in previous years, the Working Group solicited input from industry via a letter from the Associate Administrator for Commercial Space Transportation. This letter is shown in Appendix C. The letter requested that each company provide a forecast of the number of addressable commercial GSO payloads per year for the period 2002 - 2011.

Launch vehicle payloads in this context are satellites that are open for internationally-competitive launch service procurement. These satellites are considered the "addressable" market. 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 vehicle launches per year is less than the satellite launch demand forecast due to the potential for multiple manifesting of satellites on launch vehicles. The remainder of the commercial market, non-geosynchronous orbit (NGSO) launches, is addressed in a separate forecast developed by FAA/AST.

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). For 2002, the Working Group decided to update the mass class categories used in the launch demand forecast to better reflect the current product mix in the industry. In previous years, the mass class categories used were representative of clusters of launch vehicles of similar capability. The 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.

To establish the new mass class categories, the Working Group performed an analysis of the masses of satellites launched in the last five years and those satellites currently under contract. The analysis showed that the spacecraft bus models produced by different manufacturers could be grouped into consistent mass categories. The revised mass categories are similar to the categories used in previous years, but now more accurately reflect the spacecraft models being sold in the market, as shown in Table 3.

The following organizations responded with data used to develop this report:

- Asiasat
- Astrium
- Binariang
- The Boeing Company*
- Broadcasting Satellite System Corp.
- China Great Wall Industries, Inc.
- Destiny Cable Inc.
- Eurasiasat
- Hispasat
- INMARSAT
- Kelly Space & Technology, Inc.
- Kistler Aerospace Corp.*
- Lockheed Martin Space Systems Corp.*
- Loral Skynet
- Loral Space & Communications*
- Miraxis
- Mobile Satellite Ventures
- NEC Toshiba Space Systems, Ltd.
- PanAmSat
- Rocket Systems Corporation
- Shin Satellite Plc.
- SingTel Optus
- Space Communications Corporation
- StarOne
- Telenor
- Telesat Canada
- Thuraya Telecommunications

Table 3: Satellite Mass Classes

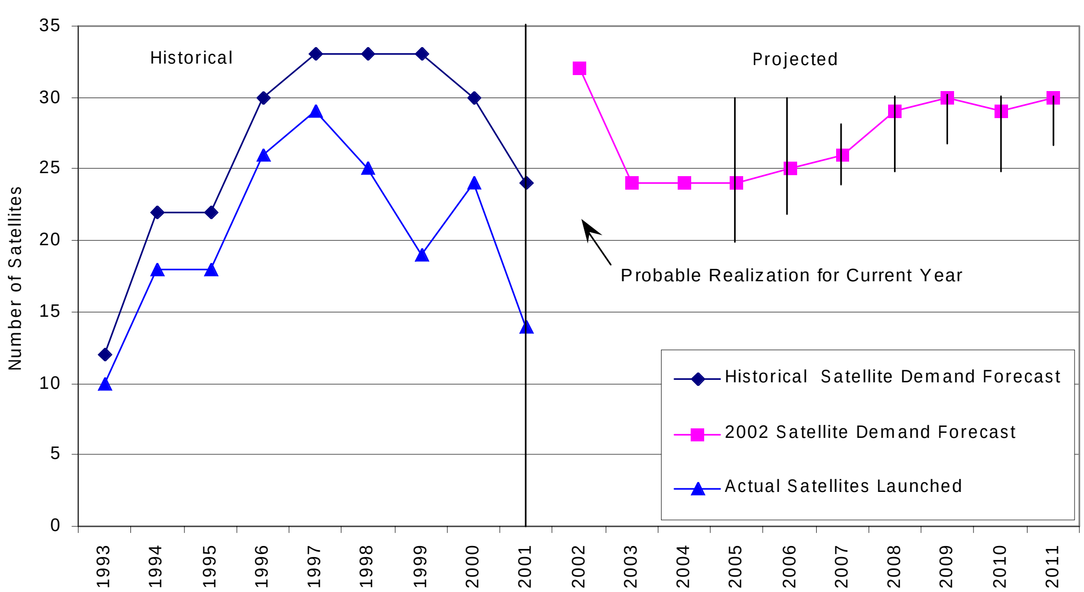
GTO Launch Requirement	Satellite Bus Models
Below 2,200 kg (<4,850 lbm)	LM A2100A, Boeing 376, Orbital Star 2, Astrium ES2000, Alcatel SB 2000
2,200 - 4,200 kg (4,850 - 9,260 lbm)	LM A2100, Boeing 601/601HP, Loral 1300, Astrium ES2000+, Alcatel SB 3000A/B/B2
4,200 - 5,400 kg (9,260 - 11,905 lbm)	LM A2100AX, 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

Comprehensive mission model forecasts from the organizations marked by an asterisk (*) were used in determining the demand forecast. The comprehensive inputs were of the total addressable market of customers seeking commercial launch services for GSO spacecraft from the years 2002 to 2011. Other responses provided partial market or company-specific satellite launch demand information.

The near-term COMSTAC mission model (2002-2004) 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 resulting from unanticipated launch failures, nor delays in the launch vehicle or satellite supply chain. Minor delays at the end of a year due to launch vehicle problems or satellite manufacturing issues can also 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.

Over the history of this report the forecasted demand, in terms of both satellites and launches, has exceeded the actual number of satellites and launches for the first year of the forecast. This variance is shown in the historical portion of Figure 6. Over the nine years that this report has been published the variance between forecasted demand in the first year of the forecast and the actual number of satellites launched in that year has averaged 23 percent. In 1997 this variance was only 12 percent, while in 1999 and 2001 the variance was 42 percent. Over the first five years the variance averaged 16 percent, while during the last four years this variance averaged 32 percent. If this range of variance were applied to this year's demand forecast of 32 satellites, the probable number of satellites that will actually be launched in 2002 would be somewhere between 22 and 27 (as illustrated in Figure 6). It is important to note that this historical variance applies only to the first year of the forecast and should not be applied to the entire forecast.

Figure 6: COMSTAC Commercial GSO Satellite Demand Forecast



The Working Group used the comprehensive inputs from the U.S. respondents to derive the average launch rate for years 2005 through 2011. 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. The highest and lowest inputs (shown by the bars in years 2005 through 2011 in Figure 6) represent the single highest or lowest estimated number of satellites to be launched in that year from these comprehensive inputs. This data is also included in Table 4.

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

- Firm contracted missions
- Current satellite operator planned and replenishment missions
- Projected operator growth
- An estimate of "unidentified growth"
- Attrition from launch or in-orbit satellite failures
- Availability of financing for commercial space projects
- Industry consolidation
- Competition from terrestrial systems
- Regulatory environment

"Unidentified growth" is used to include information that may be proprietary or competition-sensitive, such as company-specific plans on future systems and trends, and assumptions on possible new markets. Other factors may have influenced each individual company's specific inputs.

There is a certain amount of difficulty and uncertainty involved in forecasting the commercial launch market. The satellite production cycle of an existing design is on the order of two years. Orders within a 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. As seen in the past, entirely new systems can spring up in less than three years from both new and existing companies. The long-term growth shown in this forecast, therefore, is based on both the replenishment of existing satellites and assessments of potential new markets and satellite concepts.

2002 Mission Model

The 2002 COMSTAC mission model consists of three elements. The first element is a forecast of demand for competed launches of commercial satellites to GSO from 2002 to 2011. The second element is an estimate of the mass distribution of these satellites. The third element is a launch vehicle demand projection derived from the satellite launch demand forecast.

Satellite Launch Demand Model

Figure 7 shows the Working Group's demand forecast for commercial satellite launches to GSO for the years 2002 through 2011. Also plotted in Figure 7 is the actual number of satellites launched each year from 1993 to 2001, for reference. The range of individual estimates from the various comprehensive inputs is shown in Table 4. This information is presented to give a sense of the variations in the forecasts for any given year. 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.

It is not the intent of the Working Group to project the actual number of satellites to be launched. In this report, COMSTAC strives to provide the user with the best knowledge possible of the number of satellites that could be launched.

The near-term forecast shows 32 satellites to be launched in 2002, 24 in 2003, and 24 in 2004. This year's mission model predicts an average demand of 27.3 satellites to be launched per year over the period from 2002 through 2011. The COMSTAC average annual demand forecasts of the 2000 and 2001 reports were 30.6 and 30.5 satellites per year, respectively. This year's average forecast of 27.3 satellites per year is approximately 11 percent lower than the average forecast of 30.5 satellites per year in the 2001 report. Several factors are impacting the demand for commercial GSO

Figure 7: COMSTAC Commercial GSO Satellite Demand Forecast

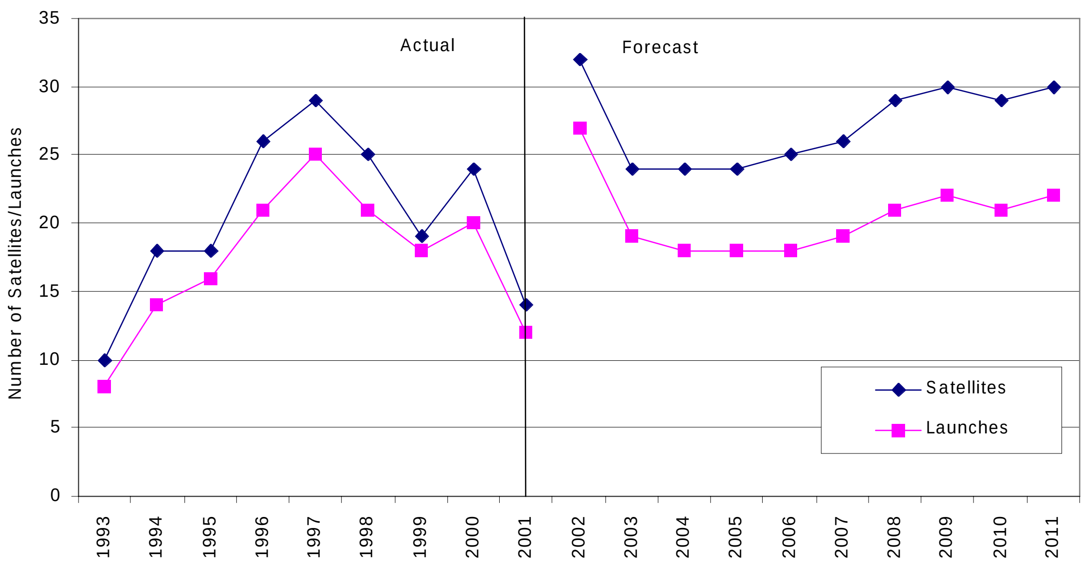


Table 4: COMSTAC Commercial GSO Satellite Forecast

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Average
High				30	30	28	30	30	30	30		
2002 Satellite Demand	**32**	**24**	**24**	**24**	**25**	**26**	**29**	**30**	**29**	**30**	**273**	**27.3**
Low				20	22	24	25	27	25	27		

satellites, including economic conditions, availability of financing for satellite projects, and industry consolidation. The influence of these factors is addressed in more detail on page 17. Note that the average annual demand for the 2000, 2001, and 2002 reports cover different spans of time. The 2000 report average annual demand is the average demand from 2000 to 2010, the 2001 report from 2001 to 2010, and the 2002 report from 2002 to 2011.

Table 5 shows the consensus near-term mission model for 2002 through 2004, which is a compilation of the currently-manifested launches and an assessment of satellites 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 service providers.

Table 5: Commercial GSO Near-Term Mission Model (as of April 24, 2002)

	2002	**2003**	**2004**
Total	32	24	24
Below 2,200 kg (<4,850 lbm)	3	3	4
	Astra 3A - Ariane e-Bird 1 - Ariane N-Star C - Ariane	AMOS 2 - Ariane BSat-2C - Ariane Galaxy 12 - Ariane	AMC-10 - TBD AMC-11 - TBD Galaxy 5R - Ariane Telkom 2 - TBD
2,200 – 4,200 kg (4,850-9,260 lbm)	12	5	9
	Asiasat 4 - Atlas Atlantic Bird 1 - TBD DirecTV 5 - Proton Echostar 7 - Atlas Eutelsat W5 - Delta Hispasat 1D - Atlas Hot Bird 6 - Atlas Hot Bird 7 - Ariane Insat 3C - Ariane JCSAT 8 - Ariane Nimiq 2 - Atlas Stellat - Ariane	Agrani 2 - Ariane Insat 3A - Ariane MBSat - TBD Superbird 6 - Atlas XTAR EUR - TBD	Arabsat - TBD Hot Bird 8 - TBD Insat 3D - TBD Insat 3E - Ariane Spainsat - TBD ST-2 - TBD StarOne C1 - TBD Attrition - TBD Attrition - TBD
4,200 – 5,400 kg (9,260 – 11,905lbm)	17	5	8
	AMC-9 - Proton Astra 1K - Proton Chinasat 8 - Long March EchoStar 8 - Proton EchoStar 9 - TBD Estrela do Sul - Delta Galaxy IIIC - Sea Launch Galaxy 8iR - Sea Launch Galaxy XIII - Sea Launch INTELSAT 903 - Proton INTELSAT 904 - Ariane INTELSAT 905 - Ariane INTELSAT 906 - Ariane INTELSAT 907 - Ariane NSS 6 - Ariane NSS 7 - Ariane Optus C1 - Ariane	AMC-12 - Proton AMC-13 - Atlas Cablevision - Atlas Eutelsat W3A - TBD Thuraya 2 - Sea Launch	Amazonas - TBD AMC-15 - TBD AMC-23 - TBD Eurasiasat 2 - TBD Measat 3 - TBD Telstar 130 - TBD XM-3 - TBD Attrition - TBD
Over 5,400 kg (>11,905 lbm)	0	11	3
		Anik F2 - Ariane DirecTV 7S - Ariane Inmarsat 4 - Atlas Inmarsat 4 - Ariane Intelsat 10 - Sea Launch Intelsat 10 - Proton NSS 8 - Sea Launch SatMex 6 - Ariane Spaceway 1 - Sea Launch Spaceway 2 - Sea Launch Telstar 8 - Sea Launch	iPSTAR - Ariane Miraxis - TBD Nahuel 2 - TBD

Satellite Launch Mass Class

Figure 8 and Table 6 show the forecasted distribution of the satellite demand by mass. The satellites are forecasted in four mass classes: below 2,200 kilograms (<4,850 pounds); 2,200 to 4,200 kilograms (4,850 to 9,260 pounds); 4,200 to 5,400 kilograms (9,260 to 11,905 pounds); and above 5,400 kilograms (>11,905 pounds). As described earlier, these mass classes are representative of the requirements of various satellite models. More specifically, the definition refers to the separated mass of a satellite to a nominal geosynchronous transfer orbit. In the near-term forecast, the Working Group tried to place each satellite in the appropriate class based on what was known of its mass. The remainder of the forecast derives from the estimates provided by each of the respondents of the potential breakdown among the classes for that year. This means the forecast for each mass class is an average of the domestic comprehensive inputs for that mass class for each year beyond the near-term forecast. The prediction of future satellite sizes was calibrated by inputs received from satellite service providers.

