Federal Aviation Administration

2012 Commercial Space Transportation Forecasts

May 2012

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

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About the Office of Commercial Space Transportation

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) licenses and regulates U.S. commercial space launch and reentry activity, as well as the operation of non-federal launch and reentry sites, as authorized by Executive Order 12465 and the Commercial Space Launch Act, 51 U.S.C. Ch. 509, §§ 50901-23 (2011).

FAA/AST's mission is to ensure public health and safety and the safety of property while protecting the national security and foreign policy interests of the United States during commercial launch and reentry operations. In addition, FAA/AST is directed to encourage, facilitate, and promote commercial space launches and reentries. Additional information concerning commercial space transportation can be found on FAA/AST's web site at http://www.faa.gov/about/office_org/headquarters_offices/ast/.

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EXECUTIVE SUMMARY

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) and the Commercial Space Transportation Advisory Committee (COMSTAC) have prepared forecasts of global demand for commercial space launch services for the 10-year period from 2012 through 2021.

The *2012 Commercial Space Transportation Forecasts* report is in two sections:

- *The COMSTAC 2012 Commercial Geosynchronous Orbit (GSO) Launch Demand Forecast*, which projects demand for commercial satellites that operate in GSO and the resulting commercial launch demand to GSO; and

- *The FAA's 2012 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits (NGSO)*, which projects commercial launch demand for satellites to NGSO, such as low Earth orbit (LEO), medium Earth orbit (MEO), elliptical (ELI) orbits, and external (EXT) orbits beyond the Earth.

Together, the COMSTAC and FAA forecasts project an average annual demand of 29.1 commercial space launches worldwide from 2012 through 2021, up from 28.6 launches in the 2011 forecasts. The reports project an average of 16.3 commercial GSO launches and 12.8 NGSO launches for 2012 through 2021. Figure 1 shows the combined 2012 GSO and NGSO Historical Launches and Launch Forecast. Table 1 shows the number of payloads and launches projected from 2012 through 2021.

It important to distinguish between forecast demand and the number of satellites actually launched. Launch vehicle and satellite programs are complex, and susceptible to delays, which generally makes the forecast demand for launches the upper limit of actual launches in the near-term forecast.

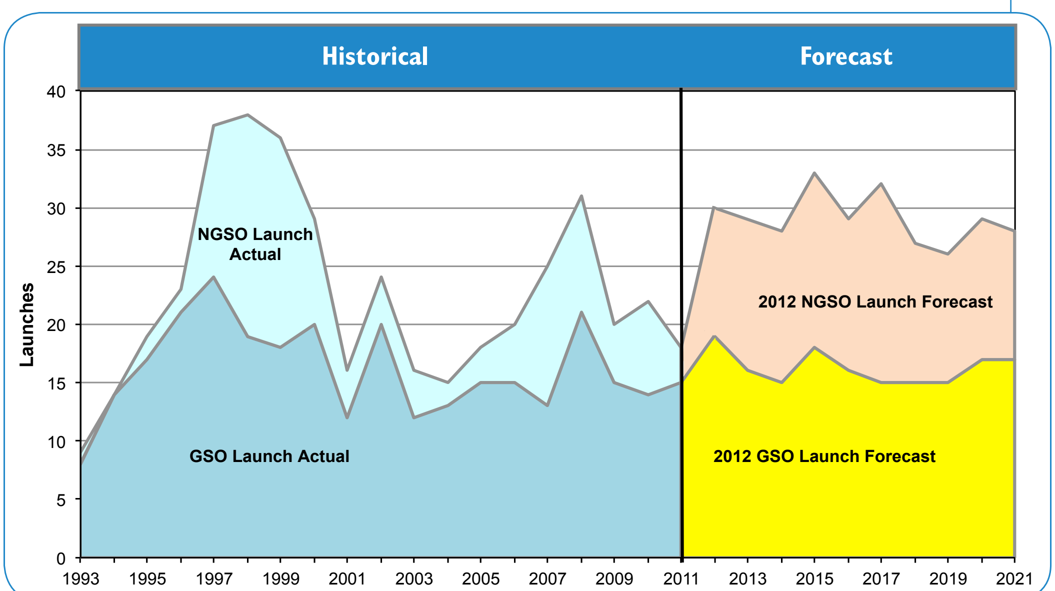

Figure 1. Combined 2012 GSO and NGSO Historical Launches and Launch Forecasts

Table 1. Commercial Space Transportation Payload and Launch Forecasts

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total	Average
Payloads												
GSO Forecast (COMSTAC)	23	21	20	23	21	20	20	20	22	22	212	21.2
NGSO Forecast (FAA)	37	44	28	35	42	49	16	15	16	15	297	29.7
Total Satellites	60	65	48	58	63	69	36	35	38	37	509	50.9
Launches												
GSO Medium-to-Heavy	19	16	15	18	16	15	15	15	17	17	163	16.3
NGSO Medium-to-Heavy	10	12	13	15	12	16	11	10	11	10	120	12.0
NGSO Small	1	1	0	0	1	1	1	1	1	1	8	0.8
Total Launches	30	29	28	33	29	32	27	26	29	28	291	29.1

The GSO market remains stable with a projected demand of 21.2 satellites per year, up slightly from last year's projection of 20.5 satellites per year. Figure 2 shows the 2012 GSO Historical Launches and Launch Forecast. Forty-three percent of GSO satellites projected to be launched from 2012 to 2021 are in the highest mass class (above 5,400 kilograms). In contrast, less than 5 percent of the satellites in the same period are in the lowest mass class (below 2,500 kilograms). Dual-manifesting is increasing beyond just the Ariane 5, with the Proton and Long March launch vehicles having demonstrated the capability, and Falcon 9 being offered for dual launches to GSO in the next few years. In 2011, there was a significant increase in unaddressable launches – launch contracts that were not open to international (including U.S.) competition – as Chinese and Russian government-owned aerospace companies routinely package satellites, launches, and financing together. Global demand for satellite services continues to be strong, led by substantial growth in Asia and solid growth in the Middle East. Operators are optimistic about the ability to resolve technical and export control issues, however, they are much more pessimistic about issues related to economic growth, competiveness, and licensing.

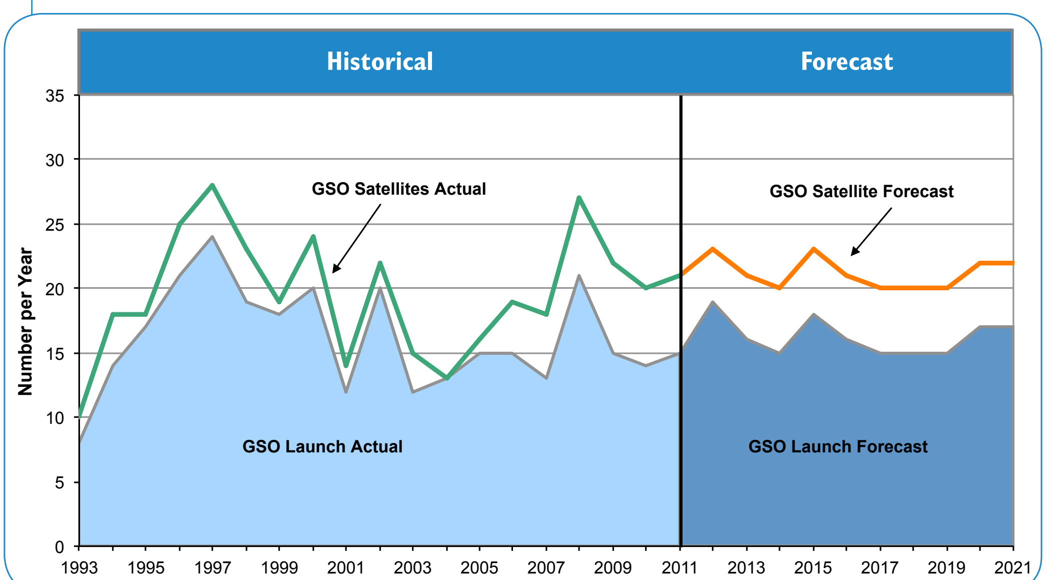

Figure 2. 2012 and Historical GSO Payloads and Launches

For NGSO, from 2012 to 2021, nearly 300 payloads are projected to launch commercially on 128 launches. The NGSO market projects an average of 12.8 launches per year from 2012 to 2021, which is slightly down from last year's average of 13.0 launches. Figure 3 shows the projected NGSO launches for the next 10 years. An average of 12.0 launches per year are on medium-to-heavy class vehicles, with an average of 0.8 of a launch a year on a small class vehicle. Fifty percent of the predicted launches over the next 10 years are for commercial cargo and crew transportation services to the International Space Station (ISS). Commercial crew transportation and resupply of the ISS are planned for vehicles that are yet to be proven. Technical or financial issues could delay ISS resupply launches. The NGSO telecommunication forecast shows a significant number of launches between 2012 and 2017, as Globalstar, ORBCOMM, and Iridium replace their constellations. After 2017, NGSO telecommunication launch demand is projected to drop off, though unforeseen developments in this market could change this. The other NGSO markets, including commercial remote sensing and science and engineering, remain stable.

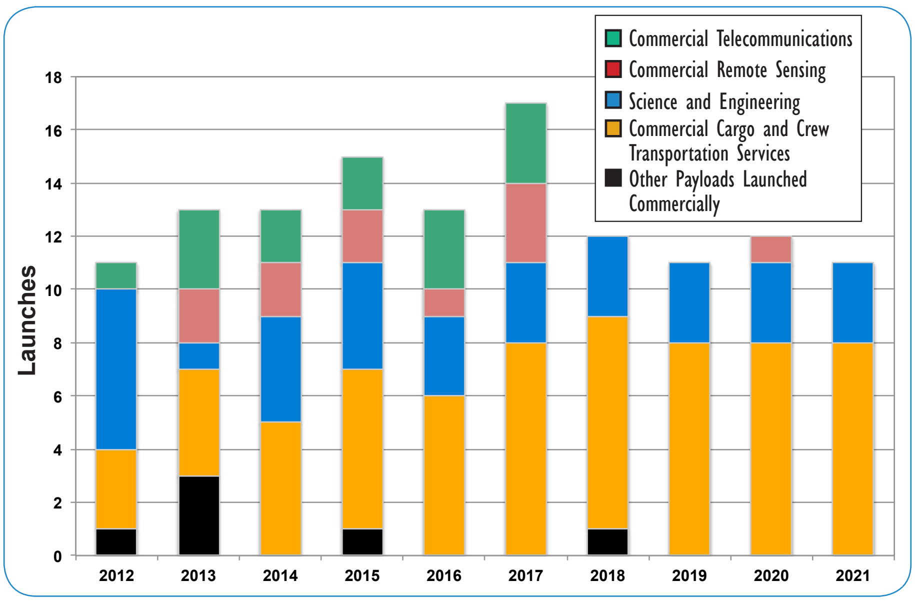

Figure 3. Projected NGSO Launches from 2012-2021

New commercial launch services providers such as SpaceX, with its Falcon 9 and Falcon Heavy, and Orbital Sciences Corp., with its Antares, are developing and demonstrating their vehicle capabilities for application to commercial and government markets. Lockheed Martin has recently stated its intentions to position the Atlas V more competitively in the commercial market through United Launch Alliance. Arianespace's Vega small-class launch vehicle performed a successful inaugural flight in February 2012, and the Russian Soyuz launch vehicle had its debut launch from Kourou, French Guiana in October 2011.

New vehicles expected to become available within the next two to three years include Athena (U.S.), Epsilon (Japan), and Long March 6 (China). These vehicles are designed to launch several micro- and small-class payloads at a time. However, the GSO forecast projects a trend toward higher mass class payloads. For the

NGSO market, the per-kilogram cost to orbit for a small-class launch vehicle tends to be higher than that for a larger capacity vehicle, which may make these new small-class launch vehicles too expensive for many micro-satellite customers. Therefore, many small NGSO satellites may go as piggy-back payloads on larger vehicles leaving small-class launch vehicles with the smaller market of time-critical delivery of payloads in orbit.

The two sections that follow – GSO and NGSO – provide detailed information on the two market segments.

COMSTAC 2012 COMMERCIAL GEOSYNCHRONOUS ORBIT (GSO) LAUNCH DEMAND FORECAST

EXECUTIVE SUMMARY

The Commercial Space Transportation Advisory Committee (COMSTAC) for the Office of Commercial Space Transportation of the Federal Aviation Administration (FAA/AST) compiled the 2012 Commercial Geosynchronous Orbit (GSO) Launch Demand Forecast (the Report). This year's Report is the 20th annual forecast of global demand for commercial GSO satellites and launches addressable by the U.S. space launch industry—that is, launches open to internationally competitive (including U.S.) launch service procurement—over the next 10 years. The Report provides a detailed analysis of satellites scheduled for launch in the next three years and a broader forecast of launch demand for the subsequent seven years. The Report is intended to assist FAA/AST in resource planning for licensing and in efforts to foster commercial space launch capability in the United States.

The Report is updated annually, using inputs from commercial satellite operators and manufacturers and launch service providers. Both satellite and launch demand forecasts are included in the Report. The satellite demand is a forecast of the number of commercial GSO satellites that operators expect will be launched. The launch demand is determined by the number of satellites to be launched adjusted by the number of satellites projected to be launched together on a single launch vehicle, referred to in the Report as "dual-manifest" launches.

Figure 4 provides a summary of the forecast, showing annual projected satellites and launches. Table 2 provides the corresponding values, including the projected number of dual-manifested launches.

The number of addressable satellites launched in each of the last three years has steadily decreased. The factors driving this decrease include launch delays, larger

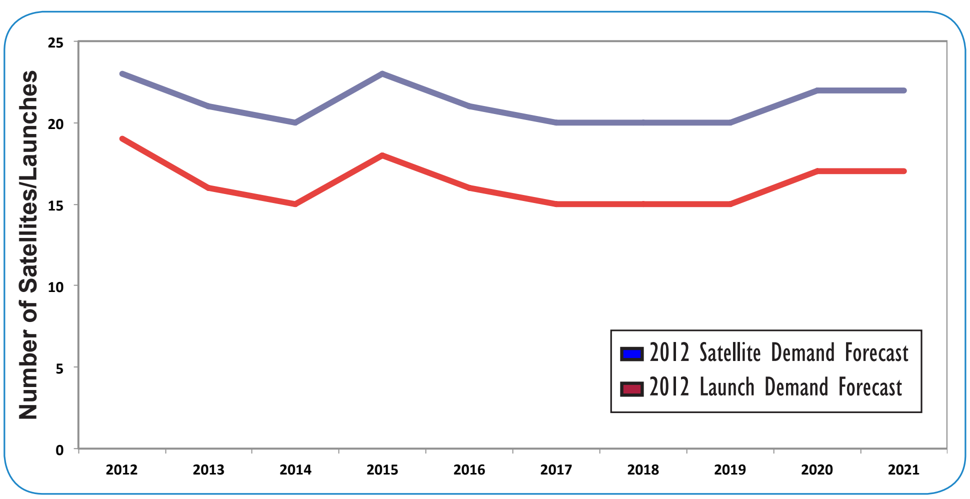

Figure 4. Forecast Commercial GSO Satellite and Launch Demand

Table 2. Forecast Commercial GSO Satellite and Launch Demand Data

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total	Average 2012 to 2021
Satellite Demand	23	21	20	23	21	20	20	20	22	22	212	21.2
Dual Launch Forecast	4	5	5	5	5	5	5	5	5	5	49	4.9
Launch Demand	19	16	15	18	16	15	15	15	17	17	163	16.3

satellites, greater availability of captive international launch capability, and the state of financial markets. Nonetheless, the Report forecasts an average demand of 21.2 satellites and 16.3 launches per year in the 10-year period from 2012 through 2021, up from 20.5 satellites and 15.6 launches per year in last year's Report. This growth demonstrates the "bow-wave" phenomenon, where the first two out-years of each Report reflect the most optimistic scenario.

It is important to distinguish between forecast demand and the number of satellites that are actually launched. Satellite programs, like most complex projects, are susceptible to delays, so the forecast demand is an upper limit on the number of satellites that may actually be launched. To account for these differences, the forecast team developed a "launch realization factor." This factor is based on historical data comparing actual satellites launched and predicted satellite demand from previous Reports. This factor is then applied to the near-term forecast to provide a range of satellites reasonably expected to be launched. For example, while 23 satellites are projected to be launched in 2012, applying the realization factor adjusts this to a range of 18 to 23 satellites.

HISTORY OF THE REPORT

One of the goals of the FAA/AST is to foster a healthy commercial space launch capability in the United States. In 1993, the U.S. Department of Transportation requested that COMSTAC annually prepare a commercial GSO satellite launch demand forecast to present the commercial space industry's view of future space launch requirements.

Table 3. 2012 GSO Forecast Team

Forecast Team Member	Affiliated Company
Alan Keisner	Space Exploration Technologies
Chris Kunstadter	XL Insurance
David Keslow	Orbital Science Corporation
Jozsef Lore	The Boeing Company
Kate Maliga	The Tauri Group
Pete Stier	Sea Launch
Rob Unverzagt	The Aerospace Corporation
Tom Monroe	Space Systems Loral
Veronica Johnson	United Launch Alliance

COMSTAC, working with U.S. launch service providers, prepared the first forecast in April 1993 as part of a report on commercial space launch systems requirements. The following year, U.S. satellite manufacturers and satellite service providers began to contribute to the forecast. In 1995, FAA/AST formally chartered COMSTAC to prepare the forecast. A Forecast Team of COMSTAC members and industry experts, listed in Table 3, compiled this year's Report.

FORECAST METHODOLOGY

The methodology for developing the forecast has remained consistent throughout its history. The Forecast Team, through FAA/AST, requests projections of satellites to be launched over the next 10 years from global satellite operators, satellite manufacturers, and launch service providers. Two types of requests are issued:

- Individual input from global satellite operators for a projection of their organization's satellite plans; and
- Comprehensive input from global satellite manufacturers and launch service providers for a broad, industry-wide estimate of total GSO launches.

This year, the following organizations responded with data used to develop the Report:

- Arabsat (also responded in 2011)
- Arianespace (also responded in 2011)
- Boeing*
- Hispasat (also responded in 2011)
- Intelsat*
- Loral*
- Sea Launch*
- Sirius XM* (also responded in 2011)
- SpaceX*
- Telenor (also responded in 2011)
- TerreStar* (also responded in 2011)

* = U.S. company or company with significant U.S. operations

The Forecast Team, using individual satellite operators' inputs, public sources (e.g., satellite operator and launch provider web sites), and the team's own industry knowledge, develops the near-term forecast, covering the first 3 years (2012–2014) of the 10-year forecast period. The combined comprehensive inputs as well as the above sources are then used to generate the long-term demand forecast for 2015 to 2021. This year, COMSTAC received fewer responses from U.S. companies than in 2011; therefore, the comprehensive inputs from U.S. and foreign respondents have been combined and averaged, rather than simply using the U.S. data.

Other factors that were considered in developing the forecast include:

- Publicly-announced satellite and launch contracts
- Projected planned and replenishment missions
- Growth in demand from new and existing services and applications
- Availability of financing and insurance
- Potential consolidation among operators
- New launch vehicle capabilities
- Hosted payload opportunities

The production cycle for today's satellite models is typically two to three years, but it can be longer for heavier or more complex satellites. Orders within a two- to three-year horizon are thus generally reliable. Satellite orders more than three years out can be difficult to identify, as many of these programs are in early stages of planning or procurement. Beyond five years, new markets and new uses of satellite technology may emerge that are currently unanticipated.

COMSTAC COMMERCIAL GSO LAUNCH DEMAND FORECAST RESULTS

Addressable vs. Unaddressable

To clarify which launch opportunities can be "addressed" by U.S. launch providers, satellite launches are classified as either "addressable" or "unaddressable." Addressable, in the context of this Report, is defined as commercial GSO satellite launches subject to an open to internationally competitive (including U.S.) launch service procurement process. Satellites and launches bundled in government-to-government deals, launches captive to particular launch service providers, and others that are not internationally competed are classified as unaddressable.