Commercial GSO Satellite Trends

In the early years of publication of this mission model report, commercial satellites were not projected to grow much beyond the 2,200 – 4,200 kg (4,850 to 9,260 lbm) mass class. Over the past five years, however, the mass range of commercial satellites has exhibited a profound shift from

Figure 8: Forecast Trends in Annual GSO Satellite Mass Distribution

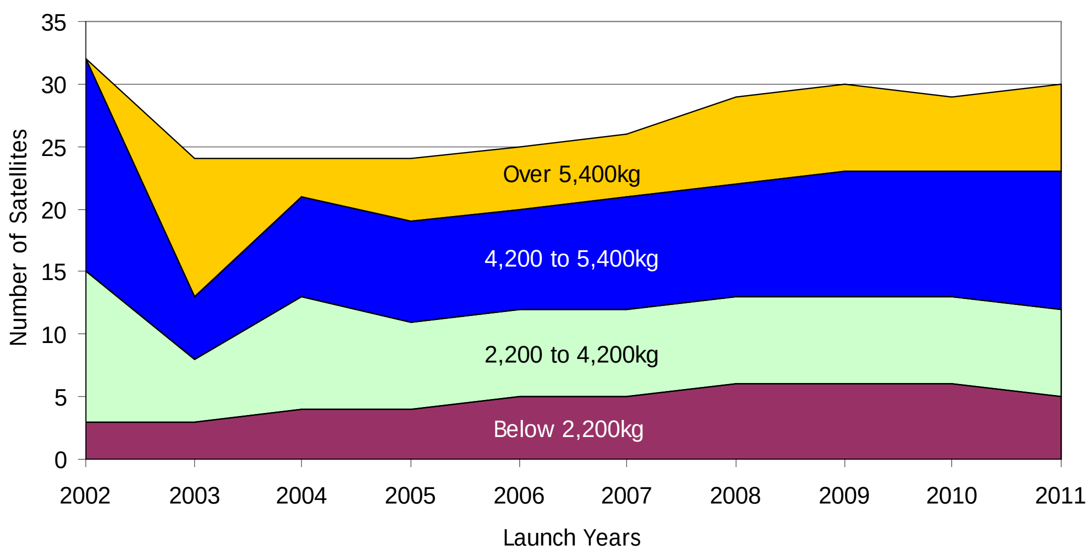


Table 6: Forecast Trends in Satellite Mass Distribution

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Average 2002 to 2011	Percent of Total
Below 2,200 kg (<4,850 lbm)	3	3	4	4	5	5	6	6	6	5	47	4.7	17%
2,200 to 4,200 kg (4,850 – 9,260 lbm)	12	5	9	7	7	7	7	7	7	7	75	7.5	27%
4,200 to 5,400 kg (9,260 – 11,905 lbm)	17	5	8	8	8	9	9	10	10	11	95	9.5	35%
Above 5,400 kg (>11,905 lbm)	0	11	3	5	5	5	7	7	6	7	56	5.6	21%
Total Satellite Forecast	**32**	**24**	**24**	**24**	**25**	**26**	**29**	**30**	**29**	**30**	**273**	**27.3**	**100%**

this original projection. Very heavy commercial satellites, over 5,400 kg (>11,905 lbm), have been developed and ordered over the last few years to address some specific market segments. Satellites designed to provide broadband data communication services (such as Spaceway) and mobile communications services (such as Inmarsat 4) require high levels of power and sophisticated on-board processing circuitry. These requirements have driven designs of these satellites to approach and exceed 5,400 kg (11,905 lbm). Other heavy-class commercial satellites have been developed to serve traditional broadcast applications with broader scope and greater efficiency. Many of the next generation of satellites will exceed 4,200 kg (9,260 lbm), such as PanAmSat's Galaxy IIIC, and even 5,400 kg (11,905 lbm), such as Telesat's Anik F2.

This growth has occurred for a few key reasons. Many global and regional satellite service providers are attempting to maximize their capacity and geographic coverage at prime orbital locations. Many service providers now provide regional coverage instead of specific area. Also introducing upward pressure on the mass of traditional satellites is the demand for greater on-orbit lifetime, which generally requires greater amounts of station-keeping fuel, which in turn drives up the satellite mass. These types of large satellites typically offer a lower cost per transponder, making them more attractive to the service provider's bottom line.

Enabling such designs to be launched is the next generation of commercial launch vehicles. The Atlas V and Delta IV vehicle families feature GTO lift capability exceeding 8,000 kg (>17,635 lbm). The improvements in launch vehicle capability have aided the introduction of these large satellites into the market.

Nevertheless, in the last year we have seen at least two stabilizing trends that have mitigated what appeared to be the swift dominance of the >5,400 kg (11,905 lbm) satellites. The satellite manufacturers have seen a decrease in satellite reliability. This in turn is causing significant changes in the insurance industry and a more risk-averse attitude. A year ago, the industry saw rapid infusion of technology to gain more power or add more transponders. Today, the manufacturers are slow-rolling the introduction of their new technology to insure that it will be reliable once on orbit. The slower infusion of new technology could mean a slower growth curve for the mass of satellites. Poor financial markets have led to the second trend: service providers are pushing out their broadband plans waiting for the market demand to prove itself. In poor financial markets, it is more difficult to get funding for large satellites and service providers are more concerned with their business case and meeting market needs. This is reducing the number of large satellites being ordered, but many service providers are still buying satellites in the 2,200 – 4,200 kg (4,850 to 9,260 lbm) mass class because they are cheaper to build and launch and can adapt more easily to changing market conditions. Evidence of these trends is the Boeing Company's work on a scaled down 702 that will provide more power than the 601HP, but be smaller than the current 702.

Following last year's trend, there is still demand for the stable niche of small satellites in the below 2,200 kg (<4,850 lbm) mass class. These small satellites are attractive to existing and emerging service providers because they often require a smaller up-front investment, and can be built and launched far more quickly than larger satellites.

Comparison with Previous COMSTAC Demand Forecasts

The forecasts of the prior two years are compared to this year's forecast in Figure 9. They are all characterized by a near-term rise, intermediate-term decline and long-term moderate growth. The near-term rise and fall is, perhaps, inherent in the near-term forecast methodology, which focuses on identifiable programs. The consequence of this approach, when considering that progressively higher attrition in the second and third years (i.e., 2003 and 2004) is yet to be realized, creates the near-term rise, or "bow wave".

The average satellite demand over the forecast period 2002 to 2011 is approximately 11 percent lower than last year's average. This year's model has an average demand of 27.3 GSO satellites per year for the period 2002 to 2011, with a modest increase in the last four years. The average demand in the 2001 mission model was approximately 31 satellites per year between 2001 and 2010, with demand being relatively flat after 2003. With the exception of the forecast for 2002, each year in this year's forecast is lower than last year's forecast. This year's forecast does not return to previously forecasted levels until 2008.

There are several factors that are affecting the projected demand for satellites. These factors include global and regional economic conditions, availability of financing, and industry consolidation. This year the Working Group included a supplemental questionnaire asking satellite service providers how certain factors are impacting their plans to purchase and launch satellites. The results of this questionnaire are shown in Appendix B of this report.

One significant factor in the decrease in the demand forecast is the continuing deterioration of expectations in the broadband marketplace. Previous forecasts have included near-term and mid-term demand based on the expected deployment of several new broadband satellite systems. During 2001, projects such as Astrolink (4 satellites) and Wildblue (2 satellites) were suspended, and several other companies that had been expected to procure broadband satellites signaled their intention to defer such programs. These developments are in part fostered by satellite service providers' intentions to reduce risk exposures and focus on near-term financial results.

Also affecting the mid-term decline in launch demand is the replacement cycle for existing geosynchronous satellites. Due to

Figure 9: 2000 and 2001 versus 2002 COMSTAC Mission Model Comparison

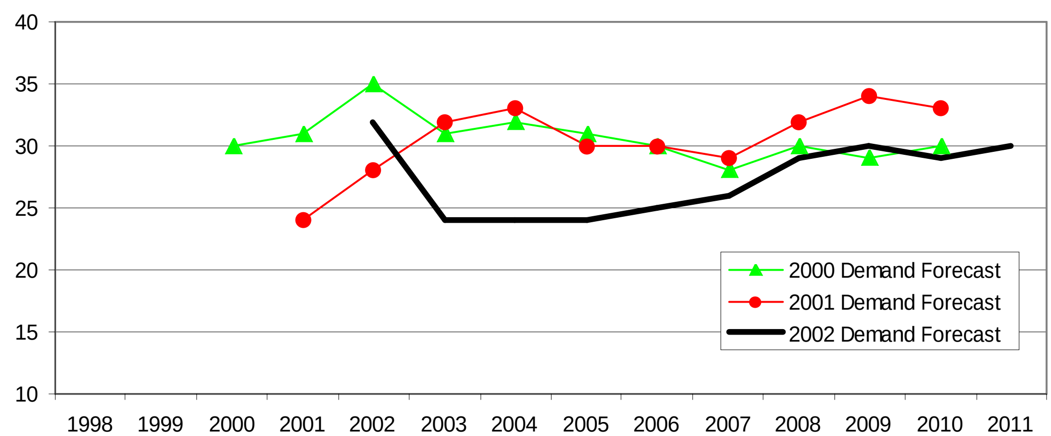


Figure 10: 2000 and 2001 versus 2002 COMSTAC Mission Model Comparison

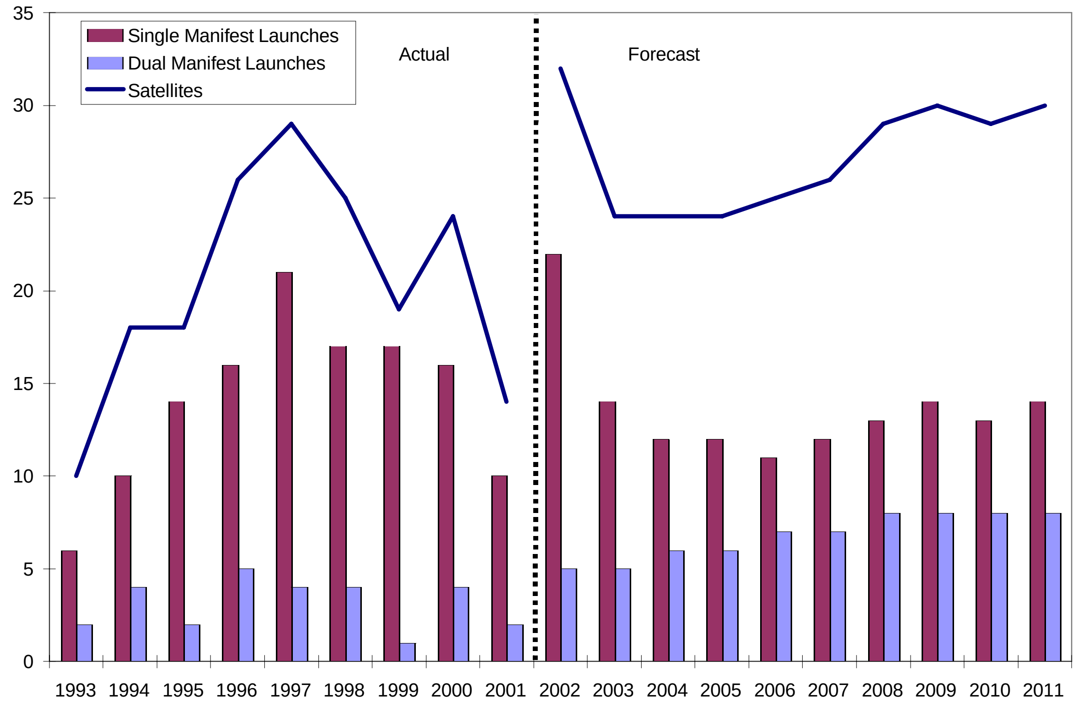


Table 7: 2000 and 2001 versus 2002 COMSTAC Mission Model Comparison

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Average
Satellite Demand	32	24	24	24	25	26	29	30	29	30	273	27.3
Dual Launch Forecast	5	5	6	6	7	7	8	8	8	8	68	6.8
Launch Demand Forecast	27	19	18	18	18	19	21	22	21	22	205	20.5

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. In addition, many of the major satellite service providers have recently completed fleet replacement and expansion efforts.