The number of unaddressable launches increased significantly in 2011, as the Chinese and Russian government-owned aerospace companies continued packaging satellites, launches, and financing for commercial satellite programs. This trend is expected to continue as Chinese, Russian, Indian, and Japanese satellite manufacturers pursue such contracts on a strategic, non-competitive basis. Figure 5 and Table 4 compare the numbers of addressable and unaddressable satellites since 1993.

Mass Classes

An appropriate metric for determining launch requirements is satellite mass. Mass classes based on ranges of satellite masses are used to analyze developments in satellite and launch demand. Four mass classes are currently used, as shown in Table 5.

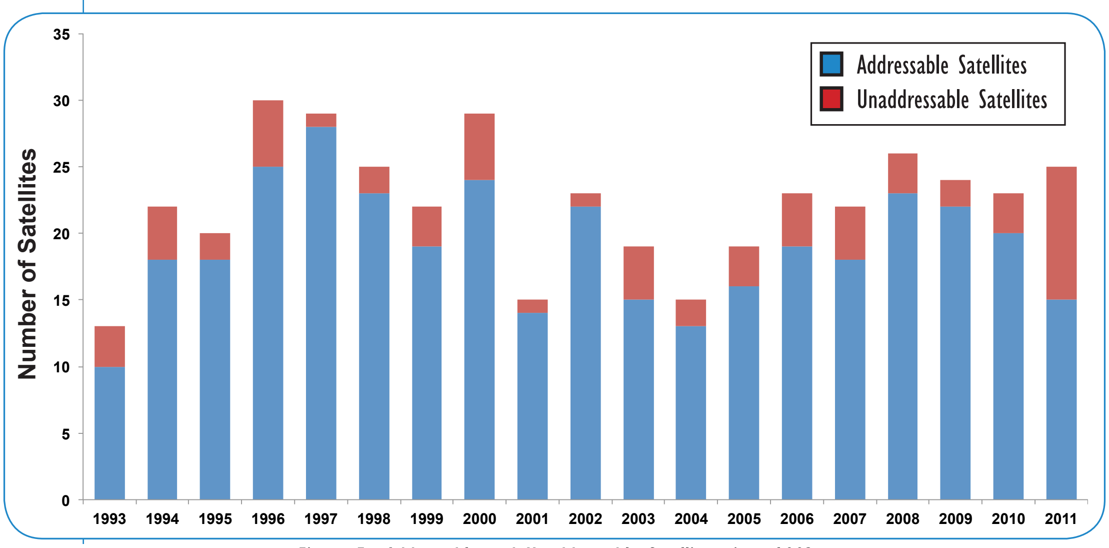

Figure 5. Addressable and Unaddressable Satellites since 1993

Table 4. Addressable and Unaddressable Satellites since 1993

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Adressable	10	18	18	25	28	23	19	24	14	22	15	13	16	19	18	23	22	20	15
Unaddressable	3	4	2	5	1	2	3	5	1	1	4	2	3	4	4	3	2	3	10
Total	13	22	20	30	29	25	22	29	15	23	19	15	19	23	22	26	24	23	25

The upper limit of the smallest mass class was increased in 2008 from 2,200 kg to 2,500 kg. This adjustment captures the growth in mass of the smallest commercial GSO satellites currently being manufactured. As an example, Orbital's GEOStar bus, which dominated the lower end of the mass scale in previous years, has recently been used for satellites in excess of 3,200 kg, which fall in the intermediate mass class range.

Table 5. Satellite Mass Class Categorization

Class	Separated Mass	Representative Satellite Bus Models
Medium	Below 2,500 kg (<5,510 lbm)	Lockheed Martin A-2100, Orbital GEOStar, Boeing BSS-702, Space Systems Loral LS-1300
Intermediate	2,500 - 4,200 kg (5,510 - 9,260 lbm)	A-2100, IAI Amos, MELCO DS-2000, GEOStar, LS-1300, Thales SB-4000
Heavy	4,201 - 5,400 kg (9,261 - 11,905 lbm)	Astrium ES-3000, BSS-702, IAI Amos, A-2100, DS-2000, GEOStar, LS-1300, SB-4000
Extra-heavy	Above 5,400 kg (>11,905 lbm)	ES-3000, BSS-702, A-2100, LS-1300, SB-4000

The 2011 forecast, issued in May 2011, predicted no launches of satellites in the smallest mass class in 2011, and in fact, none were launched. This year's forecast shows an average of one satellite in this mass class will be launched each year for the next 10 years. At the same time, the largest mass class is expected to see significant growth, with an average of 9.2 satellites of this mass class projected to be launched each year for the next decade, up from 7 per year in the 2011 forecast.

Figure 6 and Table 6 show the total mass launched per year and the average mass per satellite launched. The total mass launched per year correlates with the number of satellites launched per year, as does the total number of transponders. The average mass of satellites launched in the past eight years was well over 4,000 kg, reaching a new high in 2011. The average mass in 2012 is expected to increase even further, with a shift to heavier, higher power satellites. The 23 satellites scheduled for launch in 2012 have a mass of 113,006 kg, for an expected average satellite mass of 4,913 kg.

One technical development that may affect this trend is the development of satellites using exclusively electric propulsion rather than chemical propulsion (such as liquid apogee motors) for orbit-raising. By reducing the mass of propellant used for orbit-raising, which in many cases is greater than the dry mass of the satellite, the satellite can carry a significantly larger payload. Alternatively, by keeping the satellite mass low, two satellites, each with the payload capacity of a large satellite, can launch together.

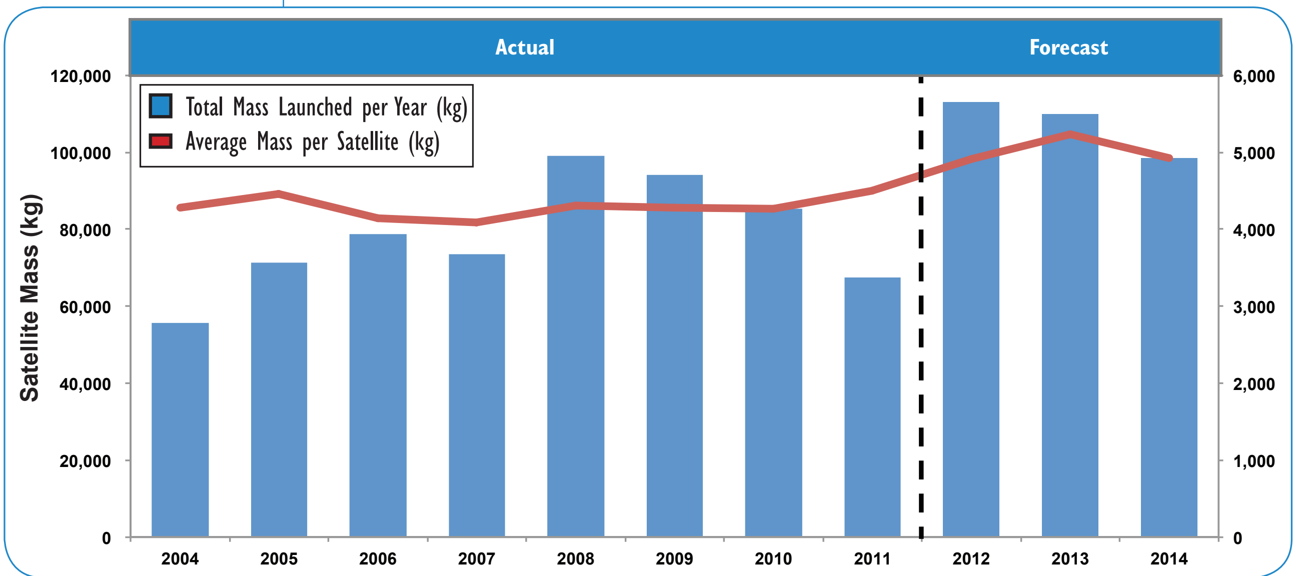

Figure 6. Total Satellite Mass Launched per Year and Average Mass per Satellite

Table 6. Total Satellite Mass Launched per Year and Average Mass per Satellite

	Actual								Forecast		
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total Mass Launched per Year (kg)	55,616	71,456	78,736	73,611	99,019	94,196	85,368	67,554	113,006	109,934	98,515
Average Mass per Satellite (kg)	4,278	4,466	4,144	4,090	4,305	4,282	4,268	4,504	4,913	5,235	4,926

Using electric propulsion for orbit-raising extends the required the time, by months instead of days. Nonetheless, in many cases, the benefits of the mass savings will outweigh the delay in achieving final orbital position.

Table 7 and Figure 7 show the trends in satellite mass class distribution.

Past forecasts tracked the number of transponders on commercial GSO satellites as a metric for determining launch demand. The changing landscape of satellite technology has resulted in a move away from individual transponders to architectures involving single transponders, multiple spot beams, onboard processing, ground-based beam forming, alternative sparing technologies, and other methods. As a result, raw transponder count is no longer a meaningful proxy for satellite launch demand. Therefore, the Forecast Team discontinued using transponder count as a factor in its analysis, choosing to focus instead on satellite mass.

Table 7. Trends in Satellite Mass Class Distribution

	Actual										Forecast												
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total 2012 to 2021	Avg. 2012 to 2021	% of Total 2012 to 2021
Below 2,500 kg	2	4	2	3	1	4	2	3	3	0	0	0	0	1	1	2	1	1	1	1	8	0.8	4%
2,500 to 4,200 kg	11	6	3	3	7	5	6	9	6	6	6	5	7	7	7	6	6	6	7	7	64	6.4	30%
4,201 to 5,400 kg	9	5	5	4	9	6	10	2	4	6	6	2	3	6	5	5	5	5	5	6	48	4.8	23%
Above 5,400 kg	0	0	3	6	2	3	5	8	7	3	11	14	10	9	8	7	8	8	9	8	92	9.2	43%
Total	22	15	13	16	19	18	23	22	20	15	23	21	20	23	21	20	20	20	22	22	212	21.2	100%

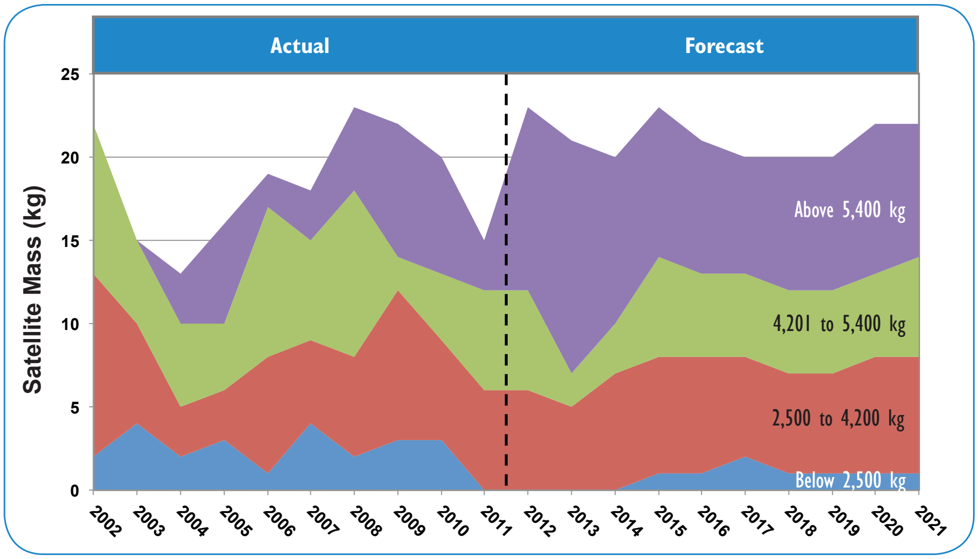

Figure 7. Trends in Satellite Mass Class Distribution

Dual-Manifesting

Projecting launches based on satellites is complicated by the use of dual-manifesting by several launch service providers. The Ariane 5 and Proton launch vehicles have the ability to launch two satellites to GSO, and SpaceX recently indicated the Falcon 9 will have the same capability in the next several years. Therefore, the analysis of launch demand must account for dual-manifested missions, which effectively increase the number of satellites that can launch in a year. Furthermore, an addressable satellite can be paired with an unaddressable satellite. Because the primary goal of the Report is to count the number of launches (rather than satellites), a dual-manifested launch of an addressable satellite with an unaddressable satellite is counted as a single addressable launch.

The Forecast Team projected the number of dual-manifest launches using the existing backlog of Ariane 5 and Proton dual-manifested launches, as well as the announced Falcon 9 dual-manifested launches, and extrapolating this into the future. Ariane 5 planned six launches for 2012, including the launch of ATV 3 to the International Space Station (ISS), which occurred early in 2012. The remaining five Ariane 5 launches (and all future Ariane 5 GSO launches considered in this Report) are dual-manifested launches.

Dual-manifesting may be problematic for heavy payloads, given the minimal number of satellites forecasted to be launched in the smallest mass class; the introduction of the Soyuz launch vehicle from French Guiana, which is well-suited to launching small satellites; and the frequent lack of a viable co-payload for dual-manifested launches of the heaviest satellites.

Figure 8 presents the 2012 satellite and launch demand forecast through 2021 as well as actual launch statistics for 1988 through 2011.

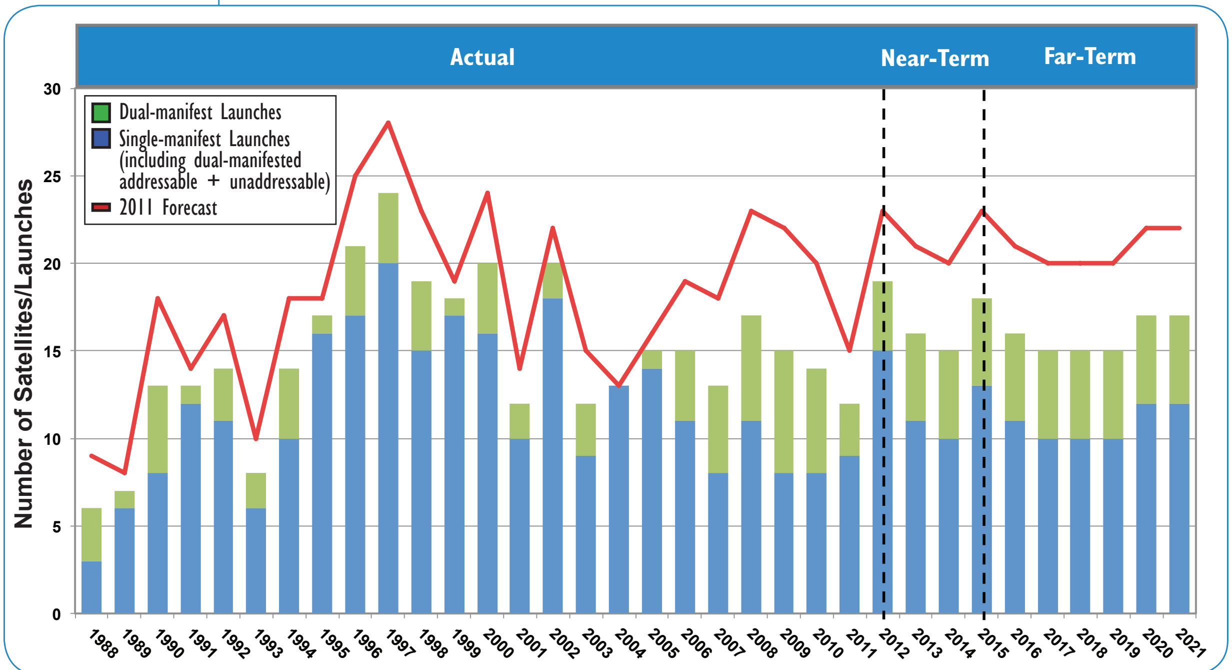

Figure 8. Dual Manifesting and Launch Demand

Near-Term Demand Forecast

Table 8 shows the satellites projected to be launched in the next three years. The projections for 2012 to 2015 show a significant increase in the number of satellites to be launched from the previous three years (2009-2011). As noted earlier, the trend is to build heavier, more capable satellites; over 50 percent of the satellites to be launched in the next three years are in the heaviest mass class.

Comparison with Previous COMSTAC Forecasts

The current forecast shows a slight increase over previous reports in average annual launches for the next 10 years. The average number of satellites for the forecast period was in a narrow range in the reports from 2004 to 2011—between 20.5 and 21.8 satellites. The 2012 Report shows a slight increase in satellite activity from the 2011 Report, up by 0.7 satellites per year for the next 10 years with an average of 21.2.

Table 8. Commercial GSO Satellite Near-Term Manifest

	2012			2013			2014		
Total	23			21			20		
Below 2,500 kg	0			0			0		
2,500 - 4,200 kg	6			5			7		
	DM	Azerspace 1A	Ariane 5	DM	Arsat 1	Ariane/Soyuz	DM	Hispasat AG1	Ariane/Soyuz
	DM	HYLAS 2	Ariane 5	DM	Optus 10	Ariane 5		Asiasat 6	Falcon 9
	DM	Star One C3	Ariane 5		SES 8	Falcon 9		Asiasat 8	Falcon 9
	DM	Vinasat 2	Ariane 5		Thaicom 6	Falcon 9		Amos 4	Falcon 9
	DM	Mexsat 3	Ariane/Soyuz		Türksat 4A	Proton M		Türksat 4B	Proton M
		Intelsat 23	Proton M				DM	Amazonas 4A	TBD
							DM	Amazonas 4B	TBD
4,201 - 5,400 kg	6			2			3		
	DM	BADR 7	Ariane 5	DM	Thor 7	Ariane 5	DM	Eutelsat 9B	Ariane 5
	DM	Eutelsat 21B	Ariane 5	DM	Sicral 2	Ariane 5		Amos 6	TBD
	DM	JCSat 13	Ariane 5					JCSat 14	TBD
		Anik G1	Proton M						
		Nimiq 6	Proton M						
		Eutelsat 70B	Sea Launch						
Above 5,400 kg	11			14			10		
	DM	Echostar 17	Ariane 5	DM	Alphasat	Ariane 5	DM	DirecTV 15	Ariane 5
	DM	Intelsat 20	Ariane 5	DM	Astra 2F	Ariane 5	DM	Intelsat 30	Ariane 5
		Echostar 16	Proton M	DM	Astra 5B	Ariane 5	DM	Measat 3B	Ariane 5
		Intelsat 22	Proton M	DM	ABS 2	Ariane 5	DM	Mexsat 2	Ariane 5
		Satmex 8	Proton M	DM	DirecTV 14	Ariane 5	DM	Star One C4	Ariane 5
		SES 4	Proton M	DM	Amazonas 3	Ariane 5		Astra 2G	Proton M
		SES 5	Proton M	DM	Eutelsat 25B	Ariane 5		Inmarsat 5F3	Proton M
		Sirius FM6	Proton M		Astra 2E	Proton M		Eutelsat 3B	Sea Launch
		Yahsat 1B	Proton M		SES 6	Proton M		Intelsat 28	TBD
		Intelsat 19	Sea Launch		Inmarsat 5F1	Proton M		Arabsat 6E	TBD
		Intelsat 21	Sea Launch		Inmarsat 5F2	Proton M			
					Mexsat 1	Proton M			
					Eutelsat 7B	Proton M			
					Intelsat 27	Sea Launch			

DM = Potential Dual-Manifested Satellites

The 2011 Report projected 26 satellites to be launched in 2012. The reduction to 23 in this year's Report reflects:

- Satellite issues in 2011, which resulted in the need to rework several satellites awaiting launch
- Changing business climate for several operators who have encountered financial issues
- Reclassification of several launches as unaddressable

The cascading delays thus pushed satellite launches out, delaying the first commercial Proton in 2012 to February, and the first commercial Ariane 5 to May.