Finally, 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 getting more financial scrutiny, which has impacted the launch of new ventures.

Launch Vehicle Demand

Since 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 recorded from 1988 through 2001 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 10 presents the satellite demand forecast described earlier as well as actual values for 1993 through 2001.

Historically, only Arianespace has been capable of dual manifesting commercial GSO satellites, and its highest publicly-announced launch capability is approximately eight 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 will become commercially available in a few years. As these new systems mature, it is believed customers will become more comfortable with their capabilities and will begin to use their dual-manifest services. The Working Group feels that this will cause 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 7 shows the estimated number of dual launches forecasted.

Factors That May Affect Future Launch Demand

Last year, the Working Group noted that "several anticipated events and compelling factors have the potential to impact satellite and launch demand" that were expected to continue for the next few years. These events and factors include inaugural flights of several new launch vehicles, the trend toward heavier satellites, and longer satellite lifetimes. As discussed earlier in this report, a more-cautious view of proposed space-based programs is impacting demand for satellites and launches. Current global and regional economic conditions are contributing to this more-cautious view and may be a factor in accelerating consolidation within the industry. Potential new applications, specifically broadband coupled with a focus on utilization of Ka-band spectrum, that had been expected to spur growth in satellite and launch demand have been impacted by this more-cautious business environment. The U.S. Government regulatory environment has also served as a catalyst for a redistribution of the sources of supply of satellites and launches.

This year, inaugural flights of Boeing's Delta IV, Lockheed Martin's Atlas V, and the next generation of the Ariane 5 launch vehicle are all scheduled to occur. If all of these new vehicles are successful, two impacts can be anticipated. The first is that the competition among launch service providers can be expected to be fierce. The second is that the availability of capable and competitively-priced launch services will facilitate a previously observed, if modest, trend toward heavier satellites. However, an early failure of one or more of these systems will cause delays in, or migration of, scheduled launches. To the extent that alternatives are limited, the expected launch demand in a particular year is likely to be deferred into the next year if such a failure occurs. It is difficult to predict the actual "ripple" effect of any one failure on launch demand.

The trend toward heavier satellites is accompanied by the trend toward satellites capable of longer lifetimes, as customer preferences for 15 years or more of usable lifetime on orbit is now routine. This obviously slows the pace of replenishment, thereby delaying demand.

These impacts were expected to have been offset by demand for broadband applications, where a satellite's capability to satisfy the "last mile" dilemma, among other attributes, has in the last couple of years had a positive effect on the demand for satellites and attendant launches. However, demand for these Ka-band/broadband satellite applications has become impaired by "time to market" concerns versus terrestrial alternatives. Additionally, some of these initiatives, as well as future initiatives, are potentially threatened by the poor results of various satellite projects and general economic circumstances.

While probably not affecting absolute satellite and launch demand, 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. U.S. satellite manufacturers and launch vehicle providers continue to be hampered in meeting the expectations of their international customers due to this environment. The impact is not limited to delays in the initiation and execution of programs, but now the actual capture of business. In 2000 one satellite contract was cancelled and another satellite was (and remains) in storage pending receipt of a license in order to deliver. There continues to be reason to believe that new orders were lost due to the continuation of this environment.

Summary

This year's COMSTAC Commercial Mission Model forecast predicts a decrease in average annual demand for satellites. This change, from 30.5 satellites forecast to be launched per year, on average, to 27.3, is a reflection of the current environment for commercial satellite systems. Global economic conditions, availability of financing for satellite projects, and industry consolidation 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 last experienced in the latter half of the 1990s.

While the forecasted demand for 2002 has risen to 32 satellites and 27 launches, a significant number of these satellites and launches were forecasted to have occurred last year. The forecasted demand for 2003 through 2007 averages 25 satellites per year, which is the same as the actual average for the period 1996-2000. It is not until 2008 that the forecasted demand returns to levels expected in the last four COMSTAC forecasts. The highly-publicized failure of several commercial satellite projects has resulted in a more-conservative tone within the industry, which is expected to continue until new projects prove financially-viable. While broadband applications have been, and remain, a source of demand for satellites and launches, the expected impact of these initiatives on forecasted demand has decreased from previous forecasts.

The Working Group continues to foresee market events that have the potential of impacting the launch industry. Inaugural flights of Atlas V, Delta IV, and the next generation Ariane 5 are scheduled to occur this year. This portends a significant increase in the industry's capacity to launch heavy and extra-heavy payloads at competitive prices. This could and does seem to influence a modest trend toward heavier satellites, but any failures could cause delays of planned launches. Also, the U.S. Government regulatory environment continues to have an impact. While this factor does not necessarily diminish the level of demand for satellites and launches, there is evidence that this more-restrictive environment is impacting the distribution and timing of that demand.

Given the prospective nature of these factors, it is expected that the variance between forecasted launch demand and the actual number of launches achieved will continue to be higher than that experienced during the first five years of this report.

Appendix A. Use of the COMSTAC GSO Launch Demand Model

Demand Model Defined

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

For example, the participants in the 2002 Mission Model Update named actual satellite programs that were currently manifested on each of the launch providers for 2002. Though 32 satellite programs were named for the year 2002, the industry probably will not execute all corresponding launches in this year. However, the demand on the launch industry for 2002 is for the launch of 32 satellites (27 launches after discounting for dual manifesting).

COMSTAC Demand Projection vs. Actual Launches

Factors That Affect Launch Execution

Several factors can affect the execution of a scheduled launch. These can include launch failure, launch vehicle components problems, or manifesting issues. Satellite suppliers also have factory and/or supplier 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.

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 higher costs and hardships caused by these regulations could also cause satellite customers to look to terrestrial systems to provide services previously performed by satellite systems.

The customer may also raise issues including financing or reprioritizing their business focus, thereby delaying or canceling satellite programs and their launches. Satellites can have more than one issue involved. It is not uncommon to see, for example, a satellite delayed due to both factory and launch manifesting issues.

2001 Space Industry Performance on Launch Demand

In the 2001 COMSTAC Commercial GSO Demand Model, the Working Group listed 24 satellites that were then manifested in that year. Of the 24 satellites manifested in 2001, only 13 were actually launched in 2001 along with one satellite that was not included in the forecast. And while there was a demand for 24 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 11 satellites that did not make their launch dates follows:

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

Projecting Actual Launches

As noted earlier, the first three years of the demand forecast 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 2002 is 32 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 2002 will also experience delays.

For the convenience of the reader, the Working Group has provided the compiled list of 2002 payloads in Table 5 on page 14. The participants cannot provide consensus guidance on which particular payloads may be delayed. 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 2002 will likely fall in the range of 22 to 27.

This number of payloads expected to be realized in 2002 is consistent with the historical deviation of the actual number of payloads launched in a given year and the COMSTAC assessment of maximum identified demand for that year (i.e. the 2001 forecast for year 2001, etc.). Over the nine years this report has been published, the variance between forecasted demand in the first year of the forecast and the actual number of satellites launched has averaged 23 percent. In 1997 this variance was only 12 percent while in 1999 and 2001 the variance was 42 percent. Over the first five years the variance averaged 16 percent while during the last four years this variance averaged 32 percent. In each instance, multiple types of delay factors have affected the launch schedule, preventing realization of the identified demand.

Providing guidance on realization of identified demand in 2003 and 2004 is impractical because there are many more variables in these years. Satellites originally planned for 2002 may be delayed into these later years; new satellites may add to the demand for these years as they approach; and some programs may be cancelled.

As described earlier in this report, future years of the demand forecast beyond 2004 are calculated using the inputs from U.S. satellite manufacturers and launch providers. Each company providing inputs contributes its 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 2002 survey of industry participants, the Working Group included a supplemental questionnaire for satellite service providers. The questionnaire shown on page 27 asked service providers how certain factors are impacting their plans to purchase and launch satellites. The Working Group felt that additional input from the companies who buy and operate commercial satellites was important given the current environment. The Working Group received inputs from the following 15 satellite service providers:

- Asiasat Miraxis
- Binariang
- Mobile Satellite Ventures
- Broadcasting Satellite System Corp.
- PanAmSat
- Destiny Cable Inc.
- SingTel
- Optus
- Eurasiasat
- Space Communications Corporation
- Hispasat
- StarOne
- Loral Skynet
- 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 below.

To what extent have your company's plans to purchase and/or launch a geosynchronous satellite system been impacted by the following:

	Not At All	Very Little	Somewhat	Significantly	Completely	No Response
Regional or global economic conditions	1 = 7%	0	5 = 33%	8 = 53%	0	1 = 7%
Demand for satellite services	0	0	2 = 13%	8 = 53%	4 = 27%	1 = 7%
Ability to compete with terrestrial services	1 = 7%	3 = 20%	6 = 40%	4 = 27%	1 = 7%	0
Availability of financing	0	4 = 27%	4 = 27%	6 = 40%	1 = 7%	0
Availability of affordable insurance	1 = 7%	3 = 20%	7 = 47%	2 = 13%	1 = 7%	1 = 7%
Consolidation of service providers	2 = 13%	3 = 20%	4 = 27%	4 = 27%	0	2 = 13%
Increasing satellite life times	0	6 = 40%	5 = 33%	2 = 13%	1 = 7%	1 = 7%
Availability of satellite systems that meet your requirements	2 = 13%	3 = 20%	3 = 20%	3 = 20%	3 = 20%	1 = 7%
Reliability of satellite systems	1 = 7%	1 = 7%	4 = 27%	5 = 33%	3 = 20%	1 = 7%
Availability of launch vehicles that meet your requirements	2 = 13%	6 = 40%	4 = 27%	1 = 7%	1 = 7%	1 = 7%
Reliability of launch systems	2 = 13%	4 = 27%	5 = 33%	1 = 7%	2 = 13%	1 = 7%
Ability to obtain required export licenses	1 = 7%	1 = 7%	7 = 47%	5 = 33%	1 = 7%	1 = 7%
Ability to obtain required operating licenses	2 = 13%	2 = 13%	1 = 7%	9 = 60%	0	1 = 7%

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 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 Satellite Mission Model for geo-synchronous satellites. The Mission Model update 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. Last year's report can be viewed on-line at http://ast.faa.gov/comstac_info/reports/.

The Commercial Spacecraft Mission Model is now in the process of being updated for 2002. In support of this effort, our office hereby requests inputs from your company based on your forecasts of future spacecraft and launch needs. The COMSTAC Technology and Innovation Working Group will then develop the comprehensive mission model update based on your and other industry inputs.

The FAA and the industry use this report to identify projected commercial space launch user requirements. It is also used to facilitate the planning of FAA support of the commercial space transportation industry. Your participation is important and we request your response be returned by February 23, 2002.

Attached is a table that shows the different launch mass ranges and the years that will be forecasted. Please complete this table with your forecast of potential commercial geo-synchronous satellite launches from 2002 through 2011. In addition, 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 factors (see 'Demand Questionnaire'). This will provide useful insight to underlying causes for increasing shortfalls between the demand for launches and the number of launches actually realized.

Responses should be comprehensive and represent your organization's projection of a forecast of your company's needs and/or a regional market view. Your inputs will be integrated with the inputs from other companies to create the updated mission model.

Again, your response is needed by February 23, 2002 to ensure that the mission model update is available to the FAA and the Space Industry in May 2002. Please forward this request to the department most appropriate within your organization (e.g., market analysis, marketing, contracts). The attachment will give you more detailed information on how and where to respond as well as contact points. Of course 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) 2002 Commercial Geo-Synchronous Satellite Mission Model Update Instructions
(2) Satellite Demand Forecast by Payload Mass
(3) COMSTAC 2002 Commercial GSO Launch Demand Questionnaire

2002 Commercial Geo-Synchronous Satellite Mission Model Update Instructions

As with the 2001 and previous year efforts, the goal for the 2002 COMSTAC geo-synchronous mission model update is to forecast the demand for worldwide commercial space launch requirements. This demand is based on the projected sales of geo-synchronous satellites and the size, in terms of mass, of those satellites. We are requesting your assistance in this effort by filling out the attached table with your forecast.

The forecast will be of the addressable commercial geo-synchronous satellites sales through 2011.

"Addressable" payloads in this context are those payloads that are open for internationally competitive launch service procurement. For reference purposes, if possible, please identify specific missions by name. In addition, if your forecast has changed significantly from the forecast that you submitted last year, please provide a brief explanation of the changes.

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

In addition, 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 factors (see 'Demand Questionnaire'). This will provide useful insight to underlying causes for increasing shortfalls between the demand for launches and the number of launches actually realized.