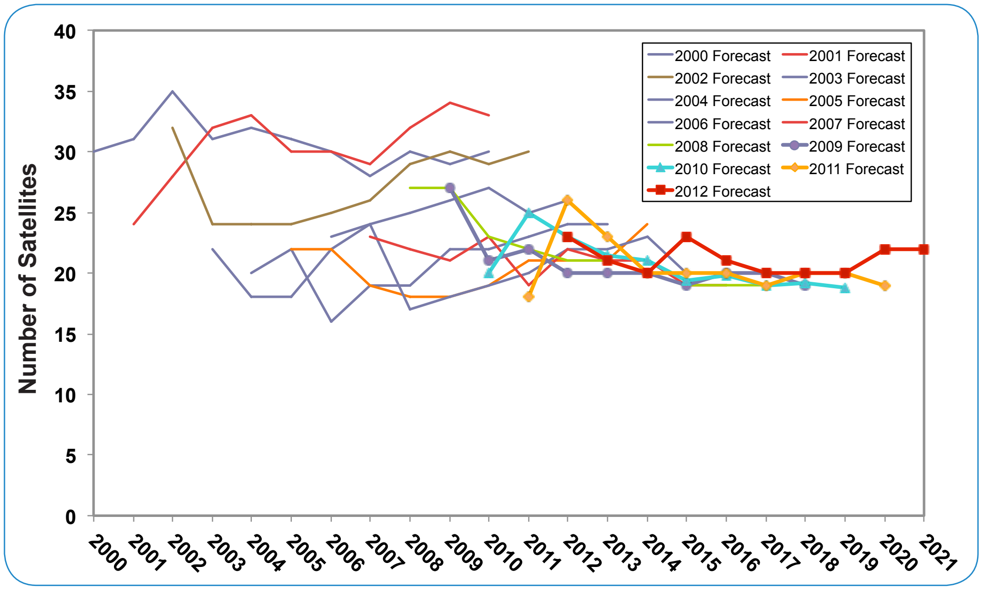

Figure 9. Comparison of Annual Forecasts: 2000-2012 (last four years highlighted for clarity)

COMSTAC DEMAND PROJECTION VS. ACTUAL LAUNCHES REALIZED

Factors That Affect Satellite Launch Realization

The demand for satellite launches is typically larger than the number of satellites that will actually be launched in a year. Some factors that contribute to the difference between forecast and realized launches are:

Satellite technical issues: Satellite manufacturers may have manufacturing, supplier, or component issues that delay the delivery of a satellite. On-ground and in-orbit anomalies can affect the delivery of satellites under construction until fleet-wide issues (such as commonality of parts, processes, and systems) are resolved. Delays in delivery of spacecraft to the launch site then impact the scheduling of launches.

Launch vehicle technical issues: Launch vehicle manufacturers and launch service providers may have manufacturing, supplier, or component issues that cause launch delays. Recovery from launch anomalies and failures can also significantly affect launch schedules. Delays have a cascading effect on subsequent launches, and some missions have specific launch windows (such as science windows) that, if missed, may result in lengthy delays and manifest issues.

Weather: Inclement weather, including ground winds, flight winds, cloud cover, lightning, and ocean currents often cause launch delays, though these are typically short-term (on the order of days).

Range availability issues: The lack of launch range availability due to prioritized government missions, schedule conflicts with other launch providers, launch site maintenance, and other range-related issues can cause launch delays.

Dual-manifesting: Dual-manifesting requires that two satellites are delivered to the launch site on time. A delay on one satellite results in a launch delay for the other satellite and subsequent satellites. Payload compatibility issues (such as mass mismatch, technical differences, and differing orbit insertion requirements) can also cause delays.

Business issues: Corporate reprioritization, changing strategies and markets, and inability to obtain financing may delay or cancel satellite programs; however, this can make launch slots available for other customers.

Regulatory issues: Export compliance, FCC or international licensing, and frequency coordination can cause delays, launch vehicle shifts, and satellite program cancellations. U.S. government policy regarding satellite and launch vehicle export control can make it difficult for U.S. satellite manufacturers and launch vehicle operators to work with international customers.

Projecting Actual Satellites Launched Using a Realization Factor

Over the history of this Report, the forecast demand for satellites and launches has almost always exceeded the number of satellites and launches actually accomplished in each of the first three years of a forecast period. To better estimate the number of near-term satellites that will be launched, the near-term demand is adjusted by a "realization factor." This factor is derived by comparing forecast satellite launches with actual satellites launched in the five years prior to the current Report.

The range of satellite launches expected to be realized is calculated by multiplying the near-term forecast by the highest and lowest variations of forecast versus actual over the preceding five years. The actual number of satellites launched in the first year of the forecast was 58% to 100% of the forecast number, with an average of 78%. For the past five years, the range was 78% to 100%, with an average of 86%. Based on this methodology, while 23 satellites are forecast to launch in 2012, the expected realization for 2012 is 18 to 23 satellites.

The consistent overestimation illustrates the "bow-wave" effect of the forecast: survey respondents list satellites that were planned to be launched the previous year but slipped into the subsequent year, without compensating for the subsequent year's satellite launches concurrently slipping forward.

The calculation becomes less precise for the second out-year. The forecast has almost always overestimated the actual launches two years hence. Since 1993, the actual realization for the second out-year ranged from 45% to 105%, with an average of 76%. For the past five years, the range was 60% to 105%, with an average of 85%. Using the same methodology, while 21 satellites are forecast to be launched in 2013, the expected realization for 2013 is 13 to 22 satellites.

Since the launch realization factor was added to the Report in 2002, the actual number of satellites launched has mostly fallen within the launch realization range, demonstrating the robustness of the realization factor methodology.

As shown in Figure 10, the 2011 report forecast 18 satellites for launch in 2011, with a realization range of 14 to 18. Fifteen satellites were launched in 2011.

FACTORS THAT MAY AFFECT FUTURE DEMAND

Many market, regulatory, and financial factors affect current and future demand for commercial GSO satellite launches, such as:

Demand for Satellite Services: Global demand for satellite services continues to be strong, led by substantial growth in Asia and solid growth in the Middle East, Central Asia, and South America, despite uncertain economic environments in the United States and Europe. This growth can be attributed to:

- increased globalization and interconnectivity of modern enterprise communications;

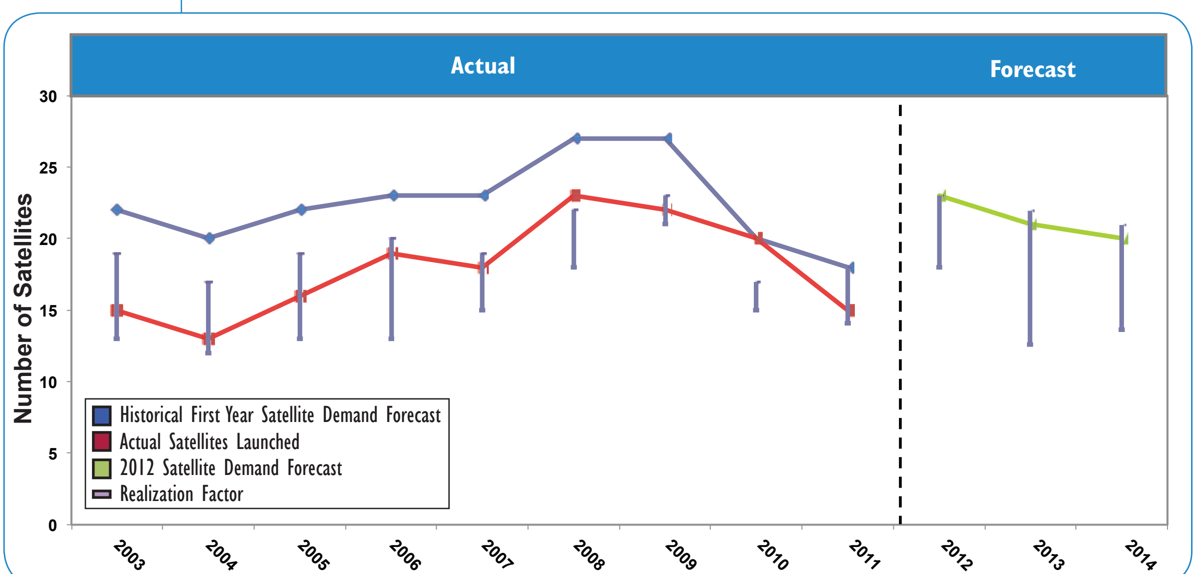

Figure 10. Realization Factor

- improved economic standards creating an expanded middle class with available discretionary incomes;
- the adoption of common practices and standards;
- increased deregulation of the telecommunications sector;
- the development of cost-effective personal mobile voice, data, and broadband devices;
- increased travel and cultural integration;
- adoption of commercial solutions by governments to supplement defense and military capabilities; and
- the revolution in software applications, creating new information portals for consumers

Globalization: Growth in telecommunications and broadcasting markets is being driven by an increasing number of multi-national companies with office hubs and distribution networks spread across the world. This enables companies to operate globally while being perceived as an integral part of the local economy. Companies recruit and train personnel to use modern communications tools such as social media, Internet marketing, and wireless devices, overcoming the limits of national borders and cultural boundaries.

Content distribution is more accessible and less expensive, enabling consumers and enterprises to fully integrate, share similar experiences, and improve productivity and responsiveness to customer needs and orders on a global basis. The rapid explosion of affordable information delivery to end-consumers, through satellite dishes, cable head-ends, fiber-to-the-curb, and wireless broadband, enabled a significant expansion of content choices while permitting two-way interactivity on an unprecedented scale. This drives significant demand for more bandwidth availability, increasing the need for satellite-based and ground-based delivery systems.

Deregulation: Many countries are experiencing economic advantages and growth in consumer classes by opening their telecommunications markets to domestic and foreign competition. In Asia, Africa, and South America, new competitive sectors in telephone, TV broadcasting, and Internet are emerging, replacing state-controlled service monopolies. Many countries are now securing rights to bandwidth by establishing national regulators, as well as through international regulators such as the International Telecommunication Union (ITU), to exercise rights to frequency spectrum and orbital slots for delivery of satellite services. New operators are entering the marketplace, such as Hong Kong DTH operator Asia Broadcast Satellite, Abu Dhabi DTH operator Yahsat, Azerbaijan FSS operator Azerspace, Bulgarian DTH operator Bulsatcom, and U.S.-Swedish mobile broadband operator OverHorizon. India is contemplating relaxation of its highly regulated satellite market to allow increased satellite services and content from foreign satellite operators. It is anticipated that over the next 10 years, relaxed regulation in the Middle East, Africa, Southern and Eastern Asia, and South America will account for more than 60% of new transponder and bandwidth demand globally.

Mobility: The global demand from enterprises and consumers for mobile communications has exploded over the past decade. The development of low-cost mobile equipment unleashed significant growth best met by the ubiquity only satellite delivery can provide. From global communications to direct-to-consumer services such as mobile television, Internet and broadband services, and satellite radio, and enterprise capabilities such as mobile broadcasting, satellite news gathering, and transportation fleet management, the demand for mobile connectivity appears insatiable. Transportation systems are rapidly incorporating mobile communications technologies, such as airline operator JetBlue with its DirecTV service to passengers, rental car fleets featuring Sirius Satellite Radio, and emergency services such as OnStar expanding beyond General Motors vehicles. Route planning and asset tracking with GPS is also experiencing significant growth. The long-awaited European Galileo navigation system is about to be deployed, the Russians continue to build their GLONASS system, and the Chinese are deploying their own Beidou (Compass) system. Mobile connectivity will be a major driver for market growth in the next decade, particularly in Asia, where countries such as South Korea, Japan, Taiwan, and Singapore typically adopt new technologies early.

Market Segments

Fixed Satellite Services (FSS): The FSS market continues to perform well. Major global operators such as Intelsat, SES, and Eutelsat and regional operators such as Telesat, AsiaSat, and SkyPerfecTV report high transponder utilization rates and stable transponder lease pricing. The market is driven by demand for larger replacement spacecraft, with additional expansion in new orbital slots for new satellites. Asia continues to lead growth in the past year, due to increasing demand for enterprise VSAT services, expansion of high definition television services (HDTV), and Internet connectivity. Demand in Western Europe remains solid, but growth is focused in Central and Eastern Europe and Russia. The Middle East and Africa are experiencing moderate growth in transponder demand, due to deregulation, increased competition, and the availability of more local content from broadcasters. Due to the prolonged impact of the economic recession, the North American market has experienced some transponder pricing weakness, but this has not substantially affected operator financial performance. South America continues to rise with the emergence of a larger consumer class, improved regulatory climate, and several nations seeking ITAR-free low-cost satellites to exercise their rights to ITU-assigned orbital slots and frequencies. Another positive sign is increased demand by governments for capacity to support civil applications and military operations such as communications. The U.S. Department of Defense has continually increased its demand for commercially procured bandwidth in recent years and may order more satellites under commercial contracts to meets its growing needs. Intelsat, Eutelsat, Hispasat, and other operators expect to derive significant revenues from national governments for the provision of transponder capacity.

Direct Broadcasting Services (DBS): The lethargic U.S. economy has pressured the DBS market, increasing consumer churn rates, competition from low-cost fiber-to-the-curb in urban areas, and cost pressures from cable operators trying to protect market share. Satellites have even reached saturation in selected metropolitan areas. This accounts for EchoStar's motivation to expand its consumer and enterprise presence by providing broadband and mobile services with the acquisition of Hughes Communications and its Jupiter 1 (now EchoStar 17) satellite. Both EchoStar and DirecTV have strong capital investment programs and expect to launch several satellites each in the next few years to replace and add to current capacity. Telesat will also meet increasing demand with the launch of new satellites, in regions where the cost of laying fiber or cable is prohibitive. Demand for direct-to-home services in Europe is increasing, but many consumers receive HDTV via cable head-end distribution channels from FSS operators such as SES, Eutelsat, and Telenor. As with FSS, growth will be driven by demand for HDTV in Asia from operators such as Japan's SkyPerfecTV, South Korea's KT, and Singapore's SingTel/Optus.

Broadband Services (BB): The BB market continues to spread globally, as enterprise and consumer needs for mobile connectivity drive investments in high-capacity systems such as Hughes Communications (now EchoStar), INMARSAT, ViaSat, and newcomers such as Great Britain's Avanti and Australia's NewSat and National Broadband Network systems. INMARSAT is developing its Global Express system to provide broadband connectivity in land mobile, aeronautical, and maritime market segments. The U.S.'s LightSquared 4G wireless hybrid terrestrial/satellite system encountered a major hurdle with the FCC, which stated the system's transmissions cause interference with signals from the GPS constellation. This ruling may impact LightSquared's SkyTerra-2 launch scheduled for later this year. As with the FSS and DBS markets, demand from Asia, led by South Korea, Japan, China, Taiwan, and Singapore, will drive the market for broadband satellite services. Government-funded initiatives and mandates to provide broadband services and Internet connectivity will help drive the market, particularly where those demands cannot be met by laying fiber, such as in remote and rural locations.

Mobile Satellite Systems (MSS): The MSS market remains in flux. MSS requires significant investment to expand the ground network, including the ancillary terrestrial network in urban areas, to attract enterprise and consumer users. Both LightSquared and TerreStar entered bankruptcy in an attempt to rearrange financing and acquire new investors, but for now, their SkyTerra 2 and TerreStar 2 satellites, respectively, remain unlaunched. EchoStar's Dish Network recently acquired all the assets of TerreStar.

Other companies in the MSS market are performing well. INMARSAT continues to perform strongly with steady demand in its vertical enterprise markets as it prepares to deploy its advanced INMARSAT 5 satellites. Mexico's Mexsat constellation will provide mobile services for civil administration and emergency communications. In the Middle East, Thuraya remains very successful and is considering system expansion with a potential fourth spacecraft to meet demand. Europe and Japan have been contemplating dedicated MSS services to build on capabilities currently provided through FSS systems, but coordination across European nations remains an issue.

Digital Audio Radio (DARS): DARS remains an exclusively North American product since the merger of XM Satellite Radio and Sirius Satellite Radio. This service has yet to attract global attention, although South Korea and Japan cooperated on the MBSAT system. DARS will likely expand to Asia first, followed by Western Europe.

In summary, enterprise and consumer demand for connectivity via satellite is expected to increase over the next decade. The outlook for satellite services from GSO remains strong, driven by replacement and modest expansion in FSS and DBS systems and by new BB systems. Economic recovery in North America, Europe, and Asia will enable a return to growth, with robust pent-up demand from enterprise, consumer, and government markets from existing and emerging satellite operators.

Hosted Payloads

Hosted payloads are payloads that are typically too small to justify a dedicated mission due to payload size, budgets, or potential revenues. Hosted payloads are often paired with a commercial satellite mission, where the satellite operator accommodates the payload to offset its costs or to add to a revenue stream to close a business case. The current U.S. National Space Policy directs the use of hosted payload solutions to maximize reliability, affordability, and responsiveness.

There are a variety of potential hosted payload types, including experimental payloads, technology demonstrations, scientific missions, remote sensing, weather and climate monitoring, FAA GPS and WAAS, and national security missions. Payload hosting benefits both parties. The total price of the satellite and launch service is shared, offsetting the primary payload's costs while providing affordable space access for the hosted payload. In addition, the hosted payload gains the efficiency of using a commercial launch system that provides access to more orbital locations. Furthermore, the schedule from the start of a program to launch is relatively short (two to three years) and fairly predictable compared to a shared launch with other government missions.

Commercial satellite operators regularly formulate their satellite procurement contracts to address their needs and take advantage of opportunities, like hosted payloads, to improve return on investment. There is a ready supply of commercial satellite launches willing and eager to accommodate hosted payloads, and the number of hosted payload launches and awards continues to increase.

Examples of hosted payloads include:

- In September 2011, SES Government Solutions launched the Commercially Hosted Infrared Payload Flight Demonstration Program (CHIRP) on the SES-2 satellite (built by Orbital Sciences Corporation). This Third-Generation Infrared Surveillance (3GIRS) program will be used to validate missile-warning technologies.
- The Australian Defense Force (ADF) purchased a specialized UHF communications payload from Intelsat. This payload is hosted aboard the Intelsat 22 satellite (built by Boeing Space & Intelligence Systems) and was launched in March 2012.
- Avanti Communications is placing a Ka-band broadband payload, designated HYLAS 3, aboard a European Space Agency (ESA) European Data Relay System (EDRS) satellite due to be launched in late 2015.
- NASA contracted with Space Systems Loral (SS/L) to host a Laser

Communications Relay Demonstration (LCRD) terminal, to test laser optical communications between a geostationary-orbiting satellite and a NASA ground terminal, aboard a commercial satellite yet to be selected. Launch is planned for 2016.

- Boeing is building a second UHF payload for the Intelsat 27 satellite. This new system is designed to meet the needs of the U.S. government and its allies.
- Inmarsat recently added hosted payloads to three of its Boeing-built Ka-band satellites, Inmarsat-5 F1, F2, and F3.
- ESA, the European Commission, and Eurocontrol (a European analog to the FAA's air traffic control organization) contracted with SES to host two Satellite-Based Augmentation Systems (SBAS) for the European Geostationary Navigation Overlay Service (EGNOS). EGNOS will supplement GPS, GLONASS, and the Galileo satellite navigation systems by measuring the accuracy of satellite navigation signals. The first payload will be hosted aboard SES 5 (built by SS/L) and the second aboard Astra 5B (built by EADS Astrium).

There are limitations to widespread use of hosted payloads. The contractual relationships are complex, because there are typically three or more parties involved in the mission, rather than two (satellite manufacturer and operator). In some cases, a hosted payload is added after a contract is signed between the satellite manufacturer and operator. In such cases, the manufacturer and operator do not want to impact their program schedule and require firm deadlines for delivery of the hosted payload, as well as clearly defined interfaces at the start of satellite integration. If the hosted payload fails to arrive on time, the satellite operator or the hosted payload operator may be liable for any impacts to satellite cost and schedule. In such cases, the satellite manufacturer may seek "off-ramps" to offset the possibility of late delivery penalties if the hosted payload causes a delay in delivery of the satellite.

There is a broad and growing interest in developing, launching, and operating hosted payloads. Industry collaboration or other co-operative leadership is necessary to bring together clients, financing sources, satellite operators, and launch vehicle providers to standardize the hosted payload process. When this is accomplished, hosted payloads will be a routine part of the commercial satellite business.

Seven satellite manufacturers and operators recently agreed to form an industry alliance to increase awareness of the benefits of hosted government payloads on commercial satellites. The Hosted Payload Alliance (HPA) will serve as a bridge between government and industry to foster open communication between potential users and providers of hosted payload capabilities. HPA Steering Committee members are Boeing Space and Intelligence Systems, Intelsat General Corporation, Iridium Communications Inc., Lockheed Martin Space Systems, Orbital Sciences Corporation, SES Government Solutions, and SS/L.