Your inputs, along with those of other satellite manufacturers, launch vehicle suppliers, and satellite services providers will be combined to form a composite view of the demand for launch services through 2011. 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. Data from all of these types of inputs are essential to assuring a complete and comprehensive forecast of the future commercial satellite and launch needs. Please indicate in your response what type of forecast you are submitting. This information will be used by corporations in their planning processes and governments in the administration of international space launch policy and decisions. As such, an accurate and realistic projection is vitally important.

We are looking forward to receiving your response by February 23, 2002 in order to support our update schedule. Your responses should be sent directly to Mr. Douglas Howe at the following address:

Douglas Howe
The Boeing Company
MC H014-C424
Huntington Beach, CA 92647-2099

Phone: 714-896-1150
Fax: 714-372-0886
Email: douglas.a.howe@boeing.com

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

To what extent have your company's plans to purchase and/or launch a geosynchronous satellite system been impacted by the following:

	Not At All	Very Little	Somewhat	Significantly	Completely
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 lifetimes					
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:

2002 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits

Executive Summary

Since 1994, the Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (FAA/AST) has prepared annual assessments of the non-geosynchronous commercial satellite launch market. The *2002 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits* (NGSO) covers commercial launch demand for global space systems expected to be deployed in orbits other than geosynchronous orbit (GSO), including low Earth orbit (LEO), medium Earth orbit (MEO), and elliptical orbits (ELI).

This year's 2002-2011 AST forecast shows a 21 percent decrease in demand for commercial launches as compared to last year's forecast. Conditions have not improved for many companies seeking financial backing to deploy satellites in NGSO. Bankruptcies and business restructuring by high-profile systems, coupled with the high cost of entering the market, continue to negatively impact investor confidence in most of the NGSO telecommunications sector. The NGSO market peaked in 1998-1999 when the number of launches per year rivaled that of the GSO market.

International science and remote sensing sectors together account for 68 percent of NGSO payloads seeking commercial launches on the open market. However, the total numbers of payloads in these two sectors have also declined slightly from previous years.

As with previous forecasts, AST has developed two scenarios assessing satellite and launch services demand: a "baseline" scenario for payloads likely to be launched and a "robust" scenario that assumes greater market demand.

Baseline Scenario: AST is forecasting an average of 6.3 launches per year during 2002-2011. This includes about two and a half launches per year for medium-to-heavy launch vehicles and about four launches per year for small vehicles.

A total of 63 launches throughout the 2002-2011 forecast are divided into the following sectors:

- 33 launches of international science and other satellites
- 16 launches of remote sensing satellites
- 14 launches of telecommunications satellites

A total of 79 payloads are forecast to seek commercial launches during 2002-2011. About 43 percent of the payload market is comprised of international science and other satellites (such as digital audio radio services), 32 percent is telecommunications (including deployment of one Big LEO system) and 25 percent is remote sensing. This year's total baseline is down 48 percent compared to last year's forecast of 151 payloads.

Robust Scenario: A more favorable market could see an increase to 84 total launches throughout the forecast period, or an average of about three medium-to-heavy vehicle launches per year and five small vehicle launches per year.

The robust payload market expands to a total of 132 payloads during 2002-2011. An increase of 44 payloads in the telecommunications sector (with one new Broadband satellite system and one Little LEO satellite system) are forecast in addition to the baseline. Under the robust scenario, telecommunications accounts for about 52 percent of the market, followed by 30 percent for international science/other and 17 percent for remote sensing. Only a few additional payloads are projected in the robust scenario for remote sensing and international science/other sectors.

Introduction

In 1990, the Federal Communications Commission (FCC) received six applications for LEO satellite constellations. These systems, later dubbed “Big LEO” systems because of their high-frequency band, represented a wave of interest in mobile telecommunications on a global scale. Development capital from investors was relatively plentiful during the 1990s, a time marked by the longest sustained growth period in U.S. economic history. By the end of 1997, applications for follow-on Big LEO systems had been filed even as the first generation began launching. In addition to mobile communications, other new services such as commercial remote sensing, broadband “internet in the sky”, and digital radio were envisioned. Prior to this, the market for commercial launches to LEO and other NGSO orbits was practically non-existent beyond the occasional launch of a scientific payload for a foreign country. This dynamic changed in 1997 with the deployment of Iridium, the first Big LEO system.

In 1998, at the apex of NGSO activity, FAA/AST projected a remarkable 1,202 payloads would be launched between 1998 and 2010. An average annual launch demand of 19 medium-to-heavy launch vehicles and nine small launch vehicles was also forecast during this period.

Despite the many FCC applications and proposals for a variety of telecommunications systems, the bulk of NGSO launch activity to date has come from three satellite systems: ORBCOMM, Iridium, and Globalstar. Together, these three systems accounted for 37 launches, or 86 percent of worldwide commercial NGSO launches during 1997-1999. Launches to NGSO during this period also accounted for 44 percent of the overall launch market, just behind launches of traditional geosynchronous orbit (GSO) satellites.

Table 8: Commercially-Competed Launches

	NGSO	GSO	**Total**
1996	2	21	**23**
1997	13	25	**38**
1998	19	21	**40**
1999	18	18	**36**
2000	9	20	**29**
2001	4	12	**16**
2002 est.	5	27	**32**

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

Since the completion of the ORBCOMM, Iridium and Globalstar deployments, NGSO activity has decreased. No new Little LEO, Big LEO, or any Broadband systems have been fully deployed and many systems under development have stalled.

Iridium, ICO Global, ORBCOMM, and Globalstar all declared bankruptcy because the number of customers needed to pay back the capital investment on these NGSO systems did not appear. Nevertheless, the new owners of Iridium and ORBCOMM continue to operate their existing satellite constellations successfully. Globalstar plans to emerge from bankruptcy and is also currently serving customers. ICO conducted one launch in 2001 and plans to launch its full system in the near future. Although no second-generation systems are expected at this time, this forecast includes a limited number of replacement satellite launches, which will occur before the end of the three active constellations’ lifespans. Some of the companies that have not deployed constellations now face the risk of losing their assigned frequency spectrum if FCC progress milestones are not met.

Regardless of the difficulties experienced by deployed NGSO systems thus far, several companies still plan to deploy NGSO systems to take advantage of the value of their licensed spectrum. One Big LEO system awaits a crucial FCC frequency determination, while seven broadband Ku-band applicants await their licenses and Little LEO companies without satellites in orbit are still active. Three Digital Audio Radio Services

(DARS) are currently operating (Worldspace, XM Radio and from NGSO, Sirius) and early success of U.S. market operators has inspired other entrants.

Table 9: Commercial Services Debuted in NGSO

Satellite Service	First Satellite Launch	Beginning of Formal Service
Narrowband Data Messaging	1995	1998
Mobile Satellite Telephony	1997	1998
High Resolution Remote Sensing	1999	1999
Digital Audio Radio Services	2000	2002

International science payloads, many belonging to nations with fledgling space programs but without a domestic launch provider, continue to have a steady effect on launch demand. Remote sensing systems are also continuing to develop as the markets and interest in using imagery of the Earth taken from space increases.

In order to assess demand for international commercial launch services resulting from the deployment of NGSO satellites, AST compiles the *Commercial Space Transportation Forecast for Non-Geosynchronous Orbits* (NGSO) on an annual basis.

Market Scenarios

There are two market scenarios used to assess NGSO launch demand through 2011: a “baseline” scenario and a “robust” scenario.

The **baseline scenario** covers the launches required to launch those systems likely to be deployed within the forecast period. The baseline scenario represents AST’s assessment of how many systems will *actually* be deployed, not how many would attract enough business to prosper after deployment.

The **robust scenario** covers the launches required in the event that market demand for NGSO satellite services is sufficiently great to support the entrance of additional service providers or expanded follow-on systems.

The results of this forecast do not indicate Federal Aviation Administration support or preference for any particular satellite system. The report does not forecast the business success of the systems. Rather, the information provided reflects an FAA/AST assessment of overall trends in the NGSO satellite markets, with the ultimate purpose of projecting future commercial space transportation demand. The satellites in the forecast are (or were) open for international launch services procurement or were sponsored by commercial entities for commercial launch.

The following sections review each market segment and present baseline and robust scenarios to address launch services demand.

NGSO Satellite Systems

"Little LEO" Telecommunications Systems

"Little LEO" satellite systems were dubbed "Little" by the FCC because they are at comparatively lower frequencies than 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.

A wide variety of commercial and quasi-commercial organizations have proposed Little LEO systems. Some use a store-and-forward approach (storing received messages until in view of a ground center) while others function as more conventional relay systems. Two-way communication between the satellite and the ground is maintained through small mobile or fixed transmitter/receivers, using low-power omni-directional antennas. Costs to deploy Little LEO systems vary between $2 million and $650 million, depending on system design. Operational and proposed Little LEO systems are shown in Table 10.

In addition, a number of proposed constellations of mini- and micro-satellites, as well as communications payloads on other satellites, exist to serve narrowband data markets. These systems are typically not drivers of demand for commercial launch services as they will be deployed as secondary payloads or as piggybacks on other satellites and, thus, will not require a dedicated launch. However, some Russian launch vehicles are small enough that these secondaries can become primaries.

Recent Developments

ORBCOMM remains the only Little LEO system that is fully deployed. The ORBCOMM constellation is comprised of 35 satellites in orbits of 825 kilometers (513 miles) in altitude. Before the last deployment launch in 1999, ORBCOMM intended to launch another series of satellites into a zero-degree plane but later opted not to do so.

ORBCOMM's services are marketed through its global network of 17 service distribution partners, which are licensed to operate in 194 countries. Its largest customers are trucking companies. Founded by Orbital Sciences Corporation (later adding major investor Teleglobe Canada), ORBCOMM was first successfully tested with the launch of two satellites in April 1995. Full operations began in November 1998. The existing system was deployed by one standard Pegasus, four Pegasus XL launches, and one Taurus launch. A small 22-kilogram (48-pound) ORBCOMM-X demonstration satellite was unsuccessful shortly after launch by Ariane 4 in 1991.

While ORBCOMM has secured a wide variety of subscribers for its service and shipped some 30,000 units, two years of operation growth was slower than expected and ORBCOMM filed for U.S. Bankruptcy Court protection in September 2000. International Licensees, LLC obtained ORBCOMM after a bankruptcy auction in April 2001. The new company changed its name to ORBCOMM Holdings, LLC and received permission from the FCC to transfer ORBCOMM licenses to the new company in March 2002.

The new firm is comprised of service providers in Europe and Asia and at least two investment firms. While Orbital Sciences no longer has a stake in the new ORBCOMM, it does have the rights to acquire up to 40 percent of the equity if it desires. Whether or not ORBCOMM will be able to launch replacement satellites is unclear.

Other potential providers of low-data-rate satellite services have struggled to gain necessary funding and in 2002 face meeting FCC milestones to retain their licenses granted in 1998.

Final Analysis, Inc. (FAI) filed for Chapter 7 bankruptcy in September 2001. In January 2002, New York Satellite Industries, LLC (controlled by an original founder) purchased the assets of Final Analysis, which included controlling shares and the FCC license of Final Analysis Communications Services, Inc. (FACS). As of April 2002, the FCC has yet to act on a milestone waiver request filed by FACS. Originally, the FAISat constellation was to consist of 26 satellites plus 4 orbiting spares. The FCC allowed the number of spares to be increased to 6 in November 2001. In April 2000, Raytheon joined General Dynamics as an equity partner in FACS, bringing total equity investment to $125 million. A launch services agreement was signed with Polyot of Omsk, Russia, for launches on Cosmos 3M from either Plesetsk or Kapustin Yar for six satellites per launch. If conditions improve, Final Analysis could launch around 2004. The first two FAISats were launched separately by Cosmos 3M in 1995 and 1997 and were built by Final Analysis with General Dynamics.

E-Sat was formed in 1994 and is currently comprised of DBSI and Echostar Communications Corporation. The company foresees future interest in data messaging from the U.S. Government for homeland security. E-Sat’s parent company, DBS Industries (DBSI), signed a seven-year agreement with Iridium Satellite in June 2001 to gain access to a space-based relay for a ground data messaging service provided by the company. Meanwhile, DBSI still plans a future launch of its own six-satellite constellation known as E-Sat on two Rockot launches. A piggyback payload called New Star to test out E-Sat technology was launched in 2001 aboard Surrey Satellite, Ltd’s SNAP-1, a 6.5-kilogram (15-pound) satellite.

Competition

Most proponents believe the data messaging market is big enough for several providers with specialized niches and different data rates and/or real vs. delay timing. However, competition comes from many poviders on the ground and from orbit. In dense urban areas, terrestrial providers are expected to dominate the market because the weaker

Table 10: Little LEO Satellite Systems

Little LEO Systems							
System	Operator	Prime Contractor	Satellites: Number + Spares	Satellites: Mass kg (lbm)	Orbit Type	First Launch	Status
Operational							
ORBCOMM	ORBCOMM Global LP	Orbital	48	43 (95)	LEO	1997	Operational with 35 satellites on orbit; FCC licensed, October
Under Development							
FAISat	Final Analysis	Final Analysis	26 + 6	151 (332)	LEO	2004	FCC licensed, March 1998; two test satellites launched in 1995
Leo One Worldwide	LEO One USA	Dornier	48	125 (275)	LEO	TBD	FCC licensed, February 1998; launch contract signed with Eurockot.
E-Sat	E-Sat, Inc.	Alcatel	6	113 (250)	LEO	TBD	FCC licensed, March 1998; launch contract signed with
Proposed							
Courier/Convert	ELAS Courier (Russia)	Moscow Inst. Thermotechnics	8 to 12	502 (1,107)	LEO	TBD	Status unknown.
Gonets-D	Smolsat (Russia)	NPO PM	36	231 (510)	LEO	TBD	Status unknown; 6 test sats launched in 1996 and 1997 based
LEO One Panamericana	LEO One Pan. (Mexico)	TBD	12	150 (330)	LEO	TBD	Status unknown; licensed for operations by the Mexican government.
LEOPACK	Space Agency of Ukraine	TBD	28	TBD	LEO	TBD	Unfunded.
Canceled							
Starsys	GE/Starsys	Alcatel	24	75 (165)	LEO	--	FCC licensed, 1995; canceled 1997.
GE Americom	GE Americom	--	24	15 (33)	LEO	--	Merged with Starsys in 1996.
GEMNet	CTA	CTA	38	45 (100)	LEO	--	CTA bought by OSC; GEMNet canceled.