Launch Service Providers

New commercial launch services providers, such as SpaceX with its Falcon 9 and Falcon Heavy and Orbital Sciences with its Antares, are developing and demonstrating their vehicle capabilities for application to commercial and government markets. Lockheed Martin recently stated its intentions to position the Atlas V more competitively in the commercial market through United Launch Alliance. Arianespace, International Launch Services (ILS), and Sea Launch seek to reshape the competitive landscape by offering reduced pricing based on low-cost vehicle development and recurring production capability, streamlined commercial practices, improved schedule assurance, and expanded choices of launch sites. Incumbents are making investments to increase payload capacity, streamline supply chains, reduce operating costs, and garner additional capital from shareholders to fund infrastructure improvements and vehicle upgrades.

SpaceX's Falcon 9 debuted in June 2010 from Cape Canaveral Air Force Station (CCAFS), and December 2010 saw the inaugural launch of the company's Dragon space capsule, designed to support cargo and crew missions to the ISS. The company conducted its first mission to the ISS in 2012, under its Commercial Orbital Transportation Services (COTS) contract with NASA, to be followed by two missions in 2012 under its Cargo Resupply Services (CRS) contract with NASA. Falcon 9 is an EELV-class vehicle featuring a 5.2-meter fairing capable of lofting a commercial satellite with a mass up to 4,540 kg from CCAFS to GTO. SpaceX is developing its Falcon Heavy vehicle with 19,500 kg capability to GTO to address the intermediate and heavy segments of the commercial marketplace as well as national security and civil government payloads to LEO, GTO, and beyond. SpaceX continues to progress in capturing commercial GTO market share with recent announcements of launch services for operators AsiaSat, Asia Broadcast Satellite, and SatMex in addition to previously announced contracts with SES, Thaicom, and Spacecom. GTO launches are expected to begin in 2013.

Orbital Sciences' Antares is expected to debut in 2012 with a demonstration flight, followed by a flight of the company's Cygnus cargo carrier under the COTS program later in 2012 and the first operational flight of the Antares/Cygnus configuration to the ISS. The company is developing a launch pad at Wallops Island's Mid-Atlantic Regional Spaceport (MARS). Antares is a two-stage (optional three-stage) vehicle that features a 3.9-meter fairing and can loft 1,900 kg from MARS to GTO. Antares is also capable of flying from CCAFS, VAFB, and Kodiak. Orbital is studying an enhanced second stage to loft 2,200 kg from CCAFS to GTO. Although the near-term intent of Antares is to fly NASA payloads to LEO, it is likely Orbital will enter the market for commercial GTO launch services with an enhanced version tentatively planned to debut in 2014 with a new second stage and a larger payload faring now under study, boosting capacity to 3,500 kg to GTO—the target size for the company's GEOStar satellite bus.

The debut launch of the Russian Soyuz vehicle from the Kourou spaceport in French Guiana occurred successfully in October 2011, launching two Galileo navigation demonstration satellites. This was followed by another successful launch lofting the Pleiades earth observation satellite for CNES, the French Space Agency. The Soyuz modified for launches from French Guiana features a 4.1-meter fairing and will provide medium-lift capability of 3,150 kg to GTO. The near-equatorial launch location significantly increases the capacity of the Soyuz over the launch capacity from Baikonur. Initially, two to three flights are planned per year but this may increase to four to six missions per year as the market warrants. The first flight of a Soyuz with a commercial GSO payload is expected in 2012 or 2013.

Existing launch service providers, including Arianespace, ILS, and Sea Launch, are improving their capabilities to become more competitive. Arianespace is continuing systems modifications to increase effective GTO payload lift capacity from the current 9,100 kg to 9,400 kg by the end of 2012. The company expects the Ariane 5 Midlife Extension Program, slated for mid-decade, will boost effective GTO payload capability to 12,000 kg by 2018 through the development of the new Vinci cryogenic upper stage engine. This development depends on the decision of the ESA Ministerial Council later in 2012. France recently floated a 250M Euro bond to fund studies towards a possible Ariane 6 single satellite launcher capable of flying up to 8,000 kg to GTO.

ILS continues to upgrade its Proton M/Breeze M vehicle capability towards the goal of placing a maximum of 6,920 kg into GTO. ILS also offers super-synchronous launches, which permit Proton to carry an additional 200 kg of payload. A larger 5-meter fairing in development will be capable of placing satellites with mass up to 5,850 kg into GTO. ILS has successfully demonstrated dual payload capability for small communications satellites to GTO and for direct insertion into GEO, with at least three flights planned over the next two years. ILS has been working with Orbital Sciences to offer the capability to launch two stacked spacecraft based on the GEOStar bus and ISS Reshetnev's Exspress-1000 platform. Khrunichev State Research & Production Space Center is in the process of streamlining and consolidating its supply chain to reduce costs to increase Proton competitiveness. Additionally, Russia continues investment in its long-delayed Angara modular launch vehicle program, which is now slated for debut in 2014 as an eventual replacement for Proton. Angara is planned to fly from Plesetsk and a new site in the Russian Far East to reduce dependence on Baikonur. The company completed a new payload processing facility at Baikonur that permits spacecraft processing every 15 days. ILS hopes to boost its launch rate to 12-14 launches per year for commercial and Russian government customers.

Now owned by the Russian aerospace company RSC Energia, Sea Launch resumed operations from its Long Beach, California facility. The company expects to increase its launch pace over the next three years with three launches in each of 2012 and 2013 and four in 2014. RSC Energia oversees production schedules, increases technical insight, and invests in facilities and manufacturing processes in Russia and Ukraine to reduce costs, improve mission assurance, and reduce cycle times. Sea Launch plans performance improvements to its Zenit 3SL vehicle to boost lift capability from the current 6,180 kg to GTO to 6,700 kg by 2014, through a combination of mass reduction, reallocation of propellant reserves, and an extension to the existing fairing configuration.

Land Launch is still available for GSO launches and continues to be used for government launches, but its low mass capability and lack of sales have relegated it to a minor position in the commercial GSO market.

Regulatory Environment

ITAR remains an issue for U.S. satellite manufacturers as international competitors develop commercial satellite offerings that are not subject to U.S. export control regulations. The U.S. Department of State approval to export satellites to international launch sites applies to U.S.-built satellites and satellites using U.S. parts. Thales Alenia Space has been selling a version of its Spacebus platform produced without ITAR-restricted components. The introduction of this and other "ITAR-free" satellites (Western-built satellites containing no ITAR-restricted components) has affected Western launch providers as well as U.S. satellite manufacturers. ITAR-free satellites will enable launch contracts to be awarded to launch service providers currently restricted from importing ITAR-controlled components. ITAR-free satellites may encourage non-U.S. satellite manufacturers to abandon flight-proven U.S. components. Six ITAR-free commercial GSO satellites launched between 2005 and 2011, most on Long March launch vehicles. The U.S. Government, through the Departments of State, Commerce, and Defense and the U.S. Congress, is currently assessing changes to the export control regime to make export regulations less onerous and improve the competitiveness of U.S. satellite manufacturers in the global marketplace.

Table 9 lists the ITAR-free satellites that have been launched since 2005.

Table 9. ITAR-free Satellites

Satellite	Operator	Launch Vehicle	Launch Date	Satellite Model
Apstar 6	APT	Long March	4/12/2005	TAS Spacebus 4000
Chinasat 6B	China Satcom	Long March	7/5/2007	TAS Spacebus 4000
Chinasat 9	China Satcom	Long March	6/9/2008	TAS Spacebus 4000
Palapa D1	Indosat	Long March	8/31/2009	TAS Spacebus 4000
Express AM4	RSCC	Proton	8/17/2011	Astrium Eurostar 3000
Eutelsat W3C	Eutelsat	Long March	10/7/2011	TAS Spacebus 4000

On the international regulatory front, the International Institute for Unification of Private Law (UNIDROIT) moved ahead with a "Space Assets Protocol" at the Berlin Conference, continuing efforts to create a set of uniform commercial rules to facilitate the financing of private satellite operations. It was met with near universal opposition from established and start-up satellite operators on all continents, most of the world's satellite manufacturers and launch providers, major satellite insurance brokers and underwriters, many banks participating in the satellite sector, and major satellite and space-related associations. Many were concerned that the Protocol will introduce legal uncertainties, deter investment, and create new opportunities for litigation—all potentially increasing costs to industry.

The European Union pressed ahead with its "EU Space Code of Conduct" to get satellite operators, launch agencies, and all other users of space to recognize and respond to the growing threat from space debris. While the GSO population has not suffered catastrophic losses due to debris in geosynchronous orbit, the issue is being studied closely. All of the users of space, including providers of insurance and financing, can be affected by the loss of a satellite in geosynchronous orbit. Because of the potential cascading effect of a single debris event across geosynchronous orbit, launch activity may be affected as operators consider their response.

Financial Markets

Although the global financial markets continue to show signs of recovery from recession, the impacts of the Eurozone crisis, financial market regulatory changes, and de-leveraging across the banking sector have all resulted in an uncertain satellite financing market. Most established companies with robust balance sheets are not experiencing problems securing debt, while those companies with more unpredictable business plans have less access to financing and often rely on project financing or export credit agency (ECA) backing.

Satellite financing in 2011 was driven primarily by refinancing. Access to corporate credit, buoyed by very low treasury yields and a strong North American institutional market for bond and debt, led to major satellite companies refinancing for longer durations, perhaps in anticipation of increased cost of debt going forward. Access to funds from private equity firms remains difficult.

Established FSS and DBS satellite systems operators generally have healthy balance sheets anchored by high satellite use rates, long-term contracts, and large backlogs. The underlying strength of these segments of the satellite services industry remains strong. Small-fleet regional and newer operators face some risk in obtaining reasonably priced credit going forward, since they do not have the revenue streams of larger operators. Growth prospects for MSS operators, other than Inmarsat, are less promising, as most are required to continue funding the build-out of expensive new satellite-terrestrial hybrid networks for service provision. LightSquared encountered a major roadblock with the FCC, which found LightSquared's L-band transmissions cause interference with GPS signals. TerreStar Networks entered bankruptcy and eventually was acquired by EchoStar's Dish Network.

Government-backed ECA financing remains active, filling the void left by the disappearance of high-yield and debt financing. The U.S. Export-Import Bank (EXIM), France's Coface, and to a lesser extent, UK Export Finance have contributed significantly in providing trade receivables financing and management to GSO satellite operators such as SES, Inmarsat, HISPASAT, Shin Satellite, Star One, Avanti, and Gazprom, as well as NGSO operators Globalstar and O3b Networks. Debate continues on whether the growth in ECA-backed financing distorts the market by subsidizing satellite projects of questionable financial viability. For the time being, the sovereign considerations associated with these loans continue to prevail. Future ECA backing or failure of an ECA-backed project could affect future satellite and launch demand during the forecast period.

Given the extended planning, budgeting, manufacturing, and launch lead-times associated with deploying GSO spacecraft assets on orbit, continued access to affordable capital will remain crucial for all operators. Barring a major downturn in global recovery, the increasing stability of financial markets will help provide confidence for existing operators to move forward with satellite orders for system recapitalization and expansion and for new operators to proceed with system introductions.

Space Insurance

Space insurance is typically the third largest cost component of a commercial satellite system, after the cost of the satellite and launch services. The space insurance market is characterized by low frequency and high severity of losses, a small number of insured events, highly complex technical underwriting and claims handling, unique risks and exposures, manuscript policy wordings, and volatile underwriting results. As a result, the number of insurance companies willing to commit capital to space insurance has always been limited: there are currently about 30 companies worldwide providing such insurance. The business cycle of space insurance, and of insurance companies in general, is influenced by worldwide catastrophe losses and investment returns, among other factors. Due to recent good experience in space insurance, as well as recovery in financial markets, there is currently an abundance of available capacity for insuring satellite launches. This has pushed pricing to relatively low levels, facilitating the insurance of satellite programs. When the business cycle eventually turns, and adverse experience reduces available capacity, pricing will increase, and insurance for commercial space programs may be constrained. Although this can affect the scheduling of launches, there is generally sufficient time between insurance policy placement and launch to allow for such contingencies.

SUPPLEMENTARY QUESTIONNAIRE RESULTS

As part of the COMSTAC request for input from industry participants, a supplementary questionnaire was provided to satellite service providers. The questionnaire focuses on factors that may impact service providers' plans to purchase and launch satellites. A summary of the responses to this questionnaire is provided in Table 10. The last column is a comparison to the survey responses received for the 2011 Report.

The following six satellite operators responded to the questionnaire. The Forecast Team offers special thanks to these companies for providing this additional input:

- Arabsat (also responded in 2011)
- Hispasat (also responded in 2011)
- Intelsat*
- Sirius XM* (also responded in 2011)
- Telenor (also responded in 2011)
- TerreStar* (also responded in 2011)

* = U.S. company or company with significant U.S. operations

Due to the small number of questionnaire responses received this year, we did not make a direct comparison of last year's 14 survey responses to this year's 6 survey responses. Instead, we isolated the responses of the five firms who contributed to

Table 10. COMSTAC Survey Questionnaire Summary

Question: "To what extent have your company's plans to purchase or launch satellites been positively or negatively impacted by the following variables in the past year?"	Significant Negative Impact	Some Negative Impact	No Effect	Some Positive Impact	Significant Positive Impact	2012 vs. 2011
Regional or global economic conditions	17%	33%	33%	17%	0%	↓
Demand for satellite services	17%	17%	17%	33%	17%	↓
Ability to compete with terrestrial services	17%	17%	50%	17%	0%	↓
Availability of financing	17%	17%	50%	1%	0%	↓
Availability of affordable insurance	0%	0%	83%	17%	0%	↓
Consolidation of service providers	17%	33%	33%	0%	17%	↓
Increasing satellite life times	0%	17%	33%	50%	0%	↑
Availability of satellite systems that meet your requirements	0%	0%	17%	67%	17%	↑
Reliability of satellite systems	0%	17%	50%	17%	17%	↓
Availability of launch vehicles that meet your requirements	0%	33%	33%	33%	0%	=
Reliability of launch systems	0%	17%	33%	50%	0%	↑
Ability to obtain required export licenses	0%	0%	100%	0%	0%	↑
Ability to obtain required operating licenses	0%	50%	50%	0%	0%	↓

↑ More positive compared to 2011 ↓ More negative compared to 2011 = No changed compared to 2011

both the 2011 and 2012 survey and compared their responses to the two years' questionnaires.

The basis of the questionnaire is the single question: "To what extent have your company's plans to purchase or launch satellites been positively or negatively impacted by the following variables in the past year?"

The variables fall into three main categories: financial, technical, and regulatory. The 2012 survey reflects a modest decline in respondents' perception of the industry. There was a significant increase in the percentage of respondents who felt global economic conditions were having a negative impact on their business plans. Respondents were satisfied with the availability of satellite systems for their business, although there was increased concern regarding the reliability of these systems.

Reflecting continuing global economic woes, the reaction to financial concerns was somewhat negative. The availability of financing was a significant concern for the 2012 respondents, with 34% reporting a negative impact compared with 20% reporting some or significant negative impact in 2011. Respondents also saw a significant decrease in demand for satellite services and showed increased concern with their ability to compete with terrestrial services, with 34% seeing a negative impact in 2012 while no respondents expressed such concern in 2011. Availability of affordable insurance was not an issue for any of the respondents.

Operators continue to be satisfied with the variety of satellite systems available to them. The longer lifetime of satellite systems was reported as a negative impact on plans to purchase and launch satellites by 17% of the 2012 respondents and none of the respondents in 2011. This implies that longer lifetimes are extending the need to replenish fleets, which could have a negative impact on future satellite demand. Operators were less optimistic with launch vehicles: 33% of the 2012 respondents said the availability of launch vehicles had some or significant negative impact on their plans, compared to none of the 2011 respondents. This is especially interesting considering Sea Launch returned to the launch market and SpaceX is aggressively promoting the Falcon 9. Perception of launch vehicle reliability has decreased somewhat, with 17% of the 2012 responses indicating a negative impact compared to none of the 2011 respondents. This could be a reflection of concern about Russian launch vehicles that experienced multiple failures in 2011.

The regulatory category reflected some significant changes from 2011. None of the 2012 respondents experienced any significant negative impact as a result of their inability to obtain required export licenses, compared to 60% of the 2011 respondents. However, 50% of the 2012 respondents saw a negative impact on their ability to obtain required operating licenses, as opposed to none of the 2011 responses.

SUMMARY

- The 2012 COMSTAC GSO forecast projects 23 addressable commercial GSO satellites on 19 launches in 2012 and an annual average of 21.2 satellites on 16.3 launches for the period from 2012 through 2021.
- The number of unaddressable launches is increasing, as are average satellite mass and transponder count.
- The satellite services market is generally robust, and new launch vehicle options will affect the dynamics of the launch industry.
- Operators are cautious about the impact of the economy on their plans but are generally satisfied with satellite and launch vehicle offerings.

Table 11. Historical Addressable Commercial GSO Satellites Launched (1993–2011)

	1993			1994			1995			1996		
Total Launches	8			14			17			21		
Total Satellites	10			18			18			25		
Over 5,400 kg (>11,905 lbm)	0			0			0			0		
4,200 - 5,400 kg (9,260 - 11,905 lbm)	0			0			0			0		
2,500 - 4,200 kg (5,510 - 9,260 lbm)	6			9			14			14		
		Astra 1C	Ariane 4		Astra 1D	Ariane 4		Astra 1E	Ariane 4	DM3	Arabsat 2A	Ariane 4
	DM2	DBS 1	Ariane 4		Intelsat 702	Ariane 4		DBS 3	Ariane 4	DM4	Arabsat 2B	Ariane 4
		Galaxy 4	Ariane 4	DM2	PAS 2	Ariane 4		Intelsat 706A	Ariane 4		EchoStar 2	Ariane 4
		Intelsat 701	Ariane 4		PAS 3	Ariane 4		N-Star a	Ariane 4		Intelsat 707A	Ariane 4
	DMU	Solidaridad 1	Ariane 4	DM4	Solidaridad 2	Ariane 4		PAS 4	Ariane 4		Intelsat 709	Ariane 4
		Telstar 401	Atlas II		Telstar 402	Ariane 4		Telstar 402R	Ariane 4		MSAT 1	Ariane 4
					DBS 2	Atlas II		AMSC 1	Atlas II		N-Star b	Ariane 4
					Intelsat 703	Atlas II		Galaxy 3R	Atlas II	DM2	Palapa C2	Ariane 4
					Optus B3	Long March 2E		Intelsat 704	Atlas II	DM1	PAS 3R	Ariane 4
								Intelsat 705	Atlas II		AMC 1	Atlas II
								JCSat 3	Atlas II		Hot Bird 2	Atlas II
								APStar 2	Long March 2E		Palapa C1	Atlas II
								ASIASAT 2	Long March 2E		Intelsat 708A	Long March 3B
								EchoStar 1	Long March 2E		Astra 1F	Proton K/DM
Below 2,500 kg (<5,510 lbm)	4			9			4			11		
	DM1	Insat 2B	Ariane 4	DM3	Brazilsat B1	Ariane 4	DM1	Brazilsat B2	Ariane 44	DM2	Amos 1	Ariane 4
	DM1	Hispasat 1B	Ariane 4	DM2	BS-3N	Ariane 4	DM1	Hot Bird 1	Ariane 44	DMU	Italsat 2	Ariane 4
	DM2	Thaicom 1	Ariane 4	DM1	Eutelsat II F5	Ariane 4	DMU	Insat 2C	Ariane 44	DM1	Measat 1	Ariane 4
		NATO 4B	Delta II	DM4	Thaicom 2	Ariane 4		Koreasat 1	Delta II	DM4	Measat 2	Ariane 4
				DM1	TurkSat 1A	Ariane 4				DM3	TurkSat 1C	Ariane 4
				DM3	TurkSat 1B	Ariane 4					Inmarsat 3F1	Atlas II
					Orion 1	Atlas II					Inmarsat 3F3	Atlas II
					Galaxy 1RS	Delta II					Galaxy 9	Delta II
					APStar 1	Long March 3					Koreasat 2	Delta II
											APStar 1A	Long March 3
											Inmarsat 3F2	Proton K/DM

= Launch Failure

DM# = Dual-manifested Launch with another Adressable Satellite. Example: DM1 was paired with DM1, DM2 with DM2, etc.