"Micro" LEO Satellite and Payload Proposals							
System	Operator	Prime Contractor	Satellites: Number + Spares	Satellites: Mass kg (lb)	Orbit Type	First Launch	Status
VITASat	Volunteers in Technical	Surrey Satellite Technology, Ltd.	2	TBD	LEO	1993	FCC licensed, 1995; communications package piggybacked on
SAFIR	OHB Teledata (Germany)	OHB Systems	6	60 (132)	LEO	TBD	Status unknown.
IRIS	SAIT RadioHolland	SAIT Systems	6	60 (132)	LEO	TBD	In development; derived from SAFIR; comm payload on Resurs-
Temisat	Telespazio (Italy)	Kayser Threde	7	40 (88)	LEO	TBD	On hold; Temisat 1 launched in 1993.
Elekon	NPO PM/Elbe Space	NPO PM	7	TBD	LEO	TBD	Status unknown; comm package piggybacks on Tsikada

satellite signals do not easily penetrate buildings. Little LEO systems are expected to be competitive with conventional wireless technology in less-densely built-out and hard-to-reach areas. Big LEOs also compete with Little LEOs for similar types of data messaging services. Inmarsat, TMI and Motient (formerly American Mobile Satellite Company or AMSC) currently offer data messaging via GSO satellites.

In addition, new companies developing very small secondary payloads (that do not necessarily generate launch demand) also compete with Little LEOs.

One such small payload system is proposed by Aprize Satellite, Inc. (owned by Spacequest, Ltd.), which plans to launch two AprizeStar satellites weighing 23 kilograms (51 pounds) each on Russia’s Dnepr as early as 2003. Up to 48 additional satellites are planned, depending on business development. These could be the first U.S. satellites to launch on Dnepr.

Licensing Status

In November 2001, the FCC approved ORBCOMM’s request to increase the altitude of satellites in the equatorial plane from 825 to 975 kilometers (513 to 606 miles) and decrease the number of satellites in that plane from eight to seven. The same approval allows ORBCOMM to operate a fourth inclined plane of eight satellites launched in 1999, while reducing the number of satellites in its two near-polar planes from eight to four each.

Final Analysis has applied for an FCC satellite construction waiver.

E-Sat is attempting to get a two-year extension of its FCC license. It faces FCC progress milestones during 2002.

During 2000, ORBCOMM, Final Analysis and LEO One petitioned the FCC for authority to use additional spectrum at 1.4 GHz for feeder links. The 6 MHz of spectrum would be used for backhaul and satellite control functions. Although the United States secured this allocation at the ITU World Radio Conference 2000, the FCC later granted operators of wireless medical telemetry services half of the segment Little LEOs seek to use.

Five Little LEO systems have received licenses from the FCC: ORBCOMM, E-Sat, Final Analysis, Leo One, and VITASat. Licenses were issued in two rounds, in 1995 and 1998. Both licensing decisions were preceded by sharing agreements among the systems. Orbital Sciences Corporation, Starsys, and Volunteers in Technical Assistance (VITA) first filed applications with the FCC to operate Little LEO systems in 1990, receiving licenses in 1995 following spectrum allocation by the International Telecommunications Union (ITU) and agreement on spectrum sharing.

In 1995, a second round of filings attracted five new applicants - E-Sat, CTA, Leo One USA, Final Analysis, and GE Americom. CTA’s GEMNet and GE Americom, which merged with Starsys, were withdrawn prior to being licensed. Following a second spectrum sharing agreement, licenses were awarded in 1998 to Leo One USA, FAISat, and E-Sat. ORBCOMM and VITA received authority for modest system expansions.

Market Demand Scenarios

It is AST’s assessment that under the baseline scenario, no new Little LEO system will be deployed during the forecast period that will generate launch demand. Under the robust market scenario, AST projects deployment of one Little LEO system.

"Big LEO" and MSS Voice Systems

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 deployed to date–Iridium and Globalstar–and a third, ICO, has one satellite in orbit while it awaits an FCC determination on ground signal repeaters. Big LEO systems are detailed in Table 11.

The initial business failures of Iridium and Globalstar continue to have a detrimental impact on other commercial space ventures, including new entrants into the NGSO satellite market and the launch industry. Big LEO systems do have market niches and their orbiting operations are expected to continue for the rest of the decade.

Recent Developments

In February 2002, Globalstar declared Chapter 11 bankruptcy after disappointing customer growth since operations began in September 1999. Globalstar is expected to emerge from bankruptcy after reorganization and continue to maintain service for its 69,000 subscribers. Regional expansion continues with service introduced throughout Central Asia, including all of the former Soviet Union republics.

Globalstar introduced data modem services in December 2000 and in February 2001 opened its 25th international gateway station. The company signed an agreement with AeroAstro to provide a relay for low-cost sensor and data tracking services in March 2002.

Globalstar has reported only two satellite failures (out of 48 satellites) in the operational constellation as of April 2002. With some seven satellites experiencing anomalies, three of four spares have been activated. There are eight satellites in storage on the ground with two launches already paid for on Delta II launch vehicles. These launches can be "called-up" if needed.

Iridium Satellite purchased all the assets of bankrupt Iridium, LLC for $25 million and began operations in April 2001. Originally conceived by Motorola in 1991, development and deployment of the Iridium system of 66 operational satellites cost around $5 billion. In the length of time it took to get to market, the cellular telephone industry expanded rapidly and costs, capability, and handheld phone size decreased. After only one year of operational service, Iridium, LLC filed for bankruptcy protection in August 1999 after gaining some 63,000 subscribers. The constellation was poised on the brink of forced reentry in 2000 when Iridium Satellite stepped in. Under the restructuring arrangement, Iridium Satellite is operating debt free. The Department of Defense (DoD) awarded Iridium Satellite a contract worth $72 million for at least two years with unlimited minutes for up to 20,000 users. DoD also agreed to indemnify Iridium from any potential future damages caused by satellite reentry.

In February 2002, five new replacement satellites were launched by Boeing's Delta II and two more satellites are scheduled for launch on Russia's Rockot in June 2002. These launches were largely paid for prior to Iridium's bankruptcy filing.

Two additional satellites will bring the total orbiting system to 80 satellites (14 satellites will be orbiting spares). Thus far, 14 satellites have failed. Two partially-assembled satellites are available for launch if needed. The Iridium constellation is expected to last until 2010, longer than originally advertised. Although it is unclear yet whether Iridium Satellite can fund a follow-on system, the company has indicated it is seriously considering a second-generation system. Originally seen as primarily a voice system, about 25% of Iridium's customer traffic is now made up of data.

ICO launched the first satellite in its planned 10-satellite constellation (plus two spares) on an Atlas IIAS in June 2001. The satellite is operating in a circular orbit at an altitude of 10,390 kilometers (6,450 miles). ICO is an abbreviation for Intermediate Circular Orbit.

ICO has upgraded its satellites to target data communications and plans to offer medium-rate wireless Internet access (up to 144 kilobits per second) in addition to voice service.

ICO filed for Chapter 11 bankruptcy protection in August 1999 after raising $3.1 billion, which was insufficient to complete its constellation and ground business support systems. In December 1999, the U.S. bankruptcy court overseeing ICO's restructuring approved an investment of an additional $1.2 billion in the company by a group of investors led by Craig McCaw, a successful wireless cellular telephone network owner. McCaw's group also holds controlling interest in Teledesic, a broadband satellite company. The first ICO satellite was lost in a Sea Launch vehicle failure in March 2000. In September 2000, the company announced that Boeing would modify 11 ICO satellites and build three additional ones. With one satellite in orbit as of spring 2002, at least 10 satellites were under construction at Boeing Satellite Systems: two satellites are in storage, five are nearly complete, and another three are in various stages of assembly. Two additional satellites are planned as ground spares.

Although ICO made a rapid recovery from Chapter 11 and has invested heavily in satellite construction, its future is unclear. In March 2001, ICO petitioned the FCC for a rule amendment that would allow use of its satellite frequencies for thousands of ground antenna repeaters, enabling a better connection to data users and callers indoors and in urban "canyons" or obstructed areas. The publicly-available letter to the FCC stated that without a favorable ruling, 2-GHz mobile satellite systems are not economically viable. The request has caused concern among cellular telephone companies who believe spectrum for ground use should be competitively bid in an auction. While cellular companies are paying for spectrum, satellite companies are not. Under the 2000 "Orbit Act" (Public Law 106-180) the FCC "shall not have the authority to assign by competitive bidding orbital locations or spectrum used for the provision of international or global satellite communications services."

Other satellite companies, including Iridium, are interested in using ground repeaters but rules governing the use of ground repeaters have not yet been established. The FCC could rule on the issue in the summer of 2002. If the decision is favorable to ICO and additional funding becomes available, ICO could resume launches around 2004 and begin rollout of services thereafter. The FCC license for 2 GHz requires the first two satellites to be launched by January 2005.

After lengthy debate, a merger between ICO and Teledesic was officially called off in November 2001. The companies are now considered independent, yet complementary.

Although Big LEOs have been proposed by Russian organizations and by other international companies, they appear to remain unfunded.

Licensing Status

In July 2001, the FCC issued licenses to eight companies, allowing them to deploy mobile satellite systems operating in the 2-GHz range. Under the terms of these licenses, satellite construction contracts for these satellites must be signed by July 2002. The companies that received these licenses are Constellation Communications, Globalstar, Iridium Satellite, ICO, Mobile Communications Holdings, Celsat, TMI and Boeing. Iridium and Globalstar have indicated they continue to plan to use these frequencies.

Big LEOs began in 1990 when the FCC received applications from six companies for Big LEO systems to provide mobile satellite services. Following a spectrum sharing plan, licenses were granted to Iridium, Globalstar, and Odyssey in January 1995. AMSC (Motient) withdrew its application prior to the granting of licenses for ECCO and Ellipso in the summer of 1997.

In September 1997, the FCC received applications for 2-GHz systems, including Iridium Macrocell, Globalstar GS-2, ECCO II, Ellipso 2G, and Boeing's 16-satellite MEO system for the commercial airline industry. At the same time, ICO Global Communications filed a letter of intent with the FCC to operate a 2-GHz system in the United States. Following the September 1997 application, TRW withdrew its Odyssey application and joined with ICO.

In August 2000, the FCC released a "Report & Order" concluding that sufficient spectrum would be available for 2-GHz mobile satellites systems. The report stated that the FCC will allocate spectrum based on the number of systems deployed, not the number of systems licensed.

Market Demand Scenarios

It is AST's assessment that under the baseline scenario, one new Big LEO system will be deployed in addition to Iridium and Globalstar. No additional systems under the robust scenario are anticipated.

Table 11: Big LEO Satellite Systems

System	Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
			Number + Spares	Mass kg (lb)			
Operational							
Globalstar	Globalstar LP	Alenia Spazio	48 + 8	447 (985)	LEO	1998	Constellation on-orbit and operational; FCC licensed, January 1995.
Iridium	Iridium Satellite LLC	Motorola	66 + 14	680 (1,500)	LEO	1997	Assets acquired in December 2000 bankruptcy proceeding. Data operations started in 6/1/01.
Under Development							
Big LEO							
ECCO	Constellation Communications	Orbital	46 + 8[1]	703 (1,550)	LEO	2001	FCC license granted July 1997; Orbital chosen as satellite, launch contractor, May 1998.
Ellipso	Mobile Comm. Holdings (MCHI)	Boeing	16 + 1	998 (2,200)	LEO & ELI	2001	FCC license granted July 1997, which was subsequently revoked in May 2001 for failure to meet required milestones. MCHI is appealing the decision.
2.0 GHz							
ICO	New ICO Global Communications (Holdings), Inc.	Boeing	10 + 2	2,744 (6,050)	MEO	2001	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							
Boeing 2.0 GHz	Boeing	Boeing	16	2,903 (6,400)	MEO	2005 est.	FCC license granted July 17, 2001. System will be used for air traffic management. Must sign construction contract by July 2002 to retain FCC license.
ECCO II	Constellation Communications	TBD	46 + TBD	585 (1,290)	LEO	2005 est.	FCC license granted July 17, 2001. Must sign construction contract by July 2002 to retain FCC license.
Ellipso 2G	Mobile Comm. Holdings (MCHI)	TBD	26 + TBD	1,315 (2,900)	LEO & ELI	2004 est.	FCC license granted July 17, 2001. Must sign construction contract by July 2002 to retain FCC license.
Globalstar GS-2	Globalstar LP	TBD	64 + 4	830 (1,830)	LEO[2]	2004 est.	FCC license granted July 17, 2001. Must sign construction contract by July 2002 to retain FCC license.
Iridium/Macrocell	Iridium Satellite LLC	TBD	96 + TBD	1,712 (3,775)	LEO	2005 est.	FCC license granted July 17, 2001. Iridium also interested in ground repeater system for urban canyons. Must sign construction contract by July 2002 to retain FCC license.
International							
ECO-8	Brazilian Space Agency	TBD	11 + 1	250 (550)	LEO	TBD	Study resumed in August 1998; frequency use coordinated with ITU.
Gonets-R	Smolsat (Russian)	NPO PM	48	953 (2,100)	LEO	TBD	Status unknown.
Koskon	Koskon Consortium (Russian)	AKO Polyot	45	862 (1,900)	LEO	TBD	Status unknown; payload tested in 1991.
Marathon/Mayak	Informkosmos	NPO PM	10	2,510 (5,533)	ELI[3]	TBD	Status unknown.
Rostelesat	Kompomash (Russian)	TBD	115	839 (1,850)	LEO & MEO	TBD	Concept definition complete; awaiting funding.
Signal	KOSS Consortium (Russian)	NPO Energia	48	308 (680)	LEO	TBD	Status unknown.
Tyulpan	NPO Lavotchkin (Russian)	TBD	6	1,089 (2,400) - 1,179 (2,600)	MEO	TBD	Status unknown.
Canceled							
AMSC	American Mobile	--	12	2,495 (5,500)	MEO	--	FCC application withdrawn, January 1997.
Odyssey	TRW	TRW	12	2,214 (4,880)	MEO	--	FCC licensed; system canceled in 1997.