DMU = Dual-manfiested Launch with Non-Addressable Satellite. DMU missions are counted as a single launch in the launch count.

Table 11. Historical Addressable Commercial GSO Satellites Launched (1993–2011) (Continued)

	1997			1998			1999			2000			2001		
Total Launches		24			19			18			20			12	
Total Satellites		28			23			19			24			14	
Over 5,400 kg (>11,905 lbm)		0			0			0			0			0	
4,200 - 5,400 kg (9,260 - 11,905 lbm)		0			0			2			4			5	
								Galaxy 11	Ariane 4		Anik F1	Ariane 4		DirecTV 4S	Ariane 4
								Orion 3	Delta III		PAS 1R	Ariane 5		Intelsat 901	Ariane 4
											Garuda 1	Proton K/DM		Intelsat 902	Ariane 4
											Thuraya 1	Sea Launch		XM Rock	Sea Launch
														XM Roll	Sea Launch
2,500 - 4,200 kg (5,510 - 9,260 lbm)		21			14			16			14			6	
	DMU	Hot Bird 3	Ariane 4	DM4	Afristar	Ariane 4		AMC 4	Ariane 4	DM1	Asiastar 1	Ariane 5	DM2	**Artemis**	Ariane 5
		Intelsat 801	Ariane 4	DM3	Eutelsat W2	Ariane 4	DM1	Arabsat 3A	Ariane 4	DM3	Astra 2B	Ariane 5		Atlantic Bird 2	Ariane 4
		Intelsat 802	Ariane 4		Hot Bird 4	Ariane 4		Insat 2E	Ariane 4		Europe*Star 1	Ariane 4	DM1	Eurobird	Ariane 5
		Intelsat 803	Ariane 4		PAS 6B	Ariane 4		Koreasat 3	Ariane 4		Eutelsat W1R	Ariane 4		Turksat 2A	Ariane 4
		Intelsat 804	Ariane 4		PAS 7	Ariane 4		Orion 2	Ariane 4		Galaxy 10R	Ariane 4		Astra 2C	Proton K/DM
		JCSat 5	Ariane 4		Satmex 5	Ariane 4		Telkom	Ariane 4		Galaxy IVR	Ariane 4		PAS 10	Proton K/DM
		PAS 6	Ariane 4		ST-1	Ariane 4		Telstar 7	Ariane 4		N-Sat-110	Ariane 4			
	DM4	Sirius 2	Ariane 4		Hot Bird 5	Atlas II		Echostar V	Atlas II		Superbird 4	Ariane 4			
	DM2	Thaicom 3	Ariane 4		Intelsat 805A	Atlas II		Eutelsat W3	Atlas II		Echostar VI	Atlas II			
		AMC 3	Atlas II		Intelsat 806A	Atlas II		JCSat 6	Atlas II		Eutelsat W4	Atlas III			
		DirecTV 6	Atlas II		**Galaxy 10**	Delta III		Asiasat 3S	Proton K/DM		Hispasat 1C	Atlas II			
		EchoStar 3	Atlas II		Astra 2A	Proton K/DM		Astra 1H	Proton K/DM		AAP 1	Proton K/DM			
		Galaxy 8i	Atlas II		EchoStar 4	Proton K/DM		LMI 1	Proton K/DM		AMC 6	Proton K/DM			
		JCSat 4	Atlas II		PAS 8	Proton K/DM		Nimiq	Proton K/DM		PAS 9	Sea Launch			
		Superbird C	Atlas II					Telstar 6	Proton K/DM						
		Agila II	Long March 3B					DirecTV 1R	Sea Launch						
		APStar 2R	Long March 3B												
		Aatra 1G	Proton K/DM												
		Asiasat 3	Proton K/DM												
		PAS 5	Proton K/DM												
		Telstar 5	Proton K/DM												
Below 2,500 kg (<5,510 lbm)		7			9			1			6			3	
	DM1	AMC 2	Ariane 4	DM4	AMC 5	Ariane 4	DM1	Skynet 4E	Ariane 4	DM3	AMC 7	Ariane 5	DM1	BSat 2A	Ariane 5
	DM2	BSat 1A	Ariane 4	DM1	Brazilsat B3	Ariane 4				DM4	AMC 8	Ariane 5	DM2	**BSat 2B**	Ariane 5
	DM4	Cakrawarta 1	Ariane 4	DM2	BSat 1B	Ariane 4				DM4	Astra 2D	Ariane 5	DMU	Skynet 4F	Ariane 4
	DM3	Inmarsat 3F4	Ariane 4	DM1	Inmarsat 3F5	Ariane 4				DM2	Brazilsat B4	Ariane 4			
	DM3	Insat 2D	Ariane 4	DM2	NileSat 101	Ariane 4				DM1	Insat 3B	Ariane 5			
	DM1	Nahuel 1A	Ariane 4	DM3	Sirius 3	Ariane 4				DM2	Nilesat 102	Ariane 4			
		Thor II	Delta II		Bonum-1	Delta II									
					Skynet 4D	Delta II									
					Thor III	Delta II									

[grey shading; bold in table above] = Launch Failure

DM# = Dual-manifested Launch with another Adressable Satellite. Example: DM1 was paired with DM1, DM2 with DM2, etc.

DMU = Dual-manfiested Launch with Non-Addressable Satellite. DMU missions are counted as a single launch in the launch count.

Table 11. Historical Addressable Commercial GSO Satellites Launched (1993–2011) (Continued)

	2002	2003	2004	2005	2006
Total Launches	20	12	13	15	15
Total Satellites	22	15	13	16	19
Over 5,400 kg (>11,905 lbm)	0	0	3 Anik F2 Ariane 5 Intelsat X Proton M DirecTV 7S Sea Launch	6 DM1 Spaceway 2 Ariane 5 Thaicom 4 Ariane 5 Inmarsat 4F1 Atlas V IA-8 Sea Launch Inmarsat 4F2 Sea Launch Spaceway 1 Sea Launch	2 DM2 Satmex 6 Ariane 5 DM3 DirecTV 9S Ariane 5
4,200 - 5,400 kg (9,260 - 11,905 lbm)	9 Intelsat 904 Ariane 4 Intelsat 905 Ariane 4 Intelsat 906 Ariane 4 NSS-6 Ariane 4 NSS-7 Ariane 4 Astra 1K Proton K/DM Echostar 8 Proton K/DM Intelsat 903 Proton K/DM Galaxy IIIC Sea Launch	5 Intelsat 907 Ariane 4 DM2 Optus C1 Ariane 5 Rainbow 1 Atlas V EchoStar 9 Sea Launch Thuraya 2 Sea Launch	4 Eutelsat W3A Proton M Amazonas Proton M Estrela do Sul Sea Launch APStar V Sea Launch	4 AMC-12 Proton M Anik F1R Proton M AMC-23 Proton M XM-3 Sea Launch	9 DM4 Wildblue 1 Ariane 5 Astra 1KR Atlas V Hotbird 8 Proton M Measat 3 Proton M Echostar X Sea Launch JCSat 9 Sea Launch Galaxy 16 Sea Launch Koreasat 5 Sea Launch XM-4 Sea Launch
2,500 - 4,200 kg (5,510 - 9,260 lbm)	11 DMU Atlantic Bird 1 Ariane 5 DMU Hotbird 7 Ariane 5 Insat 3C Ariane 4 DM1 JCSat 8 Ariane 4 DM2 Stellat 5 Ariane 5 Echostar 7 Atlas III Hispasat 1D Atlas II Hotbird 6 Atlas V Eutelsat W5 Delta IV DirecTV 5 Proton K/DM Nimiq 2 Proton M	6 DM1 Insat 3A Ariane 5 DM3 Insat 3E Ariane 5 Asiasat 4 Atlas III Hellas-sat Atlas V AMC-9 Proton K/M Galaxy XIII Sea Launch	4 Superbird 6 Atlas II MBSat Atlas III AMC-16 Atlas V AMC-15 Proton M	3 DMU XTAR-EUR Ariane 5 Insat 4A Ariane 5 DirecTV 8 Proton M	6 DM1 Hotbird 7A Ariane 5 DM1 Spainsat Ariane 5 DM2 Thaicom 5 Ariane 5 DMU JCSat 10 Ariane 5 Arabsat 4A Proton M Arabsat 4B Proton M
Below 2,500 kg (<5,510 lbm)	2 DM1 Astra 3A Ariane 44L DM2 N-Star c Ariane 5G	4 DM2 Bsat 2C Ariane 5 DM3 e-Bird 1 Ariane 5 DM1 Galaxy XII Ariane 5 Amos 2 Soyuz	2 AMC-10 Atlas II AMC-11 Atlas II	3 DM1 Telkom 2 Ariane 5 DMU Galaxy 15 Ariane 5 Galaxy 14 Soyuz	2 DM4 AMC-18 Ariane 5 DM3 Optus D1 Ariane 5

= Launch Failure

DM# = Dual-manifested Launch with another Adressable Satellite. Example: DM1 was paired with DM1, DM2 with DM2, etc.

DMU = Dual-manfiested Launch with Non-Addressable Satellite. DMU missions are counted as a single launch in the launch count.

Table 11. Historical Addressable Commercial GSO Satellites Launched (1993–2011) (Continued)

	2007		2008		2009		2010		2011	
Total Launches	12		18		18		14		12	
Total Satellites	18		23		22		20		15	
Over 5,400 kg (>11,905 lbm)	3		5		8		7		3	
	DM3 Spaceway 3	Ariane 5	Inmarsat 4F3	Proton M	Eutelsat W2A	Proton M	Echostar 14	Proton M	DM1 Yahsat 1A	Ariane 5
	DirecTV 10	Proton M	DirecTV 11	Sea Launch	Sirius FM 5	Proton M	Arabsat 5B	Proton M	Quetzsat	Proton M
	NSS-8	Sea Launch	ICO G-1	Atlas V	Terrestar 1	Ariane 5	Echostar 15	Proton M	Viasat 1	Proton M
			Echostar 11	Sea Launch	DM1 Amazonas 2	Ariane 5	XM-5	Proton M		
			Ciel 2	Proton M	DM2 NSS-12	Ariane 5	DM4 Eutelsat W3B	Ariane 5		
					Intelsat 14	Atlas V	SkyTerra 1	Proton M		
					Eutelsat W7	Proton M	KA-Sat	Proton M		
					DirecTV 12	Proton M				
4,200 - 5,400 kg (9,260 - 11,905 lbm)	6		8		2		4		6	
	DM1 Skynet 5A	Ariane 5	DM1 Skynet 5C	Ariane 5	DM3 Hotbird 10	Ariane 5	DM1 Astra 3B	Ariane 5	DM3 Arabsat 5C	Ariane 5
	DM2 Astra 1L	Ariane 5	Astra 1M	Proton M	Nimiq 5	Proton M	DM2 Arabsat 5A	Ariane 5	DM2 Astra 1N	Ariane 5
	DM5 Skynet 5B	Ariane 5	Nimiq 4	Proton M			DM5 Intelsat 17	Ariane 5	DMU ST 2	Ariane 5
	Nigcomsat	Long March 3B	DM3 HotBird 9	Ariane 5			DM6 Hispasat 1E	Ariane 5	Eutelsat W3C	Long March
	Anik F3	Proton M	Thuraya 3	Sea Launch					Telstar 14R	Proton M
	SES Sirius 4	Proton M	Galaxy 18	Sea Launch					Atlantic Bird 7	Sea Launch
			Galaxy 19	Sea Launch						
			DM5 Superbird 7	Ariane 5						
2,500 - 4,200 kg (5,510 - 9,260 lbm)	5		8		9		6		6	
	DM1 Insat 4B	Ariane 5	DM2 BADR 6	Ariane 5	DM1 Satcom BW1	Ariane 5	SES-1	Proton M	DM2 BSAT 3C	Ariane 5
	DM2 Galaxy 17	Ariane 5	DM3 Eutelsat W2M	Ariane 5	DM2 Thor 6	Ariane 5	DM1 Satcom BW-2	Ariane 5	DM1 New Dawn	Ariane 5
	DM5 Star One C1	Ariane 5	**AMC 14**	Proton M	Telstar 1N	Land Launch	DM3 Nilesat 201	Ariane 5	DM3 SES 2	Ariane 5
	DM6 RASCOM 1	Ariane 5	DM4 Vinasat	Ariane 5	Sicral 1B	Sea Launch	DM3 RASCOM 1R	Ariane 5	Intelsat 18	Land Launch
	JCSat 11	Proton M	DM2 Protostar 1	Ariane 5	Protostar II	Proton M	DM5 Hylas	Ariane 5	Asiasat 7	Proton M
			DM5 AMC 21	Ariane 5	Asiasat 5	Proton M	DM6 Koreasat 6	Ariane 5	DMU SES 3	Proton M/DM
			DM1 Turksat 3A	Ariane 5	DM4 JCSat 12	Ariane 5				
			DM4 StarOne C2	Ariane 5	Palap D	Long March				
					Intelsat 15	Long March				
Below 2,500 kg (<5,510 lbm)	4		2		3		3		0	
	DM3 Bsat 3A	Ariane 5	AMOS 3	Land Launch	DM3 NSS-9	Ariane 5	Intelsat 16	Proton M		
	DM4 Intelsat 11	Ariane 5	Thor 5	Proton M	Measat 3A	Land Launch	DM2 COMS 1	Ariane 5		
	DM4 Optus D2	Ariane 5			DM4 Optus D3	Ariane 5	DM4 BSAT 3B	Ariane 5		
	DM6 Horizons	Ariane 5								

(shaded) = Launch Failure

DM# = Dual-manifested Launch with another Adressable Satellite. Example: DM1 was paired with DM1, DM2 with DM2, etc.

DMU = Dual-manfiested Launch with Non-Addressable Satellite. DMU missions are counted as a single launch in the launch count.

Table 12. Historical Unaddressable Commercial GSO Satellites Launched (1993–2011)

		1993			1994			1995			1996	
Total Launches		3			4			1			4	
Total Spacecraft		3			4			2			5	
		Gorizont	Proton K/DM		DFH 3-1	Long March 3A	DMC	Telecom - 2C	Ariane 4	DMC	Telecom 2D	Ariane 4
		Gorizont 40	Proton K/DM		Express	Proton K/DM		Gals 2	Proton K/DM		Chinasat 7	Long March 3A
		Gorizont 41	Proton K/DM		Gals-1	Proton K/DM					Express 2	Proton K/DM
					Gorizont 42	Proton K/DM					Gorizont 43	Proton K/DM
											Gorizont 44	Proton K/DM

		1997			1998			1999			2000	
Total Launches		1			2			2			5	
Total Spacecraft		1			2			3			5	
		Chinasat 6	Long March 3A		ChinaStar-1	Long March 3B		Express A1	Proton K/DM		Express A2	Proton K/DM
					Sinosat-1	Long March 3C	DM1	Yamal 101	Proton K/DM		Express A3	Proton K/DM
							DM1	Yamal 102	Proton K/DM		Gorizont 45	Proton K/M
											SESAT	Proton K/DM
											Chinasat 22	Long March 3A

		2001			2002			2003			2004	
Total Launches		1			1			3			2	
Total Spacecraft		1			1			4			2	
		Ekran M	Proton M/M		Express A4	Proton K/DM		Express AM-22	Proton K/DM		Express AM-11	Proton K/DM
							DM1	Yamal 200	Proton K/DM		Express AM 1	Proton K/DM
							DM1	Yamal 200	Proton K/DM			
								Chinasat 20	Long March 3A			

		2005			2006			2007			2008	
Total Launches		3			4			4			3	
Total Spacecraft		3			4			4			3	
		Express AM 2	Proton K/DM		Kazsat	Proton K/DM		Sinosat 3	Long March 3B		Venesat 1	Long March 3B
		Express AM 3	Proton K/DM		Sinosat 2	Long March 4B		Chinasat 6B	Long March 3B		Chinasat 9	Long March 3B
		Apstar 6	Long March 3B		Chinasat 22A	Long March 3A		Nigcomsat 1	Long March 3B		Express AM33	Proton
					Insat 4C	GSLV		Insat 4CR	GSLV			

		2009			2010			2011	
Total Launches		1			3			8	
Total Spacecraft		2			3			10	
	DM1	Express MD-1	Proton M		ChinaSat 6A	Long March 3B		GSAT 8	Ariane 5
	DM1	Express AM44	Proton M		ChinaSat 20A	Long March 3A		Chinasat 10	Long March 3B
					Insat 4D	GSLV		Chinasat 1A	Long March 3B
								Nigcomsat 1R	Long March 3B
								Paksat 1R	Long March 3B
							DM1	Amos 5	Proton M
							DM1	Luch 5A	Proton M
								Express AM4	Proton M
							DMA	Kazsat 2	Proton M
								GSAT 12	PSLV

(grey box) = Launch Failure

DM# = Dual-manifested Launch with another Unadressable Satellite. Example: DM1 was paired with DM1, DM2 with DM2, etc.

DMA = Dual-manfiested Launch with Addressable Satellite. DMA missions are not counted as a launch in the launch count.

2012 COMMERCIAL SPACE TRANSPORTATION FORECAST FOR NON-GEOSYNCHRONOUS ORBITS (NGSO)

Introduction

The *2012 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits (NGSO)* is developed by the Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST). The report projects commercial launch demand for all space systems to be deployed to NGSO, including low Earth orbit (LEO), medium Earth orbit (MEO), elliptical orbits (ELI), and external trajectories (EXT) to the Moon or other solar system destinations. First compiled in 1994, it assesses payloads most likely to seek commercial launch services during the next 10 years. Commercial launches, as defined for this report, include those whose services are sought on the international market. It also includes U.S. domestic commercial launch services licensed by the FAA, such as commercial launches to the International Space Station (ISS).

Report Purpose and Methodology

The 2012 report helps U.S. industry, as well as the U.S. Government, understand the scope and trends of global commercial spaceflight demand. It also assists FAA/AST in licensing and planning.

This report is based on FAA/AST research and discussions with industry, including satellite service providers, spacecraft manufacturers, launch service providers, system operators, government offices, and independent analysts. The report examines progress for publicly announced payloads (satellites, space vehicles, and other spacecraft) and considers the following factors:

- Financing;
- Regulatory developments;
- Spacecraft manufacturing and launch services contracts;
- Investor confidence;
- Competition from space and terrestrial sectors; and
- Overall economic conditions.

This report includes five payload segments, defined by the type of service the spacecraft are designed to offer:

- Commercial telecommunications;
- Commercial remote sensing;
- Science and engineering, including basic and applied research and space technology test and demonstration;
- Commercial cargo and crew transportation services, including cargo and human spaceflight; and
- Other payloads launched commercially.

Future deployments of payloads that have not yet been announced are projected based on market trends, the status of payloads currently in orbit, and the economic conditions of potential payload developers and operators. Follow-on systems and replacement satellites for existing systems are evaluated on a case-by-case basis. In some cases, expected future activity is beyond the timeframe of the report or is not known with enough certainty to merit inclusion in the NGSO forecast model. For the science and engineering market, near-term primary payloads generating individual commercial launches were used in the model, while future years are estimated based on historical and near-term activity. The projected launches for commercial cargo and crew transportation services were based on the National Aeronautics and Space Administration (NASA) 2013 ISS traffic model.

Commercial NGSO Launch Industry Components

Figure 11 depicts the commercial space launch industry. Demand for commercial space launch flows from top to bottom through the industry components: satellite and commercial transportation service operators, satellite manufacturers, launch providers, and launch vehicle manufacturers.