(1) ECCO to initially consist of 12 satellites in equatorial orbit; 42 satellites in inclined orbit to follow.
(2) Globalstar GS-2 also requested authority to operate 4 GEO satellites in conjunction with the LEO.
(3) Marathon is also proposed to include three Arcos GEO satellites, in conjunction with the ELI.

"Broadband LEO" Systems

The broadband satellite market is perhaps the most speculative. While a tremendous market for high-speed data services is evident, based on growing demand for such services by businesses and consumers alike, the satellite industry has yet to capitalize on this interest. The race to provide broadband connectivity has accelerated as the Internet emerged into the mainstream around 1997. 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 service urban areas that are unwired and can also reach remote customers that conventional landline services may not even attempt to access (because of high installation expenses). In some cases, satellites and landlines are complementary, using each other as conduits to reach end users.

Proposed "Broadband LEO" systems would provide high-bandwidth data links using Ku-band (12/17 GHz), Ka-band (17/30 GHz), V-band (36/45 GHz), and Q-band (46/56 GHz) frequencies. The term "broadband" encompasses a variety of multimedia services funneled at high data speeds. Large amounts of audio, video, and data can be transmitted rapidly in comparison to low-bandwidth pathways such as copper telephone wiring. Applications such as video teleconferencing and high-speed Internet access are possible using Broadband LEO systems.

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. However, two planned Ka-band systems, WildBlue and Astrolink, suspended activity by early 2002 because of a lack of funding, although another dedicated system, Spaceway, plans to launch in 2003.

While NGSO systems can provide more focused coverage, offer higher data rates, reuse spectrum efficiently and have no latency (signal delay which could impact interactive users) compared to GSO-based systems, high start-up costs of $4-10 billion or more have slowed NGSO development. Another problem faced by NGSO systems (and not just broadband) is rapid change of communications technology: by the time a space system is designed and orbited, it may be obsolete or the consumer/business market may have shifted away from it.

Although some commercial NGSO satellite ventures have been damaged by the emergence of more-competitive terrestrial alternatives, generally the problems and uncertainty encountered by Broadband LEO systems are similar to those experienced by terrestrial broadband providers. One example is Global Crossing, a fiber optic network service provider which filed for Chapter 11 bankruptcy protection in January 2002; the $24 billion bankruptcy was the fourth-largest ever to be filed by a U.S. company. Excite@Home, a company that offered broadband data services to cable television subscribers, filed for Chapter 11 protection in 2001 and ceased operations in February 2002. Several other terrestrial broadband companies, including Flag Telecom, Metromedia, and Williams Communications, have either filed for Chapter 11 or considered doing so.

Broadband systems are summarized in Table 12.

Recent Developments

In January 2002, on the eve of their FCC milestone deadline, Teledesic LLC announced satellite contracts for the first two of a planned 30-satellite MEO constellation. Teledesic must launch the first satellite by September 2004 and have a full system operational by 2007 in order to protect its FCC license.

Formed in 1990, Teledesic was granted an FCC license in 1997 for an 840-satellite system that was eventually reduced to 288 satellites in early 1999. The ITU allocated significant spectrum for NGSO fixed satellite systems (FSS) such as Teledesic in 1997. The current plan is to begin service for fixed users in 2005 with 12 satellites weighing around 1,000 kilograms (2,200 pounds) each. The cost of the system, including launch services, will be around $1 billion. The satellites are less complex than previous designs. Later, the constellation will be expanded with an additional 18 larger satellites. The full 30-satellite constellation will provide global coverage.

Teledesic is considering launching its first two satellites on two separate launch vehicles. A Request For Information was sent to industry launch providers in April 2002 for the first 2 satellites and an option on the next 10 satellites. Previously, in 1999, a launch services agreement was signed with International Launch Services (ILS) for three Atlas launches and three Proton M launches plus options.

Table 12: Broadband LEO Satellite Systems

System	Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
			Number	Mass kg (lbm)			
Under Development							
Ka-Band							
Teledesic	Teledesic LLC	Alenia Spazio[1]	30 + 3	1,000 (2,205) and 3,455 (7,617)[2]	MEO	2004 est[3]	FCC licensed, March 1997; license amended Jan 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.
Ku-Band							
SkyBridge	SkyBridge LP	Alcatel Espace	80	1,247 (2,750)	LEO	TBD	FCC license applied for, February 1997.
Proposed							
Ka-Band							
@Contact	@Contact LLC	TBD	16 + 4	3,175 (7,000)	MEO	2005 est.	FCC license applied for, December 1997
LM-MEO[4]	Lockheed Martin	Lockheed Martin	32	2,177 (4,800)	MEO	2005 est.	FCC license applied for, December 1997
SkyBridge II	SkyBridge LP	Alcatel Espace	96	2,654 (5,850)	LEO	2005 est.	FCC license applied for, December 1997
Spaceway NGSO	Hughes Comm. (HCI)	Hughes Space & Comm. (HSC)	36	2,858 (6,300)	MEO[5]	2005 est.	FCC license applied for, December 1997
Ku-Band							
Boeing NGSO FSS	Boeing	TBD	20	3,862 (8,515)	MEO	2005 est.	FCC license applied for, January 1999.
HughesLINK	Hughes Comm. (HCI)	Boeing Satellite Systems	22	2,937 (6,475)	MEO	2005 est.	FCC license applied for, January 1999.
HughesNET	Hughes Comm. (HCI)	Boeing Satellite Systems	70	1,996 (4,400)	LEO	2005 est.	FCC license applied for, January 1999.
Teledesic Ku-Band Supplement	Teledesic LLC	TBD	30 + 6	1,325 (2,920)	MEO	2005 est.	FCC license applied for, January 1999.
Virtual GEO Satellite (VIRGO)	Virtual Geosatellite LLP	TBD	15 + 3	3,030 (6,680)	ELI	2005 est.	FCC license applied for, January 1999.
V/Q-Band							
Globalstar GS-40	Globalstar LP	TBD	80 + TBD	1,225 (2,700)	LEO	2005 est.	FCC license applied for, September 1997
GESN (Global EHF Satellite Network)[6]	TRW	TRW	15	5,965 (13,150)	MEO[7]	2005 est.	FCC license applied for, September 1997
LM-MEO[4]	Lockheed Martin	Lockheed Martin	32	2,177 (4,800)	MEO	2005 est.	FCC license applied for, December 1997
Orblink	Orbital	Orbital	7 + TBD	2,019 (4,450)	MEO	2005 est.	FCC license applied for, September 1997
Pentriad[8]	Denali Telecom	TBD	9 + 3	1,996 (4,400)	ELI	2005 est.	FCC license applied for, September 1997
Starlynx	Hughes Comm. (HCI)	Boeing Satellite Systems	24	3,493 (7,700)	MEO[9]	2005 est.	FCC license applied for, September 1997
Teledesic V-Band Supplement (VBS)	Teledesic LLC	TBD	72 + 36	612 (1,350)	LEO	2006 est.	FCC license applied for, September 1997

(1) Alenia Spazio is only contracted for the first two satellites in constellation.
(2) First 12 satellites are approximately 1,000 kg (2,205 lb), next 18 will be 3,455 kg (7,617 lb)
(3) Teledesic launched the T-1 experimental satellite in February 1998.
(4) Lockheed Martin's MEO application is for both Ka- and V/Q-band.
(5) Spaceway NGSO to be operated with 16 Spaceway GEO satellites.
(6) The GESN system will also use Ka-band frequencies for downlinks.
(7) TRW plans to operate 4 GEO sats with the 15 GESN MEO satellites.
(8) Denali Telecom's application for Pentriad also includes a Ku-band component.
(9) Starlynx plans to operate 4 GEO satellites in conjunction with its MEO system.

SkyBridge plans an 80-satellite constellation with 140 earthstations capable of supporting 20 million users. The French-led company requires an estimated $6-7 billion in capital. In February 2001, Skybridge announced it would enter the broadband market by leasing transponders on existing GSO satellites, calling into question the development of a dedicated NGSO system. The move was made because of the inability to attract investment from telecommunications companies. As of April 2002, SkyBridge GSO activity has not been announced.

Prior to its decision to lease GSO transponders, SkyBridge signed a contract in December 1999 with Boeing to launch 40 satellites on two Delta III launch vehicles and four Delta IVs. Five months later, SkyBridge signed a second launch deal with Starsem, the French-Russian joint launch company, for launch of 32 satellites on 11 Soyuz/Fregat vehicles. Both Boeing and Starsem took equity positions in the company.

SkyBridge's plans were first announced in 1997 after a consortium was formed in 1993. Partners include Alcatel, the French space agency (CNES), and Loral Space & Communications. Alcatel has stopped development work on SkyBridge satellites until more equity is obtained. Loral's contribution began with a 14 percent investment. The satellite design phase has been completed.

Licensing Status

Currently, only one applicant, Teledesic, has received a license from the FCC to operate a Broadband LEO system. In February 2002 Teledesic filed an application to modify its system license to reduce the size of its constellation to 30 satellites; that modification is currently under review by the FCC.

The FCC has yet to issue any licenses for Ku-band NGSO systems, but has been making progress on the several existing applications and is expected to render a decision by end of 2002. In April 2002 the FCC released a Report and Order describing spectrum-sharing rules to avoid interference among NGSO and GSO Ku-band systems. At the same time the FCC released a Further Notice of Proposed Rulemaking on measuring limits on transmission power of Ku-band systems. Previous concerns about Ku-band interference between NGSO and GSO systems were overcome when the World Radio Conference 2000 approved technical and regulatory parameters to allow NGSO systems to share Ku-band spectrum with GSO systems. One Ku-band NGSO system, SkyBridge, did receive a license from the French equivalent of the FCC, the Autorité de Régulation des Télécommunications, in February 2000.

Currently there are three application "processing rounds" pending at the FCC for proposed broadband systems. More than 20 applications involving satellites in NGSO orbits or with GSO systems have been submitted. An application filing window closed for use of the V-band (36/45 GHz) and Q-band (46/56 GHz) frequencies in September 1997. In December 1997, applications were filed in the Ka-band and, in January 1999, applications were filed for the Ku-band.

Market Demand Scenarios

It is AST's assessment that, under the baseline scenario, no Broadband LEO system will be deployed through 2011. This is the result of lost investor confidence in NGSO systems, high start-up costs, competition from terrestrial services, competition from GSO broadband services, slow customer acceptance of existing broadband GSOs, and general uncertainty in business strategies thus far. Under the robust scenario however, AST projects that one Broadband LEO system will be deployed.

Remote Sensing Systems

Worldwide, the number of commercial remote sensing systems is slowly increasing. The availability of sophisticated optical sensors capable of distinguishing objects as small as a half-meter, coupled with the rapid development of the Internet and other computer technologies needed to distribute and download large imagery data files, has made satellite imagery available to a growing customer base. More governments and private organizations around the world will become remote sensing consumers to fulfill their resource management and intelligence gathering requirements.

Over the next ten years, remote sensing activity will include launches of satellites with sub-meter-resolution sensors, the introduction of commercially-available hyperspectral imagery, and the deployment of small constellations of satellites designed to increase temporal frequency of observation, or revisit time.

As of early 2002, five dedicated remote sensing satellites are being operated by commercial organizations (OrbView 1, OrbView 2, IKONOS, EROS A1, and QuickBird), with more commercial imagery provided by systems funded by government agencies. The United States is well-positioned to compete in the commercial remote sensing satellite industry, with ORBIMAGE, Space Imaging, and DigitalGlobe all offering high-resolution images to clients around the world. However, since the industry is still in its infancy and commercial demand is relatively low, these companies depend on anchor tenants to maintain their viability. To achieve this end they seek to acquire and maintain relationships with both government and commercial clients. Commercial remote sensing companies have had a difficult time securing anticipated government clients in the U.S. because of the continuing evolution of remote sensing law and policy and the government's highly successful remote sensing and intelligence programs. Terrorist activity during 2001 has, however, increased government interest in potential relationships with commercial providers.

Remote Sensing systems are summarized in Table 13.

The National Oceanic and Atmospheric Administration (NOAA) has been delegated by the Department of Commerce to ensure that commercial remote sensing satellites meet certain legal and technical criteria. NOAA's licensing program was initiated in 1984, although the first license was not granted until 1993. NOAA has issued 18 licenses for remote sensing operations. The most recent license was issued on March 6, 2002 to TransOrbital, a U.S. company that plans to image both the Earth and the Moon. A NOAA license is required only for the Earth-imaging portion of the mission. There are no progress milestones required to keep a NOAA license. See Table 14 for a list of licensees.

Remote Sensing Companies

ORBIMAGE was the first company to launch a commercial remote sensing satellite. Both 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, is planned for launch in late 2002. OrbView 4 was lost to a launch failure in 2001. It is unclear what ORBIMAGE plans as a follow-on system, but because of financial difficulties, it is believed no further satellites will be launched during the forecast period. The company filed Chapter 11 bankruptcy in April 2002 and is expected to reemerge before the launch of Orbview 3.

Space Imaging, founded in 1994, provides commercially-available imagery from its IKONOS satellite. Launched in 1999, IKONOS was the first commercial space platform with image resolution of one meter. On December 6, 2000, Space Imaging was granted authorization by NOAA to develop a satellite capable of generating 0.5-meter imagery. The satellite, currently referred to as Block 2, is planned for launch in 2005. Block 2 is expected to have a design life of seven years like its predecessor, IKONOS. In addition to imagery from its own satellite, Space Imaging also markets images from Landsat 7, India's IRS satellites, and Canada's Radarsat 1.

DigitalGlobe, formerly EarthWatch, was established in 1993 and was granted the first 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 II 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 2005 or 2006, shortly before the end of QuickBird's design life. In March 2002, DigitalGlobe won one of two study contracts under the Landsat Data Continuity Mission (LDCM), a program established by NASA in lieu of the government-funded Landsat 8 project. DigitalGlobe will explore concepts for a 2005-2006 Landsat follow-on mission.

Resource21 was established by Boeing, BAE Systems, Farmland and the Institute for Technology Development. It is intended 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. While its satellite plans remain in the conceptual stage, Resource21 plans to develop and launch at least one LEO satellite with 10-meter resolution regardless of the winner of the LDCM.

GER, founded in 1980 as a provider of instruments and aerial imagery for a variety of mapping applications, recently established a space division responsible for developing the GEROS remote sensing system. GEROS will consist of six LEO remote sensing satellites designed to obtain images of the Earth in panchromatic, infrared, and multispectral bands ranging from 1.5-meter to 10-meter resolution. As of 2002, however, GER had not yet secured funding for the constellation, and it remains unclear if the company will launch their first satellite by the planned 2005 milestone.

ImageSat, founded as West Indian Space in 1997, provides commercial imagery through its 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 five satellites, with the initial launch of EROS B1 expected in 2003. All the satellites have a standard resolution of 1.8 meters, but can be programmed to obtain images with resolution less than a meter.

Radarsat International, formed in 1989 to operate Radarsat 1, is now a subsidiary of MacDonald Dettwiler and Associates. Both companies are based in Canada. Radarsat 1, launched in 1995 aboard a Delta II, has gathered radar data covering most of the Earth and provides radar imagery with resolutions between 8 and 100 meters. Radarsat 2, planned for launch in 2003, will continue the mission of its predecessor, and is expected to work in tandem with Radarsat 3, which is currently in the early development stages. Despite substantial support from the Canadian Space Agency (CSA) in the beginning, Radarsat and its ground support infrastructure are now operated commercially by MacDonald Dettwiler and Associates.

Market Demand Scenarios

AST projects that the remote sensing sector will yield about 20 payloads in the baseline forecast with three additional payloads in the robust forecast.

Table 13: Commercial Satellite Remote Sensing Systems

System	Operator	Manufacturer	Satellites	Mass kg (lb)	Highest Resolution (m)	Launch Year	Status
Operational							
EROS	ImageSat International	Israel Aircraft Industries	EROS A1 EROS B1-B5	280 (617) 350 (771)	1.5 1.5	2000 2003	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 2005	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) 185 (408) 185 (408)	10,000 1,000 1 1	1995 1997 2002 2001	OrbViews 1 and 2 continue to operate. OrbView 4 lost due to launch vehicle failure.
QuickBird	DigitalGlobe	Ball Aerospace	QuickBird 1 QuickBird	815 (1797) 909 (2004)	0.6 0.6	2000 2001	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 2003 TBD	Radarsat 1 continues to operate. Radarsat 3 will launch "a few years after Radarsat 2" and will work in tandem.
Development and Proposed							
GEROS	GER Corp.	GER	GEROS 1-6	800 (1,760)	12	2005	Company is seeking funding and launch provider for system.
RapidEye	RapidEye AG	Surrey Satellite Technology Limited	RapidEye 1-4	380 (837)	6.5	2004	RapidEye part of DLR Earth monitoring mission, but will be operated by commercial entity.
RS	Resource21	Boeing	RS 1	1,200 (2,646)	10	2005	Will proceed with program regardless of LDCM status.
Landsat Follow On	TBD	TBD	TBD	TBD	TBD	2005	Phase One Landsat Data Continuity Mission contract awarded to DigitalGlobe and Resource21.

Table 14: 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	

International Science and Other Payloads

As an increasing number of countries establish civil space science programs, the demand for commercial launch services remains somewhat constant since several nations lack domestic launch services. International governments and research organizations launch small spacecraft to conduct scientific research in LEO, including microgravity, life sciences, and communications experiments. Typically, the scientific community is on a modest budget, so the demand leans toward low-cost, small launch vehicles. In the past three years, science or demonstration payloads have been launched commercially for operators in Sweden, Germany, Malaysia, Italy, South Korea, and Taiwan. The 1994 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.

Digital Audio Radio Services

Sirius Satellite Radio (formerly CD Radio) launched three satellites to elliptical orbit (ELI) in 2000 and rolled out service in 2002. Its main U.S. rival, XM Satellite, operates two satellites in GSO. Early subscriber successes and enthusiastic responses from users have generated interest from at least two other companies in providing service to the European continent. Global Radio, based in Luxembourg, announced in 2002 it hoped to begin service in 2005 with satellites in ELI. World Space has been providing radio service from GSO to listeners in Africa and is considering adding service to Europe as well.

Market Demand Scenarios

AST projects that approximately 34 payloads of international science or other origin will be launched under the baseline scenario. This is the largest single market sector of the baseline satellite and launch demand forecast. In the robust scenario, AST projects a slight increase to 40 payloads.

Future Markets

With a reduction in the number of telecommunications satellites bound for NGSO, the question arises, what will be the next new market? When *2001: A Space Odyssey* was released in 1968, the film depicted Pan American Airlines flying commercial low Earth orbit flights to a space station with a Hilton hotel. During 1968, there were only some eight total geosynchronous satellites in orbit of which two or three were quasi-commercial.

Fast forward to the year 2001, with over 220 commercial satellites operating in GEO and the world’s 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 and more tourist missions are planned at a rate of about two per year. With customers willing to pay $20 million per launch, clearly, there is an existing market for public space travel. With regards to the NGSO forecast, however, the Soyuz tourist activities involve selling the third seat on regularly-scheduled return vehicle exchange missions and would have been launched with or without a paying passenger. Since the paying customer did not generate the primary demand for the launch, public space travel is not yet a part of this NGSO forecast.

Another potential market is commercial ISS resupply missions. It is unclear if other markets such as space-based manufacturing or orbiting hotels will emerge with associated launch demand by 2011.

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.

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 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. (This is a change from previous NGSO forecasts although, in many cases, future activity was beyond the timeframe of the forecast.) At this time, for Big and Little LEO satellite systems, it is unclear that market conditions will allow for follow-on systems. Previously-purchased launches of replacement satellites for systems that emerged from bankruptcy are included.

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

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) to a 185 kilometers (100 nautical miles) altitude and 28.5° inclination.

Commercial non-geosynchronous systems use a variety of orbits, including:

- 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.

Payload and Launch Forecast

In the *2002 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits*, payload and launch projections are lower than in the 2001 forecast. These numbers reflect reduced expectations in the telecommunications sector and a slight decline in international science and remote sensing activity.

Baseline Scenario

The baseline scenario anticipates the deployment of:

- No new Little LEO systems in addition to the already-deployed ORBCOMM. This is one less than the 2001 forecast.
- One additional Big LEO system to join the already-deployed Iridium and Globalstar systems. The latter two are planning some replacement launches but not full system replenishment at this time. This is the same number of systems projected in 2001.
- No new Broadband LEO systems.
- International science and other payloads will comprise about 43 percent of payload market.
- Remote Sensing will encompass about 25 percent of the market with about 20 payloads.

Table 15 and Figures 11 and 12 show the baseline forecast in which 79 payloads will be deployed between 2002 and 2011. This total, accounting for multiple manifesting on launch vehicles, yields a commercial launch demand of about 63 launches over the forecast period. This demand breaks down into about 2.5 launches annually on small launch vehicles and 4 launches annually on medium-to-heavy launch vehicles. In comparison to last year's forecast of 151 total payloads (2001-2010), this year's projections are down 48 percent. The 2000 baseline forecast covered 11 years (2000-2010) and contained 440 payloads. The current launch count is down 21 percent from last year's prediction of 80 launches over 10 years.

The combined telecommunications sectors (Little LEO, Big LEO and Broadband) together account for only 32 percent of the total payload market, a dramatic decrease from previous forecasts. Allowing for multiple manifesting, the launch demand forecast from the remote sensing sector is slightly higher than the demand from the telecommunications sector (16 launches compared with 14, respectively). With 33 launches projected, international science and other payloads such as digital audio radio account for about 52 percent of the launch demand through 2011.

Table 15: Baseline Market Scenario Payload and Launch Forecast

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL	Avg
Payloads												
Big LEO	7	0	10	4	0	4	0	0	0	0	25	2.5
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	2	4	4	3	4	3	4	3	4	3	34	3.4
Remote Sensing	1	2	8	5	1	0	0	1	1	1	20	2.0
Total Payloads	**10**	**6**	**22**	**12**	**5**	**7**	**4**	**4**	**5**	**4**	79	7.9
Launch Demand												
Medium-to-Heavy Vehicles	1	1	11	8	1	1	0	0	0	1	24	2.4
Small Vehicles	4	4	4	4	4	3	4	4	5	3	39	3.9
Total Launches	**5**	**5**	**15**	**12**	**5**	**4**	**4**	**4**	**5**	**4**	63	6.3

Figure 11: Baseline Market Scenario Payload Forecast

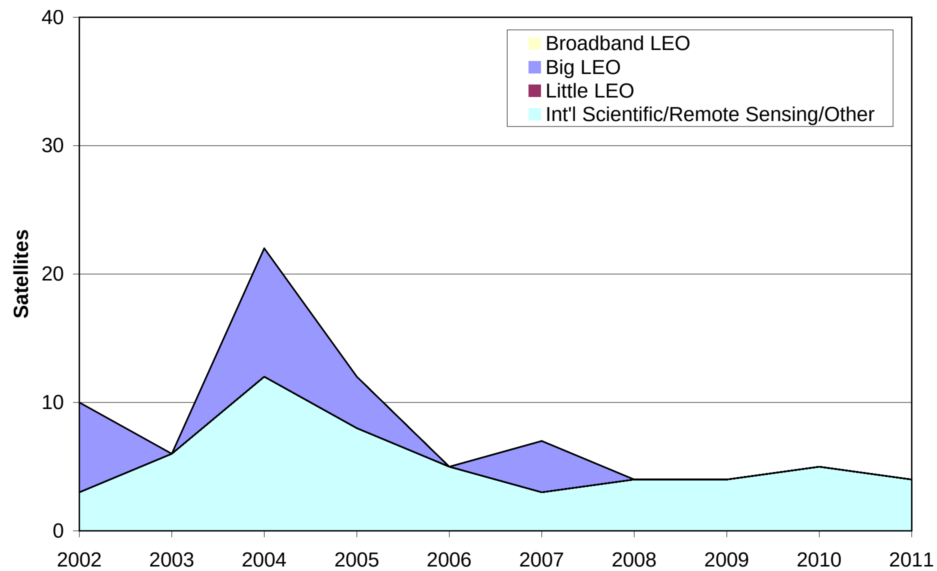
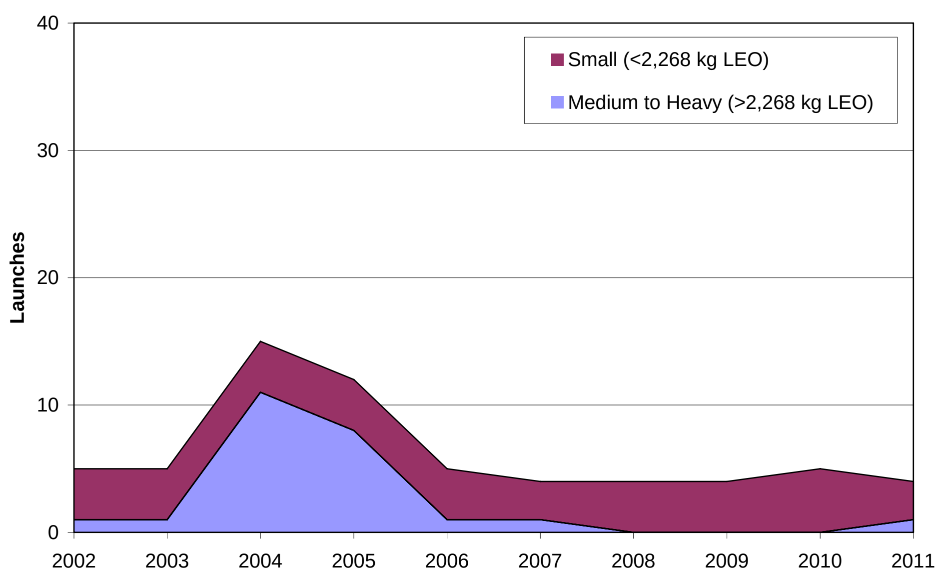


Figure 12: Baseline Market Scenario Launch Demand Forecast



Robust Scenario

The robust scenario reflects payloads and launches that could be deployed under more positive market conditions, in addition to those already included in the baseline forecast. Under the robust scenario, AST projects:

- One additional Little LEO constellation, in addition to ORBCOMM. This is a reduction of one from the 2001 robust scenario.
- No additional Big LEO systems to join the baseline total, the same as 2001. No second-generation systems are currently identified or expected to be deployed in the forecast period.
- One Broadband NGSO system, which is the same as last year's robust scenario.
- About six additional international science or other payloads will be deployed
- Three additional remote sensing systems will be deployed.