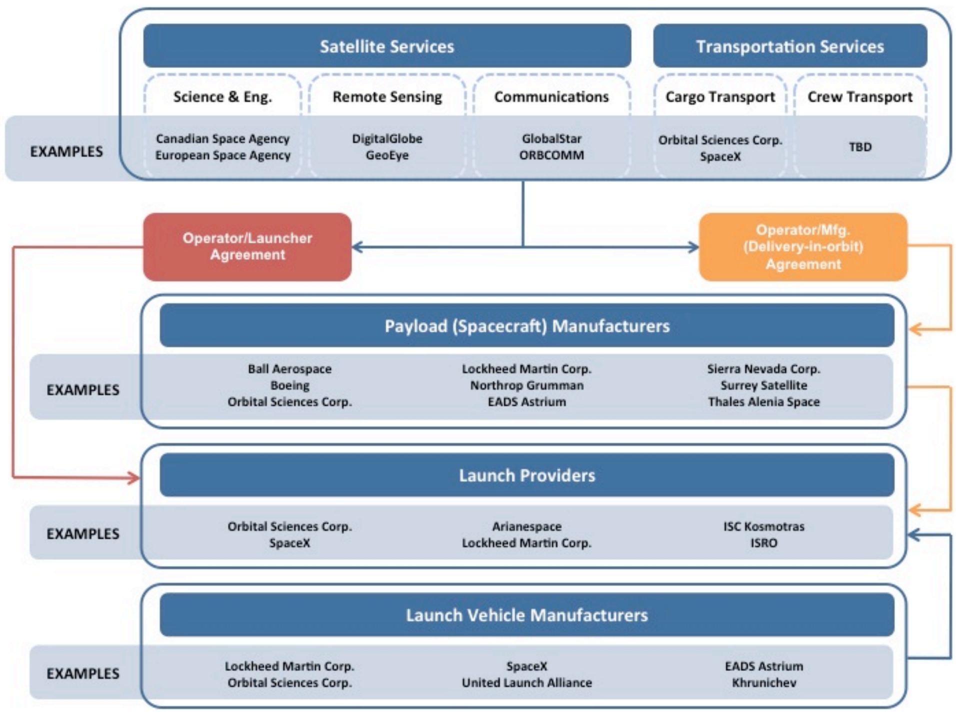

Figure 11. NGSO Launch Industry Components

SATELLITE AND COMMERCIAL TRANSPORTATION SERVICE OPERATORS

Operators purchase and operate payloads (spacecraft) that provide services such as commercial telecommunications, commercial remote sensing, science and engineering, and commercial cargo and crew transportation services. Their customers include private companies, militaries, national space programs, universities, and the general public.

Operators include private companies, government agencies, public-private partnerships, universities, and non-profit entities. Private sector payload operators typically focus on a particular service segment, for example, DigitalGlobe and GeoEye in the remote sensing segment and Iridium and ORBCOMM in the communications segment. Government agencies operate a range of satellite systems and other types of payloads across multiple service segments.

SPACECRAFT MANUFACTURERS

These organizations include private companies, universities, and occasionally government organizations that construct satellites for satellite operators. Most manufacturers can produce spacecraft for multiple service sectors, although some specialize in a particular segment. Spacecraft often include components or instruments obtained from multiple suppliers. Typically, one manufacturer serves as the prime contractor for a spacecraft and is responsible for integrating components.

LAUNCH PROVIDERS

These companies provide launch services for spacecraft under contracts with payload operators, although sometimes these contracts are signed with spacecraft manufacturers (in arrangements known as delivery-in-orbit).

LAUNCH VEHICLE MANUFACTURERS

These organizations include private companies, government organizations, and mixed publicly-privately owned entities that design and build rocket launch vehicles for launching payloads, including satellites, crew vehicles, and other spacecraft. Launch vehicle manufacturers can be the same entities as launch providers, be partial owners of launch provider companies, or market their launch vehicles through launch providers under agreements or contracts.

Although the industry components are distinct, many companies are active in more than one of them. For example, companies such as Orbital Sciences Corporation (Orbital) or Space Exploration Technologies Corporation (SpaceX) are vertically integrated: they build and launch their own rockets, and they manufacture and operate spacecraft.

Figure 11 does not include government regulators, finance sources, insurers, or other additional industry components. It is important to note these components exist and influence demand within the commercial NGSO launch market.

Report Summary

The report projects an average demand of 12.8 launches per year worldwide during the period of 2012 through 2021. The launch demand peaks in 2017, with 17 launches, due to the replacement of the Iridium constellation and frequent commercial crew and cargo launches to the ISS. For the telecommunications sector, a drop in launch demand is expected after 2017, when telecommunication constellations, including Iridium, finish deployment. This average is slightly less than last year's average of 13.0 launches per year.

It is important to note that 64 launches for commercial cargo and crew services to the ISS are projected from 2012 to 2021. These launches would take place on vehicles that are not yet operational and partly rely on government funding that is subject to annual appropriations—technical or financial issues could delay ISS resupply launches. Moreover, it is still too early to predict with accuracy new and emerging markets. If NASA's needs for commercial cargo and crew to the ISS grow, Bigelow Aerospace launches its space stations, the space tourism market matures, and commercial companies launch payloads to the Moon, there can be significant growth in NGSO launches in 2018 and beyond.

Launch demand is divided into 2 vehicle size classes, with an average of 12.0 medium- to heavy-class vehicle launches per year and 0.8 small-class vehicle launches per year for 2012 to 2021. Compared to last year's report, the number of small launches decreased slightly, and the number of medium- to heavy-class launches increased. Figure 12 depicts the distribution of satellites seeking launch and respective launches by payload segment type.

Fifty percent of the launches projected for the next 10 years in the NGSO market are for commercial crew and cargo to the ISS. This marks a slight increase from 46 percent projected in the 2011 report.

Telecommunications comprises 37 percent of the satellite market but only 11 percent of the launch market because of multiple-manifesting. All upcoming launches for the Iridium, Globalstar, ORBCOMM, and O3b fleets will be multi-manifested.

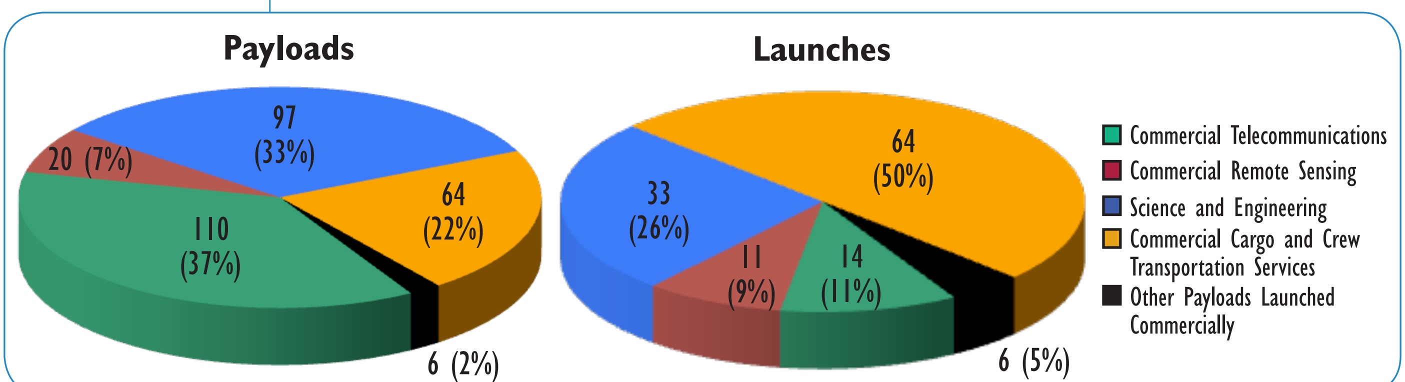

Figure 12. Number of Payloads Seeking Launch and Associated Launches in 2012-2021

Science and engineering payloads, which include basic and applied research and space technology test and demonstration spacecraft, constitute 33 percent of the satellite market and 26 percent of the launch market. Commercial remote sensing satellites account for only about 7 percent of the payload market and 9 percent of the launch demand market.

The annual launch rate during the next 10 years is considerably higher than the previous decade (see Figure 13). Commercial space transportation and telecommunications constellation replenishments drive this increase.

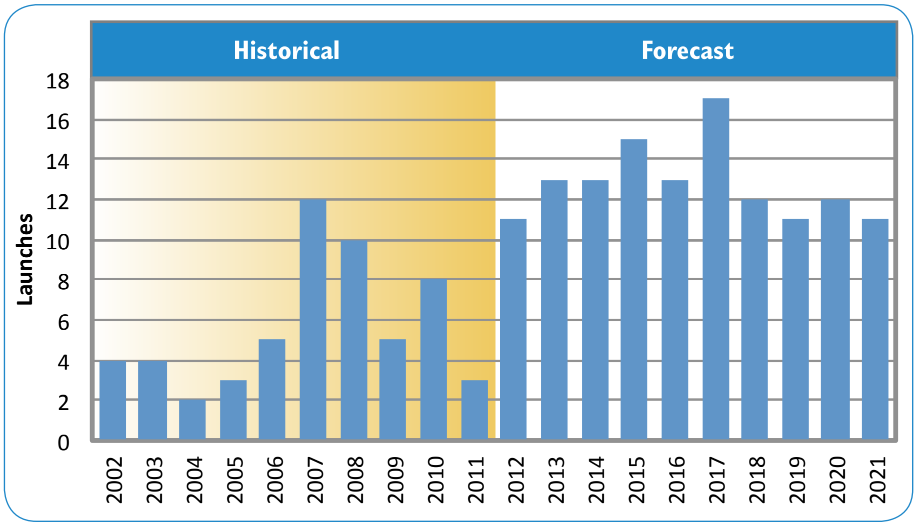

Figure 13. Commercial NGSO Launch History and Projected Launch Plans

Last year's report predicted 11 launches for 2011, but only 3 occurred. This demonstrates the challenge of projecting launch rates across all segments. Three of the launches were SpaceX flights that were delayed and then combined. The first two launches of Orbital's Antares vehicle were also delayed. The third Globalstar launch on a Soyuz was delayed pending the investigation of a Soyuz failure in December 2011. Finally, two projected Dnepr launches did not occur. A large portion of commercial launch services is tied to the development and launch of new systems both on the payload and launch vehicle sides of the industry. The realization of so few manifested launches highlights the difficulty of forecasting launches.

The near-term launch projection (2012-2015) is based on publicly announced launch demand. Table 13 identifies all NGSO satellites manifested for 2012 through 2015 that drive a launch. The report projects 11 NGSO launches for 2012 and 13 launches for 2013. However, applying a realization factor, the actual NGSO launches are more likely to be between four and seven in 2012 and five to eight in 2013. This factor is based on the difference between projected launches and actual launches in the five years before the year of the report and is only applied to 2012 and 2013. The mid- and far-term launch projections (2016-2021) are based on publically available information from satellite service providers, correspondence with service providers, and estimates of when existing constellations will reach end of life and require replacement.

Table 13. Near-Term Identified NGSO Payload Manifest

Service Type	2012	2013	2014	2015
Commercial Telecommunications Systems	Globalstar (6) - Soyuz 2	ORBCOMM (8) - Falcon 9 O3b (4) - Soyuz 2 O3b (4) - Soyuz 2	ORBCOMM (7) - Falcon 9 O3b (4) - Soyuz 2	Iridium (9) - Falcon 9 Iridium (9) - Falcon 9
Commercial Remote Sensing		GeoEye 2 - Atlas V EROS C - TBD	WorldView 3 - Atlas V DMCii (3) - TBD	TerraSAR-X2 - TBD RCM 1 - TBD
Science and Engineering	Antares Demo Flight Kompsat 5 - Dnepr DubaiSat-2 - Dnepr SWARM (3) - Rockot Falcon 9 Heavy Test Launch Cassiope - Falcon 9	Kompsat 3A - Dnepr	SAOCOM 1A - Falcon 9 Formosat 5 - Falcon 9 DragonLAB 1 - Falcon 9 Orion MPCV - Delta IV Heavy	SAOCOM 1B - Falcon 9 EnMap - PSLV DragonLAB 2 - Falcon 9 Bigelow Payload - Falcon 9
Commercial Cargo and Crew Transportation Services	Dragon COTS Demo 2/3 - Falcon 9 Dragon ISS Resupply - Falcon 9 Cygnus COTS Demo - Antares	Cygnus ISS Resupply - Antares Cygnus ISS Resupply - Antares Dragon ISS Resupply - Falcon 9 Dragon ISS Resupply - Falcon 9	Cygnus ISS Resupply - Antares Cygnus ISS Resupply - Antares Dragon ISS Resupply - Falcon 9 Dragon ISS Resupply - Falcon 9 Dragon ISS Resupply - Falcon 9	Cygnus ISS Resupply - Antares Cygnus ISS Resupply - Antares Dragon ISS Resupply - Falcon 9 Dragon ISS Resupply - Falcon 9 Dragon ISS Resupply - Falcon 9 ISS Resupply - TBD
Other Payloads Launched Commercially	Göktürk 2 - Long March 2D	ASNARO - Dnepr PAZ - Dnepr Göktürk 1 - TBD		Göktürk 3 - TBD
Total Payloads	37	44	28	35
Total Launches	11	13	13	15
FAA Launch Realization Factor	4-7	5-8		

The 2012 projection includes maiden flights of two new rockets: Antares and Falcon Heavy. It also includes the Dragon Commercial Orbital Transportation Services (COTS) Demo 2/3 and Cygnus COTS Demo, the first two cargo missions to dock with the ISS. Finally, this projection consists mostly of multi-manifested launches. The 2013 projection includes four cargo resupply missions to the ISS on two new vehicles and spacecraft. Maiden flights, new vehicles, new satellite systems, and new spacecraft missions have a greater than normal chance of slipping into the next year. The Risk Factors section of this report discusses projection uncertainty in detail.

NGSO Payload Segments

Commercial Telecommunication Satellites

The NGSO telecommunications satellite market is based on large constellations of small-to-medium-sized satellites that provide global or near-global communications coverage. The constellations can be divided into three major categories based on the frequencies the satellites use: narrowband (also known as Little LEO), wideband (also known as Big LEO), and broadband.

Narrowband LEO systems (Table 14) operate at frequencies below 1 GHz. These systems provide narrowband data communications, such as email, two-way paging, and simple messaging for automated meter reading, vehicle fleet tracking, and other remote data monitoring applications. ORBCOMM is the only fully operational narrowband system. Another system, AprizeStar (LatinSat), is partially operational with eight satellites in orbit and will reach its full capacity when the full constellation is deployed.

Table 14. Narrowband Systems

System/ Operator	Prime Contractor	Satellites: Number	Satellites: Mass kg (lb)	Orbit Type	First Launch	Status
Operational						
ORBCOMM/ ORBCOMM M Inc.	Orbital Sciences Corp. (1st Gen.); Sierra Nevada Corp. (2nd Gen.)	41/27 (in orbit/ operational)	43 (95) (1st Gen.); 142 (313) (2nd Gen.)	LEO	1997	System operational with 41 satellites in orbit. Eighteen second generation satellites are planned to begin launching in 2012.
Under Development						
AprizeStar (LatinSat)/ Aprize Satellite	SpaceQuest	8/6 (in orbit/ operational)	10 (22)	LEO	2002	Planned 12- to 30-satellite system, with intermittent launches based on availability of funding. Two more satellites are planned for launch in 2012.

Wideband LEO systems (Table 15) use frequencies in the range of 1.6–2.5 GHz (L- and S-band frequencies). Wideband systems provide mobile voice telephony and data services. The two wideband systems Globalstar and Iridium are on orbit and operational.

Table 15. Wideband Systems

System/ Operator	Prime Contractor	Satellites: Number	Satellites: Mass kg (lb)	Orbit Type	First Launch	Status
Operational						
Globalstar/ Globalstar Inc.	SS/Loral (1st Gen.); Thales Alenia Space (2nd Gen.)	62/48 (in orbit/ operational)	447 (985) (1st Gen.); 700 (1,543) (2nd Gen.)	LEO	1998	Constellation in orbit and operational, with technical anomalies. Eight replacement satellites launched in 2007. Eighteen second generation satellites launched in 2010 and 2011 on three Soyuz rockets. Six second-generation satellites are planned for launch aboard a Soyuz vehicle in 3Q 2012.
Iridium/ Iridium Communications Inc.	Motorola (Iridium); Thales Alenia Space (Iridium NEXT)	90/72 (in orbit/ operational)	680 (1,500) (Iridium); 800 (1,763) Iridium NEXT	LEO	1997	Constellation in orbit and operational. Assets acquired in December 2000 out of bankruptcy. Five spare satellites launched in February 2002, two additional spares launched June 2002. A next generation system is under development by Thales Alenia Space. Multiple launches of the Iridium NEXT constellation satellites by the Falcon 9 rocket are projected to begin in 2015.

The third category is broadband (Table 16)—satellite systems that reside in NGSO and provide high-speed data services at Ka- and Ku-band frequencies. Given O3b's successful efforts securing investment capital for this constellation, it appears that plans for an initial deployment in 2013 remain on track.

Table 16. Broadband Systems

System/ Operator	Prime Contractor	Satellites: Number	Satellites: Mass kg (lb)	Orbit Type	First Launch	Status
Under Development						
O3b/O3b Networks Ltd.	Thales Alenia Space	0/0 (in orbit/ operational)	700 (1,540)	MEO	2013	The first eight satellites of the constellation plan to launch in 2013. Four more will be deployed in 2014.

Table 17 shows Federal Communications Commission (FCC) telecommunications licenses issued to the commercial NGSO telecommunications satellite operators for activity related to this forecast.

Table 17. FCC Telecommunication Licenses

Licensee	Date License Granted or Updated	Remarks
ORBCOMM	3/31/1998	Authorized Orbital Communications Corporation to modify its non-voice, non-geostationary mobile-satellite service system, initially licensed and authorized in 1994.
Iridium Satellite LLC	7/17/2001	Authorized Iridium to operate feeder uplinks in the 29.1-29.25 Mobile-Satellite Service (MSS).
Globalstar	7/17/2001	Authorized Globalstar, L.P. to use spectrum in the 2 GHz band to provide Mobile-Satellite Service (MSS) from NGSO and geosynchronous satellite orbit (GSO) satellites.
Iridium Satellite LLC	2/8/2002	Granted assignment of licenses and authorizations pertaining to the operation of the Iridium Mobile Satellite Service System.
Globalstar	1/30/2003	Denied Globalstar's "Application for Modification of License" and its "Request for Waiver and Modification of Implementation Milestones for 2 GHz MSS System."
Iridium Satellite LLC	6/24/2003	Modified the authorization currently held by Iridium 2 GHz LLC to use spectrum in the 2 GHz band to provide mobile-satellite service.
Iridium Satellite LLC	10/7/2003	Modified the licenses of Iridium Constellation, LLC and Iridium, US LP (collectively "Iridium") and authorized Iridium to operate satellites in the "Big LEO" mobile-satellite service (MSS) system in the 1620.10-1621.35 MHz frequency band.
Globalstar	3/8/2004	International authorizations granted.
Globalstar	6/24/2004	Denied the Application for Review filed by Globalstar, LP.
Iridium Satellite LLC	9/3/2004	Modified the authorizations of Iridium to operate space and earth stations in the "Big Leo" mobile-satellite service.
AprizeStar	2010	The current FCC license, issued in 2010, covers AprizeSat 1 through 6. It is being modified and extended to cover the satellites AprizeSat 7 and 8, to launch in 2012.

The three systems originally deployed in the 1990s, ORBCOMM, Globalstar, and Iridium, are in different stages of planning, development, and deployment of their new generation of satellites.

Globalstar

Globalstar, Inc. is a publicly traded wideband system operator primarily serving the commercial global satellite voice and data markets. Their full service offering began in 2000. The company is currently in the process of updating its in-orbit satellite constellation.

Globalstar's first generation satellite constellation consisted of 52 satellites—48 operational satellites plus 4 in-orbit spares. Globalstar's original constellation began experiencing problems with its S-band amplifier in 2001. In 2007, the S-band problem began affecting the company's voice and two-way data services. The constellation's simplex one-way L-band data services were not affected by these problems. To mitigate the S-band problems and begin updating the in-orbit constellation, Globalstar launched its final eight first generation replacement satellites on two Soyuz vehicles in May and October 2007. These satellites have not suffered from the technical anomalies of the other operational satellites, but their addition to the constellation did not restore sufficient capacity for full voice and two-way data service.

As a result of the S-band problems, Globalstar's revenues started to slip in 2006. In response to these declining revenues, Globalstar lowered prices for its customers until the company could launch next generation satellites and transition to a renewed constellation. In addition to lower prices, Globalstar developed a simplex service product called the Satellite Pour l'Observation de la Terra (SPOT) Satellite Global Positioning System (GPS) Messenger. This service, the result of a software modification to the orbiting satellites, was designed for recreational and commercial customers who required personal tracking, emergency location, and messaging solutions that operate beyond the range of traditional terrestrial and wireless communications. In July 2009, Globalstar uploaded a second generation SPOT Satellite GPS Messenger software upgrade to the existing constellation.

Arianespace is in the process of launching Globalstar's first 24 second generation satellites for their new constellation. The first 6 satellites launched into orbit in 2010 and the next 12 launched in 2011. All launches were on Soyuz rockets carrying six satellites per launch. Globalstar reported significant improvement in service availability and quality after the new generation satellites came online following in-orbit testing. In 2012, Arianespace will complete its contract with Globalstar by launching the last six satellites on a Soyuz. Thales Alenia Space developed and built the 25 second generation satellites (including one ground spare) for Globalstar. Together with the 8 replacement satellites launched in 2007, Globalstar will have a 32-satellite system when the initial deployment of its new constellation concludes in 2012.

Globalstar reported it is in negotiations with Thales Alenia Space for an option of manufacturing 23 additional satellites in the coming years. The spacecraft would be spares for the existing fleet and launch as needed, likely beginning in 2013 or 2014. Because no launch contracts have been made for these additional Globalstar satellites and any launch would be contingent on the health of the satellites in orbit, this report does not project additional launches for these spares.

Figure 14 shows the decline in Globalstar's revenues from 2006 to 2009 and a rise beginning in 2010, due to higher revenues from the SPOT Satellite GPS Messenger service and simplex data services and improvements in duplex and simplex services following second generation satellite deployment. Because of the commercial success of the SPOT Satellite GPS Messenger service, Globalstar plans to introduce additional duplex and simplex products and services through its renewed constellation.

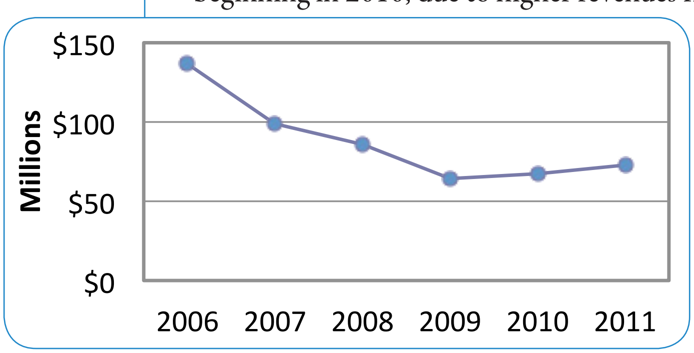

Figure 14. Publicly Reported Globalstar Annual Revenue

Iridium

Iridium Communications Inc. is the successor to the original Iridium LLC that built and launched the Iridium satellite constellation in the late 1990s. Iridium Communications Inc. owns and operates a constellation of 72 operational commercial communications satellites (66 active spacecraft and 6 orbiting functional spares). These satellites comprise a fully operational system to provide service until at least 2015. In 2010, Iridium selected Thales Alenia Space as the prime contractor for the system development of a second generation satellite constellation, named Iridium NEXT. Each satellite in the new constellation can carry an extra hosted payload in addition to the primary communications payload. Iridium is marketing this opportunity to potential customers while the satellites are under construction.

Iridium announced SpaceX, the manufacturer and operator of the Falcon 9 launch vehicle, is the primary launch provider for Iridium NEXT. Iridium also signed a contract with International Space Company Kosmotras (provider of the Dnepr launch vehicle) as a supplemental provider of launch services for Iridium NEXT. The company reportedly plans to launch 72 satellites (66 to enter active service and 6 in-orbit spares) during a 3-year period scheduled to begin in 2015. If launched by Falcon 9 rockets only, the whole Iridium NEXT constellation will be deployed by an estimated eight launches carrying nine satellites each. Nine Iridium NEXT satellites will remain ground spares.

Iridium revenues are presented in Figure 15.

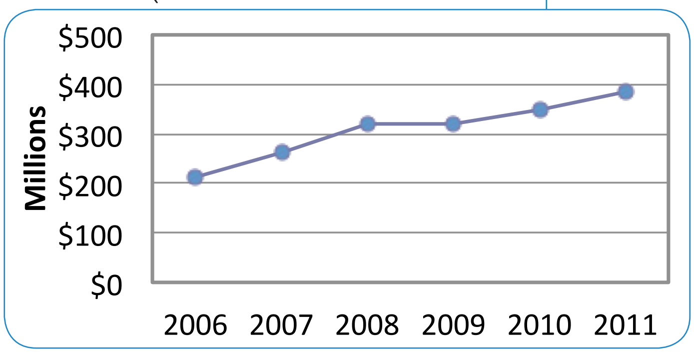

Figure 15. Publicly Reported Iridium Annual Revenue

ORBCOMM

Between 1995 and 1999, ORBCOMM deployed a narrowband constellation of 35 satellites, 27 of which are operational today. It is the only company to have fully deployed a system that provides low-bandwidth packet data services worldwide. ORBCOMM focuses on providing data services for machine-to-machine applications.

In 2008, six ORBCOMM satellites launched on a Russian Cosmos 3M vehicle to begin replacing the legacy constellation deployed in 1999. One of the planned upgrades to the constellation was the addition of the Automatic Identification System (AIS), a sea vessel identification and tracking system. Shortly after deployment, all six satellites failed, leaving ORBCOMM with no AIS capability for its subscribed customers.

To remediate the service shortfall, Luxspace, a subsidiary of the prime satellite manufacturer OHB System, developed Vesselsat 1 and Vesselsat 2. Vesselsat 1 launched into equatorial orbit on a Polar Satellite Launch Vehicle (PSLV) rocket in December 2011, and Vesselsat 2 launched into polar orbit on a Long March rocket in January 2012. Both satellites launched as piggyback payloads. ORBCOMM is the exclusive licensee for the AIS data collected by VesselSat1 and VesselSat2. These two AIS-only satellites will not be integrated into ORBCOMM's current or second generation (OG2) constellation. Instead they will serve as a supplement to these constellations.

ORBCOMM's plans for replacing its current constellation are underway. Eighteen second generation satellites, all of which include AIS payloads, are either under construction or awaiting launch. ORBCOMM ordered the satellites in 2008 from Sierra Nevada Corporation, with subcontractors Boeing and ITT Corporation. In 2011, ORBCOMM announced its plan to use SpaceX's Falcon 9 vehicle to launch the constellation. The latest ORBCOMM launch schedule shows the launch of three satellites as secondary payloads on two separate Falcon 9 vehicles in 2012, including at least one alongside SpaceX's Dragon capsule ISS resupply mission. Eight to 12 satellites will launch in 2013, and the remainder of the 18-satellite constellation will launch in 2014. This schedule plans for one Falcon 9 launch of ORBCOMM satellites per year in 2013 and 2014.

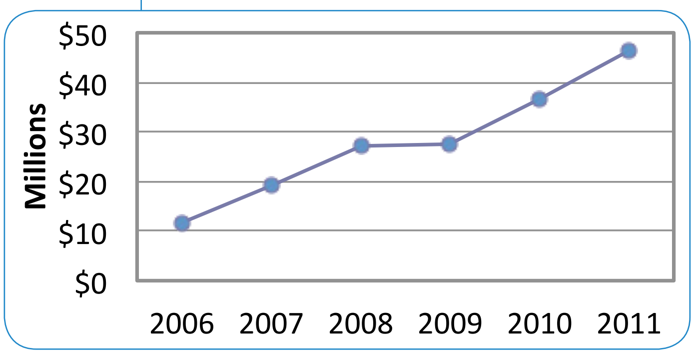

Figure 16. Publicly Reported ORBCOMM Annual Revenue

ORBCOMM posted $46.3 million revenue in 2011. The last six years of ORBCOMM revenue is plotted in Figure 16.

Aprize Satellite

Aprize Satellite, Inc. plans to deploy a 12-satellite system, depending on funding opportunities and customer demand for data communication and AIS data service. A total of eight AprizeStar (also known by its International Telecommunications Union registration as LatinSat) satellites weighing 10 kilograms (22 pounds) each, launched as secondary payloads on Russian Dnepr vehicles: two satellites a year in 2002, 2004, 2009, and 2011. Two more satellites are scheduled to launch as secondary payloads on a Dnepr vehicle in 2012. Because the satellites have an estimated orbit life of 10 years, the company will have to launch at least 6 more satellites before 2019 to maintain a 12-satellite constellation. This includes two satellites to complete the constellation and four to replace the satellites launched in 2002 and 2004. If these additional satellites are deployed, they are likely to launch as secondary payloads and not generate demand for an individual launch.

O3b

O3b Networks, headquartered in St. John, Jersey, Channel Islands, is a new company that plans to provide broadband connectivity to underserved parts of the world. The O3b constellation will operate in the Ka-band in an equatorial orbit with a minimum of five satellites to cover +/- 45 degrees of latitude around the Equator. Additional satellites can be added as needed to meet demand.

Thales Alenia Space is under contract to build 16 communications satellites for O3b, twelve of them currently under construction. O3b is under a launch services agreement with Arianespace for two Soyuz vehicle launches from Kourou in French Guiana in 2013. Each Soyuz will deploy four O3b satellites in the equatorial plane in MEO. In late 2011, O3b raised $137 million to cover the construction and launch of four satellites to launch on a Soyuz in 2014.

Digital Audio Radio Services (DARS)

Another type of NGSO satellite telecommunications service is DARS, or satellite radio. Before 2011, previous versions of the Commercial Space Transportation Forecast for NGSO report included DARS as part of a section called International Science and Other Satellites. Today, there are no existing DARS providers planning to launch new satellites or replace their previously launched satellites to NGSO.

The number and timing of future NGSO DARS satellites in the United States is uncertain. The dominant provider of DARS in the U.S. is Sirius XM. Sirius XM is currently launching GSO satellites and has no publicly announced plans to replace the heritage NGSO Sirius satellites in highly elliptical orbit. The current and future launches of Sirius XM DARS satellites to GSO are addressed in the 2012 COMSTAC GSO Report.

In the last decade, Spain-based Ondas Media announced plans to provide DARS starting in 2012 and ordered development of an NGSO DARS system. In 2008, the company authorized Space Systems/Loral to proceed with the design and development of the Ondas system, which included three ELI satellites targeted for launch around 2012. However, at the time of publication, there have been no new public announcements on the new system status since 2010, and the Ondas Media public relations email accounts were inactive; therefore, this report does not include the Ondas satellite launch demand.

Telecommunications Launch Demand Summary

From 2012 through 2017, between one and three telecommunications launches will occur each year. There will be an uptick in launches in 2013, as ORBCOMM and O3b replace their satellites, and again in 2016 and 2017 as Iridium replaces its satellites. Replacement constellations finish launching before 2018, so no telecommunications launches are projected for 2018 through 2021. Figure 17 provides a representation of telecommunications launch history and projected launch plans.

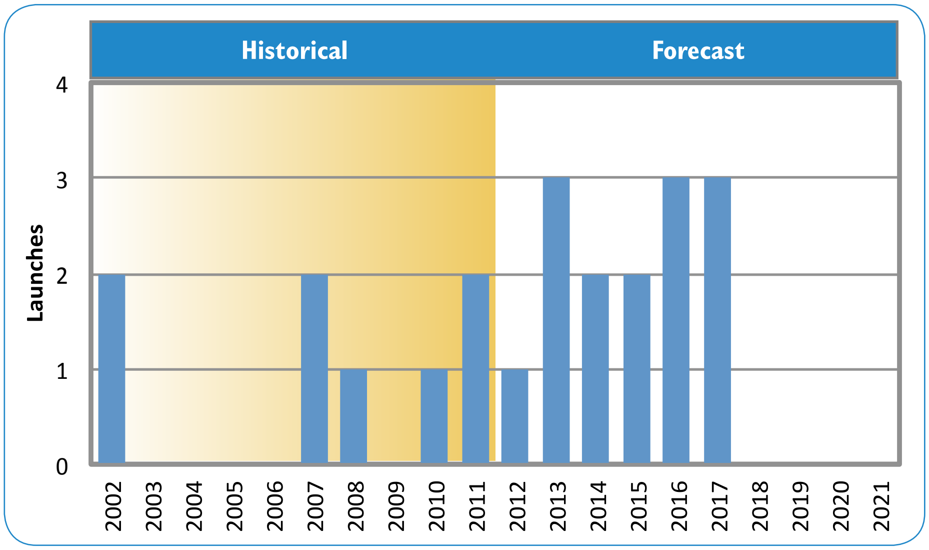

Figure 17. Commercial Telecommunications Launch History and Projected Launch Plans

Telecommunications Satellite Fleet Replacements after 2021

NGSO telecommunications satellites launched in the 1990s and early 2000s had an estimated design life of four (ORBCOMM) to seven and a half (Globalstar) years (Table 18). However, the majority of these satellites are still in orbit and continue to provide telecommunications services; most of the first generation Globalstar, Iridium, and ORBCOMM constellations have exceeded their design life by two to three times. For financial reasons, many of the satellites were not replaced when their estimated design life ended. Operators were able to continue providing services until second generation spacecraft were ready.

Now most of the satellites launched or prepared for launch by NGSO communications satellite operators have an estimated design life of 10 to 15 years, which places the estimated replacement dates beyond 2021. The exception is ORBCOMM, with a minimum design life estimate of a conservative five years. If any of these satellites need to be replaced within the 2012-2021 period, they will be piggyback payloads, unlikely to generate demand for a dedicated launch.

Table 18. Commercial Telecommunication Satellite Systems' Design Life

Satellite System	1st Generation Satellite Design Life	Current Status	2nd or Current Generation Satellite Design Life
Globalstar	7.5 years	Most of the satellites in orbit, partially operational	15 years
Iridium	5 years	Most of the satellites in orbit, operational	10 years (design), 15 years projected
ORBCOMM	4 years	Most of the satellites in orbit, operational	More than 5 years
Aprize Satellite	N/A	8 in orbit, 6 in service, launching more to complete system	10 years
O3b Network	N/A	Under construction	10 years

Commercial Remote Sensing Satellites

Remote sensing refers to any orbital platform with optical or radar sensors trained on Earth to gather data for geographic analysis, military use, meteorology, or climatology. The remote sensing industry comprises three markets: aerial imagery, satellite imagery, and geographic information systems (GIS). GIS consists of images obtained from aircraft or satellites integrated with layers of information, usually customized according to user needs. GIS constitutes the largest part of the industry both in terms of demand and revenue generation.

The commercial satellite remote sensing market consists of companies that operate satellites with optical or radar sensors trained on Earth to capture imagery used to generate revenue. This contrasts with remote sensing satellites funded by governments for military use or science missions. However, governments often serve as the largest customers of commercial remote satellite companies and are often key partners in developing and operating expensive satellites. To generate profits and produce a return on investment, companies that operate remote sensing satellites also provide GIS services.

Government support is a major factor in commercial remote sensing systems development. Companies often depend on governments as anchor tenants. The U.S. National Geospatial-Intelligence Agency (NGA) partially funded the development of the current generation of GeoEye and DigitalGlobe satellites. In 2010, NGA awarded both companies 10-year contracts worth up to $7.35 billion as part of the EnhancedView program (NGA's effort to increase current imagery collection activities and recapitalize the future commercial imagery satellite architecture), extending NGA's ability to tap imagery from the private sector and nearly guaranteeing that GeoEye and DigitalGlobe will provide remote sensing products well into the decade. In Europe, both the French and German governments strongly support commercial remote sensing systems, typically through public-private partnerships (PPP). For example, the German Aerospace Centre (DLR) and Astrium GEO-Information Systems partnered to operate the TerraSAR system using a PPP arrangement.

The U.S. National Oceanic and Atmospheric Administration (NOAA) licenses U.S. commercial remote sensing systems in accordance with the Land Remote Sensing Policy Act of 1992. There have been over 25 remote sensing licenses issued or amended since 1993. Ten of these licenses have been granted to DigitalGlobe, GeoEye, or their predecessor companies, and several have been issued for university cubesat missions (see Table 19).

Table 19. NOAA Remote Sensing Licenses

Licensee	Date License Granted or Updated	Remarks
DigitalGlobe	1/4/1993	License originally issued to WorldView for EarlyBird satellite.
ORBIMAGE (d/b/a GeoEye)	5/5/1994	License originally issued to Orbital Sciences Corporation for OrbView-3.
DigitalGlobe	9/6/1994	License issued for QuickBird-1 and QuickBird-2.
AstroVision	1/23/1995	First license issued for a commercial GSO system.
Ball Aerospace & Technologies	11/21/2000	License issued for a commercial SAR system.
DigitalGlobe	12/6/2000	First license issued to a commercial operator for a 0.5-meter resolution system.
DigitalGlobe	12/14/2000	License issued for a QuickBird follow-on.
ORBIMAGE (d/b/a GeoEye)	6/17/2003	Update to license for SeaStar satellite, changing name to Orbview-2. Originally issued to Orbital Sciences Corporation.
DigitalGlobe	9/29/2003	License issued for four-satellite high-resolution system (Worldview).
Northrop Grumman	2/20/2004	License issued for MEO system called "Continuum" with 0.5-meter resolution.
ORBIMAGE (d/b/a GeoEye)	8/12/2004	License originally issued to ORBIMAGE Inc, for OrbView-5, now GeoEye-1.
Technica	12/8/2005	License issued for four-satellite EagleEye system.
ORBIMAGE (d/b/a GeoEye)	1/10/2006	IKONOS system license transfer from Space Imaging to ORBIMAGE.
Northrop Grumman	8/24/2009	License issued for commercial SAR system called "Trinidad."
GeoEye Inc.	1/14/2010	Amendment of IKONOS Block II license to change system name to GeoEye 2 and 3.
DISH Operating LLC	2/2/2010	License transfer from Echostar to DISH for GSO satellite (Echostar-11) with television camera for low-resolution image.
Skybox Imaging, Inc.	4/20/2010	License issued for LEO satellite SkySat-1. Application for amendment to include SkySat-2 submitted in 2011.
GeoMetWatch	9/15/2010	License issued for GSO satellite GMW-1.
Kentucky Space	10/19/2010	License issued for LEO cubesat KySat-1. Satellite launched with NASA's Glory in 2011.
University of California	11/17/2010	License issued for use of cell phone camera aboard cubesat UCISAT-1.
University of Michigan	8/11/2011	License issued for use of imaging sensor aboard cubesat M-Cubed. Satellite launched with NPP in 2011.
Cosmogia, Inc.	2/10/2012	License issued for operation of cubesat Dove-1. Satellite scheduled to launch aboard inaugural flight of Antares vehicle.
Drexel University	3/30/2012	License issued for operation of cubesat DragonSat-1. Satellite scheduled to launch with SpaceX ISS resupply mission 2 aboard Falcon 9.

Note: A NOAA license granted for a particular commercial remote sensing system is in force for the duration the satellite remains in service, as long as such service is consistent with licensing terms. NOAA may also withdraw a license for a new commercial remote sensing system if the satellite development's progress is insufficient. See 15 CFR part 969, Subpart B, Section 980.9.

Since the last Commercial Space Transportation Forecast for NGSO report was published, NOAA issued a license to the University of Michigan for operation and testing of a high-resolution camera aboard its M-Cubed satellite. This camera is being tested for NASA for use on future Earth observation missions. In early 2012, NOAA issued a license to Cosmogia, Inc. for operation of Dove-1, a cubesat designed to test commercial off-the-shelf imaging technologies. Dove-1 is expected to reenter the atmosphere after two weeks of operation. In March 2012, NOAA issued a license to Drexel University for operation of DragonSat-1. This cubesat, which will launch as a secondary payload with the second Dragon cargo vehicle to the ISS, is a remote sensing technology demonstration satellite and discussed in the science and engineering section of this report.