The robust scenario projects in Table 16 and Figures 13 and 14 that 132 payloads will be deployed between 2002 and 2011. This total is down 36 payloads from last year's forecast.

The telecommunications sector sees an increase of about 44 payloads in the robust forecast over the baseline, translating to 10 additional launches.

For launch demand under the robust scenario, a total of 84 launches is projected, translating into an average of five small launch vehicle launches annually and about three launches annually for medium-to-heavy launch vehicles. The 2001 ten-year launch demand projected 104 total launches, or 10.4 per year, split between seven small launch vehicles and three medium-to-heavy launch vehicles. The robust launch demand is down 19 percent from last year.

Despite the presence of more overall telecommunications payloads compared to international science/other in the robust scenario, 69 vs. 40, respectively, the resulting number of launches in the international science/other sector is higher than the number of launches for telecommunications, 39 vs. 24, because of the tendency for more multiple manifesting of telecommunications payloads.

Table 16: Robust Market Scenario Payload and Launch Forecast

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL	Avg
Payloads												
Big LEO	7	0	10	4	0	4	0	0	0	0	25	2.5
Little LEO	0	0	6	24	2	0	0	0	0	0	32	3.2
Broadband	0	0	8	4	0	0	0	0	0	0	12	1.2
International Scientific/Other	2	4	4	3	5	4	5	4	5	4	40	4.0
Remote Sensing	1	2	8	5	1	1	0	2	1	2	23	2.3
Total Payloads	**10**	**6**	**36**	**40**	**8**	**9**	**5**	**6**	**6**	**6**	132	13.2
Launch Demand												
Medium-to-Heavy Vehicles	1	1	15	10	1	1	1	1	0	1	32	3.2
Small Vehicles	4	4	5	8	6	5	4	5	6	5	52	5.2
Total Launches	**5**	**5**	**20**	**18**	**7**	**6**	**5**	**6**	**6**	**6**	84	8.4

Figure 13: Robust Market Scenario Payload Forecast

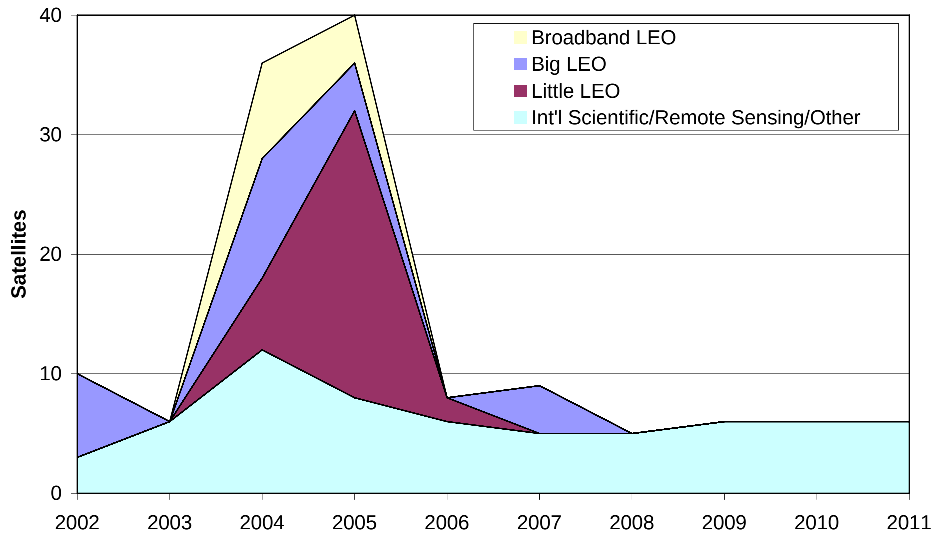
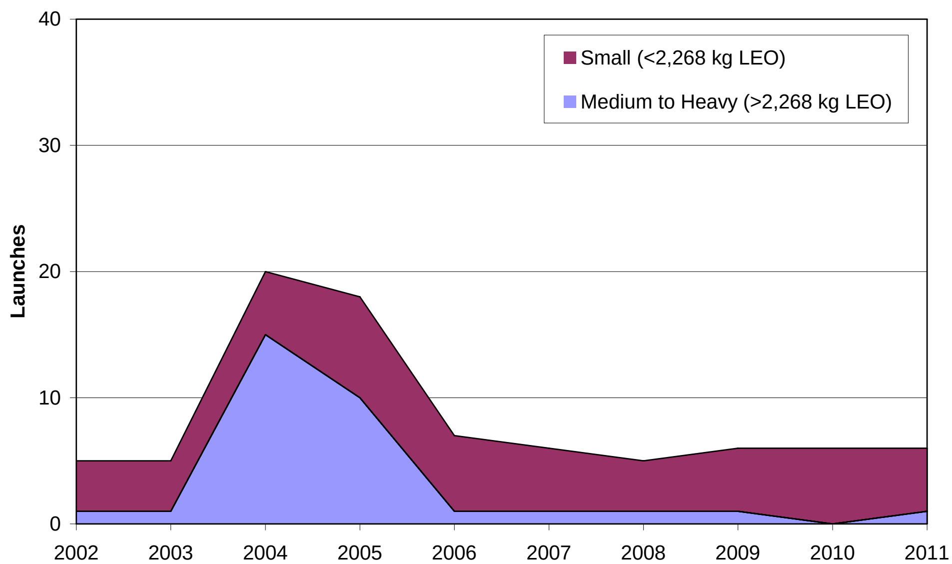


Figure 14: Robust Market Scenario Launch Demand Forecast



Historical NGSO Market Assessments

A historical comparison of AST baseline forecasts from 1998 to the present is in Figure 15. 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, 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, AST has reduced its annual forecasts as demand in the marketplace fell. This year's forecast estimates only 5 launches during 2002. 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 first time since AST began forecasting, the number of baseline international science payloads and remote sensing payloads combined are more than those in the telecommunications sector throughout the entire forecast.

Table 17: Historical Commercial NGSO Activity*

	1994	1995	1996	1997	1998	1999	2000	2001
Payloads								
Big LEO	0	0	0	46	61	42	5	1
Little LEO	0	3	0	8	18	7	0	0
Remote Sensing/Int'l Science/Other	0	2	2	3	4	7	13	3
Total Payloads	**0**	**4**	**2**	**57**	**83**	**56**	**18**	**4**
Launches								
Medium to Heavy vehicles	0	0	1	8	9	11	6	1
Small vehicles	0	2	1	5	10	7	3	3
Total Launches	**0**	**2**	**2**	**13**	**19**	**18**	**9**	**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.

Table 17 lists actual payloads launched by market sector and total commercial launches that were internationally-competed from 1994-2001. Medium-to-heavy vehicles had 36 launches during this period while small vehicles had 31. The 2002 forecast estimates launch demand for more small vehicle launches (39) than medium-to-heavy vehicle launches (24) from 2002-2011.

Historical payload and launch data for the period 1993 to 2001 are shown in Table 18. Secondary and piggyback payloads on launches with larger primary payloads were not included in the payload or launch tabulations.

Figure 15: Comparison of Past Baseline Launch Demand Forecasts

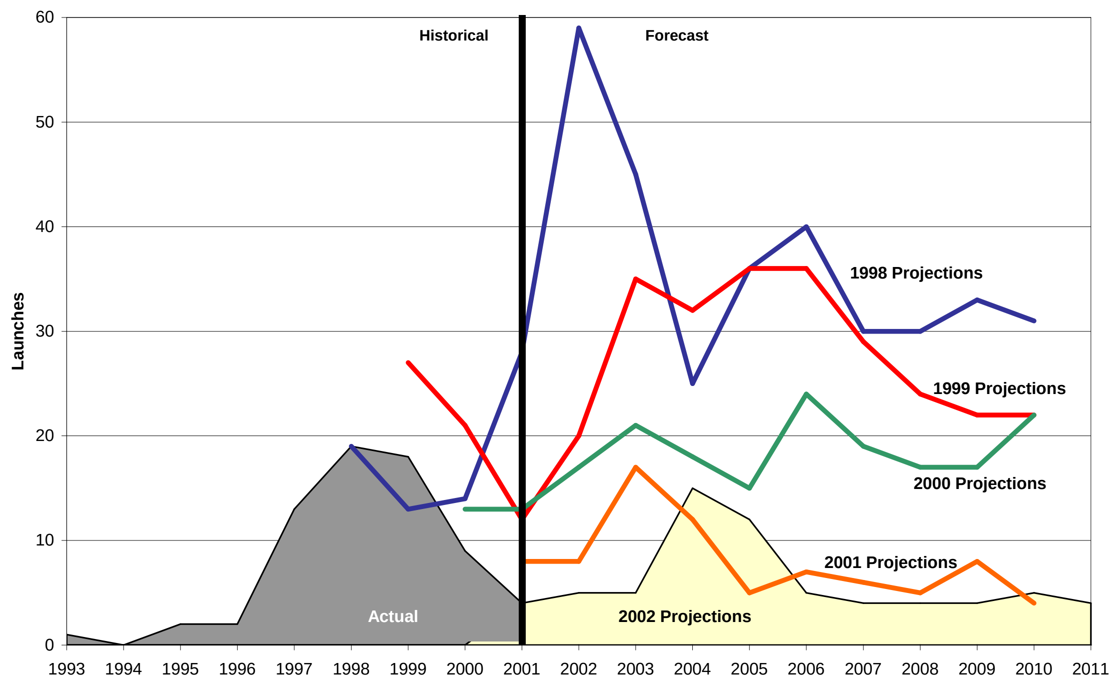


Table 18: Historical NGSO Payload and Launch Activities (1993-2001)*

Summary	Market Segment	Date	Payload	Launch Vehicle	
2001					
4 Payloads	**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 Foreign Science		10/18/01	QuickBird	Delta 2	Medium-to-Heavy
4 Launches	**Foreign Science**	2/20/01	Odin	START 1	Small
2 Medium-to-Heavy					
2 Small					
2000					
18 Payloads	**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 Foreign Science	**Remote Sensing**	11/21/00	QuickBird 1	Cosmos	Small
3 Other		12/5/00	EROS A1	START 1	Small
	Foreign 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 Payloads	**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 Foreign 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
	Foreign 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.

1998					
83 Payloads	**Broadband LEO**	2/25/98	Teledesic T1 (BATSAT)	Pegasus	Small
1 Broadband LEO					
61 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 Foreign Science		3/25/98	Iridium (3 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
		4/28/98	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	**Foreign Science**	7/7/98	Tubsat N & Tubsat N 1	Shtil	Small
10 Small		10/22/98	SCD 2	Pegasus	Small
1997					
57 Payloads	**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 Foreign 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	**Foreign Science**	4/21/97	Minisat 0.1	Pegasus	Small
1996					
2 Payloads	**Foreign Science**	4/30/96	SAX	Atlas 1	Medium-to-Heavy
2 Foreign Science		11/4/96	SAC B	Pegasus	Small
2 Launches					
1 Medium-to-Heavy					
1 Small					
1995					
4 Payloads	**Little LEO**	4/3/95	ORBCOMM (2 sats)	Pegasus	Small
3 Little LEO		8/15/95	GEMStar 1	Athena 1	Small
1 Remote Sensing					
	Remote Sensing	4/3/95	OrbView 1 (Microlab)	Pegasus	Small
2 Launches					
2 Small					
1994					
0 Payloads					
0 Launches					
1993					
2 Payloads	**Little LEO**	2/9/93	CDS 1	Pegasus 1	Small
1 Little LEO					
1 Foreign Science	**Foreign Science**	2/9/93	SCD 1	Pegasus 1	Small
1 Launch					
1 Small					