Much of the launch demand for the commercial remote sensing industry consists of cyclical replenishment of commercial remote sensing satellites. Commercial remote sensing currently generates a projected average of 1.1 launches per year. However, advances in imaging and satellite technology allow commercial remote sensing satellites to provide more capability with less mass. In the future, an increase in the number of newly deployed remote sensing satellites might not result in the same proportion of launches as observed over the past decade. However, in the near term, most commercial remote sensing satellites will have masses requiring use of medium- to heavy-class vehicles.

Commercial remote sensing satellites in the near-term portion of this report (2012-2015) are those that were announced by the company, are under construction, and are scheduled for a launch. Satellites projected for the latter portion of the report (2016-2021) are based on published statements regarding the service lives of satellites currently operating in orbit.

The major companies operating or actively developing remote sensing satellites across the globe are profiled below in Table 20. We include these satellites in the commercial sector of the report because they will be, or are likely to be, launched commercially.

Table 20. Commercial Satellite Remote Sensing Systems

System	Operator	Manufacturer	Satellites	Mass kg (lb)	Highest Resolution (m)	Revisit Time (hrs.)	Launch Year
Operational & Under Development							
DMC3	DMC International Imaging Ltd.	SSTL	DMC3 1-3	350 (771)	1	24	2014
EROS	ImageSat International	Israel Aircraft Industries	EROS A EROS B EROS C	280 (617) 350 (771) 350 (771)	1.5 0.7 0.7	24-288	2000 2006 2013
GeoEye	GeoEye	General Dynamics Advanced Information Systems	GeoEye-1 GeoEye-2 GeoEye-3	907 (2,000) 2,087 (4,601) TBD	0.41 0.34 TBD	50-199 50-199 TBD	2008 2013 TBD
IKONOS	GeoEye	Lockheed Martin	IKONOS	816 (1,800)	1	<72	1999
QuickBird	DigitalGlobe	Ball Aerospace	QuickBird	909 (2,004)	0.6	60-134	2001
RADARSAT	MacDonald, Dettwiler and Associates (MDA)	MDA	RADARSAT-1 RADARSAT-2 RCM	2,750 (6,050) 2,195 (4,840) 1,200 (2,645)	8 3 TBD	48-72 48-72 TBD	1995 2007 2015-16
RapidEye	RapidEye AG	MDA	RapidEye 1-5	150 (330)	6.5	24	2008
SkySat	SkyBox Imaging	SkyBox Imaging	SkySat 1 SkySat 2	91 (200) 91 (200)	<1 <1	<24	2012 2013
TerraSAR-X and TanDEM-X	Astrium GEO-Information Services	Astrium	TerraSAR-X TanDEM-X TerraSAR-X2	1,023 (2,255) 1,023 (2,255) TBD	3 0.5 TBD	264 264 TBD	2007 2010 2015
WorldView	DigitalGlobe	Ball Aerospace	WorldView-1 WorldView-2 WorldView-3	2,500 (5,510) 2,800 (6,175) 2,800 (6,175)	0.5 0.5 0.5	41-130 26-89 TBD	2007 2009 2014

DigitalGlobe

Established in 1992, DigitalGlobe is a commercial sub-meter remote sensing satellite operator and GIS provider based in Longmont, Colorado. The company operates imaging satellites and provides GIS products using satellite and aerial imagery. DigitalGlobe currently operates three remote sensing satellites: QuickBird, WorldView-1, and WorldView-2. Launching in mid-2014, WorldView-3 will be the fourth satellite in DigitalGlobe's constellation and be able to collect imagery in eight short-wave-infrared (SWIR) bands plus eight multispectral bands, which will extend the already industry-leading capabilities of its commercial imaging constellation.

DigitalGlobe's first satellite, QuickBird, launched in 2001 and is projected to continue operating until late 2013. In August 2010, the company announced that Ball Aerospace would build a replacement satellite, WorldView-3, to launch aboard an Atlas V intermediate- to heavy-class vehicle in 2014. The satellite will have a service life of up to 12 years. DigitalGlobe's two other satellites, WorldView-1 and WorldView-2, will reach expected end of life in the second quarter of 2018 and the first quarter of 2021, respectively.

DMC International Imaging

DMC International Imaging, Ltd. (DMCii), based in the United Kingdom, operates the Disaster Monitoring Constellation (DMC). DMCii is a wholly owned subsidiary of Surrey Satellite Technology Ltd. (SSTL).

DMC is composed of SSTL-built satellites for Algeria (Alsat-1), China (Beijing-1), Nigeria (Nigeriasat-1, Nigeriasat-2, and NX), Spain (Deimos-1), Turkey (Bilsat-1), and the United Kingdom (UK-DMC and UK-DMC2). The satellites orbit at an altitude of 700 kilometers (435 miles). The constellation's primary purpose is to distribute imagery for commercial and humanitarian purposes.

DMC became fully operational in 2006, with satellites evenly distributed in a single sun-synchronous orbit (SSO). The constellation currently consists of nine satellites launched between 2002 and 2011, each owned and controlled by the contributing nation. Nigeria's satellites Nigeriasat-2 and NX were launched in 2011 and are the latest members of the DMC constellation.

In June 2011, DMCii signed a seven-year deal with China-based Twenty First Century Aerospace Technology Company Ltd. (21AT) to lease capacity aboard a three-satellite system called DMC3. The lease allows 21AT to obtain timely imagery without procuring and operating the platforms themselves. The system will be funded by SSTL and is slated for launch in 2014. The satellites will feature one-meter resolution panchromatic optical cameras and four-meter resolution multispectral sensors. It is assumed all three satellites will launch together aboard a medium-class launch vehicle like the Russian Dnepr.

Infoterra GmbH

Infoterra GmbH is a commercial remote sensing company based in Germany. Under a PPP arrangement, Infoterra (a subsidiary of Astrium GmbH) has an exclusive contract with DLR to provide the commercial sector with radar imagery and data products obtained from DLR-operated TerraSAR-X and TanDEM-X satellites. DLR uses and distributes the data for scientific purposes. Imagery obtained from the satellites is of large value for users worldwide in programs like the European Global Monitoring for Environment and Security program and the international Global Earth Observation System of Systems. Through the PPP, Infoterra provides GIS products directly to the commercial marketplace and through Astrium Geo-Information Services, which markets GIS data and support services.

TerraSAR-X launched aboard a Russian Dnepr vehicle in 2007 and provides up to one-meter resolution X-band radar imagery for government and commercial use. It is the first of Germany's TerraSAR-X generation (TSX-1) of synthetic aperture radar (SAR) satellites. The satellite reaches the end of its design life in 2012 but should continue operating until at least 2015. The second member of the TSX-1 generation is the TerraSAR-X Add-On for Digital Elevation Measurement (TanDEM-X) satellite. It launched in 2010, also aboard a Dnepr vehicle. TanDEM-X provides government and commercial clients with digital elevation model (DEM) data. DEM data captures the raw surface structure of the Earth, without vegetation and artificial objects. TanDEM-X expects to remain operational until about 2018.

Work is currently underway at Infoterra and Astrium on a second generation of SAR satellites called TSX-2. This generation will consist of at least one satellite, planned for launch in 2015 or 2016. The launch vehicle has not yet been selected, but leading contenders include the Dnepr and the Indian PSLV.

As part of its strategic planning, Infoterra, Astrium, and DLR are also discussing a next generation of satellites beyond the 2018 timeframe to replace the TSX-1 satellites. These are not included in the report because system definition has not started. As with TerraSAR-X and TanDEM-X, imagery from these future satellites is expected to be available for scientific and commercial purposes.

GeoEye

GeoEye, Inc., based in Herndon, Virginia, is a publicly traded, commercial sub-meter imaging satellite operator and GIS leading provider. GeoEye was formed in 2006 by the acquisition of Space Imaging by ORBIMAGE, a subsidiary of Orbital Sciences Corporation. Data from GeoEye satellites are sold on the commercial market to private organizations and governments worldwide.

GeoEye currently operates two satellites. The first, IKONOS, was launched aboard a Lockheed Martin Athena II vehicle in 1999 and continues to operate. The second, GeoEye-1, was launched in 2008 aboard a Boeing Delta II medium-class vehicle and has a planned operational lifetime of at least seven years. GeoEye-2 is currently under construction at Lockheed Martin and has a planned launch in 2013 aboard an Atlas V vehicle.

GeoEye-1 will probably retire before the conclusion of the EnhancedView contract in 2020, so the company expects to solicit bids for construction of GeoEye-3 in 2013. However, due to the threat of reductions in the NGA's fiscal year 2012 budget, renegotiation of the NGA's EnhancedView contract with the company is anticipated, which may impact GeoEye-3 procurement. Currently, GeoEye-3 is projected to launch aboard a medium- to heavy-class vehicle in 2017.

ImageSat International NV

Israel-based ImageSat, founded as West Indian Space in 1997, and officially a Netherlands Antilles company, provides commercial sub-meter resolution imagery with the Earth Remote Observation Satellite (EROS) family of satellites. Like many remote sensing companies, ImageSat's major customers are governments. Israel Aerospace Industries Ltd. manufactures the EROS satellites, and ELBIT-Electro Optics Industries develops the imaging system.

ImageSat currently operates two satellites, EROS A and EROS B. EROS A launched in December 2000 aboard a Russian Start-1 small-class launch vehicle and should continue to operate until at least 2014, four years beyond its projected service life. EROS B launched aboard a Start-1 in 2006 and should continue to operate until 2020.

ImageSat plans to develop a third satellite, EROS C, which likely will also be manufactured by Israel Aircraft Industries. This satellite is projected to launch on a small-class vehicle in 2013 as a replacement for EROS A.

MacDonald, Dettwiler and Associates

Canada-based MacDonald, Dettwiler and Associates, Ltd. (MDA) is a commercial provider of radar satellite remote sensing data collected by the RADARSAT series of satellites. The company markets and sells data derived from several satellites, including RADARSAT-1 and RADARSAT-2. The Canadian Space Agency (CSA) operates RADARSAT-1, while RADARSAT-2 is operated by MDA in a partnership with the Government of Canada. On November 4, 1995, the first RADARSAT satellite launched aboard a Delta II vehicle. RADARSAT-2 launched aboard a Starsem Soyuz intermediate-class vehicle on December 14, 2007.

To continue the radar data missions, the Government of Canada, through the CSA, proposed a three-satellite RADARSAT Constellation Mission (RCM). Although the RCM is funded by the Canadian government, MDA would expect to obtain the mandate to sell RCM imagery to continue serving commercial users. In March 2010, the CSA authorized MDA to start the design phase (Phase C) of the RCM.

In 2010, the Canadian government included funding to begin construction of RCM (Phase D). However, in early 2012, the budget did not include funding for RCM, and Phase D of the program is delayed pending reassessment.

Despite this delay, discussions with MDA concerning the program's viability indicate that RCM satellite launches merit projection in this report. Each RCM satellite will have a mass of about 1,200 kilograms (2,600 pounds). RCM-1 is projected for launch in 2015, with RCM-2 and RCM-3 launched together in 2016. Based on the mass of the satellites, they will likely launch aboard medium- to heavy-class vehicles.

RapidEye

RapidEye is headquartered near Berlin, Germany and has additional offices in Luxembourg, Canada, and the United States. The company operates a five-satellite multispectral remote sensing constellation that provides wide-area, repetitive coverage and 6.5 meter pixel size multi-spectral imagery. MDA is the prime contractor for the mission, responsible for design and implementation. MDA subcontracted to SSTL for construction of the satellites.

The RapidEye constellation launched aboard a Dnepr vehicle on August 29, 2008. The five satellites are expected to remain operational until 2018.

Though planning for the next generation of satellites is underway, RapidEye has not released details publicly. Based on the health of the company and growing demand for remote sensing products, a launch of a replacement constellation of five satellites is projected in 2017, one year before the projected end of life of the constellation. The satellites will likely launch aboard a medium- to heavy-class vehicle.

Skybox Imaging

Skybox Imaging, Inc., based in Mountain View, California, is a new entrant to the commercial satellite remote sensing industry. The company was awarded a NOAA license for SkySat-1 on April 20, 2010, and has applied to amend the license to include a second satellite, SkySat-2. Both satellites will operate in a polar orbit and constitute the first elements of a projected constellation. Skybox manufactures and operates its own satellites and will provide frequently updated imagery online. Users will be able to purchase imagery through a website on an as-needed basis.

SkySat-1 is scheduled to launch in 2012 aboard a Dnepr vehicle along with several other satellites. SkySat-2, also multi-manifested with other payloads, should follow in 2013 aboard a medium-class vehicle. Additional SkySats are not projected due to uncertainty in financing and application of a new business model.

Remote Sensing Launch Demand Summary

The commercial remote sensing industry is characterized by relatively stable satellite replacement schedules. Launches of commercial remote sensing satellites will take place at an average of 1.1 per year through the forecast period. A peak in the number of launches can be seen in 2017, reflecting projected deployment of satellites operated by DigitalGlobe, GeoEye, and RapidEye. Figure 18 provides a launch history and projected launch plans for commercial remote sensing satellites.

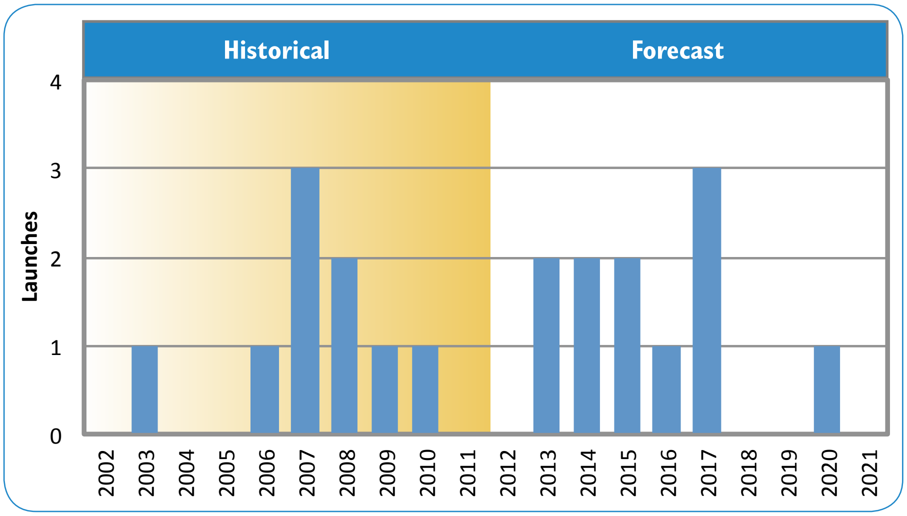

Figure 18. Commercial Remote Sensing Launch History and Projected Launch Plans

Science and Engineering

For this report, science and engineering includes payloads related to basic and applied research and those with missions related to space technology test and demonstration. The science and engineering segment only includes primary payloads that drive demand for a commercial launch.

Basic and Applied Research

Payloads with basic research missions include biological and physical research, space science, Earth science, and related fields. Payloads with applied research missions are designed to solve practical problems and are usually driven by government or industry needs.

In general, these payloads are launched as clusters, often on Russian vehicles, like the small-class Rockot and medium-class Dnepr. Though it is difficult to predict exactly which cluster of payloads drive a launch, we do know that basic and applied research payloads from countries that do not have indigenous launch capability drive a small, but steady number of commercial launches per year.

Space Technology Test and Demonstration

Payloads with missions focused on space technology test and demonstration address engineering questions. These payloads demonstrate communications and remote sensing technologies. Universities and governments new to satellite development often launch such satellites to gain experience before embarking on more ambitious projects. Space technology test and demonstration payloads also include satellites to evaluate experimental communications systems or telemetry packages, also known as "dummy" payloads, to gain performance data for new launch vehicles or reusable capsules. SpaceX's inaugural launch of the Falcon 9, in June 2010, was such a test. The inaugural launch of Orbital's Antares vehicle planned for 2012 is included in this section, as is the demonstration flight of SpaceX's Falcon Heavy launch vehicle, also planned for 2012. The report also includes the technology test and demonstration launches of the Orion Multi Purpose Crew Vehicle (MPCV) and Bigelow's payload for its Bigelow Expandable Activity Module (BEAM) mission. Orion MPCV, NASA's spacecraft for missions beyond low earth orbit, plans to launch uncrewed aboard a Delta IV Heavy in 2014. Bigelow plans to launch its first BEAM payload in 2015.

Primary Science and Engineering Payloads

Table 21 lists the near-term manifested science and engineering launches for 2012-2015 that drive a launch. A full list and descriptions of science and engineering payloads, including secondary payloads, can be found in Appendix 3 of this report.

Table 21. Science and Engineering Payloads for 2012-2015

Launch Vehicle	Science and Engineering Payload	Mass (kg/lb)	Type
2012			
Antares	Antares Test Flight	TBD	Test / Tech and Demo
Dnepr	KOMPSAT-5	1,280 / 2,822	Research
Dnepr	DubaiSat-2	300 / 661	Research
Falcon 9	CASSIOPE	500 / 1,102	Research
Falcon 9	Falcon Heavy Test Flight	TBD	Test / Tech and Demo
Rockot	SWARM 1-3	500 / 1,102	Research
2013			
Dnepr	KOMPSAT-3A	800 / 1,764	Research
2014			
Falcon 9	SAOCOM-1A	1,500 / 3,307	Research
Falcon 9	Formosat-5	525 / 1,157	Research
Falcon 9	DragonLab Mission 1	TBD	Research
Delta IV Heavy	Orion MPCV	TBD	Test / Tech and Demo
2015			
Falcon 9	DragonLab Mission 2	TBD	Research
Falcon 9	Bigelow Payload	TBD	Test / Tech and Demo
Falcon 9	SAOCOM-1B	1,500 / 3,307	Research
PSLV	EnMap	810 / 1,786	Research

NASA's Science and Engineering Payload Development

In 2010, NASA began the CubeSat Launch Initiative (CSLI), providing a method to launch auxiliary payloads on planned launches. The initiative is open to NASA centers, U.S. nonprofit organizations, and accredited U.S. educational organizations. Selected cubesats launch in missions called Educational Launch of Nanosatellites (ELaNa) missions. CSLI is partly responsible for the increase in the number of projected science and engineering payloads between 2012 and 2014. Whereas previous ELaNa flights took place on non-commercial flights, the next two are scheduled to take place on FAA-licensed Falcon 9 cargo flights to the ISS, carrying over 15 small satellites. Future ELaNa flights may take place routinely aboard commercial cargo flights to the ISS, an opportunity that will begin in 2012.

ELaNa-4 and ELaNa-5 satellite clusters are planned for launch aboard Falcon 9 Mission 2 to the ISS and Falcon 9 Mission 3 to the ISS, respectively. ELaNa-1 launched aboard a failed non-commercial Taurus XL flight in 2009. ELaNa-2, originally scheduled for a non-commercial Taurus XL launch in 2013, was postponed. ELaNA-3 launched aboard a non-commercial Delta II flight in 2011.

Revised Method for Science and Engineering Launch Demand

Previously, projected science and engineering payloads were calculated using a weighted average of the last five years of actual launches. This method produced results that did not take into account anticipated launches for the first two years of the projection. Thus, it would take three years to see any emerging trends.

This forecast uses a revised model for payloads and launches related to basic and applied research only. The new methodology features a five-year average that includes three prior years and two projected years (for this report, 2009-2013) with equal weight. This simple model is applied to payloads as well as launch vehicles pertaining to basic and applied research beginning in 2016, the mid and far out-years. This revision makes the out-years of the basic and applied research projection more sensitive to emerging trends identified in the near-term through research. Because space technology test and demonstration payloads and launches are infrequent, the model does not apply a forecasting method to this segment. The most significant impact of this revision is that it excludes eight small-class vehicle launches from this year's projection that were forecasted in the 2011 report. The change does not mean the actual demand is gone; instead, it is made in recognition that these types of payloads are irregular and efforts to forecast their occurrence in the out-years can lead to an overstatement of launch demand.

Science and Engineering Launch Demand Summary

The market characterization of the near term (2012-2015) includes 11 manifested basic and applied research launches and 4 manifested space technology test and demonstration launches. For the period of 2016-2021, the application of the revised method projects 18 basic and applied research launches for an average of 3 in each of the out-years. There are no publicly available manifested launches for the 2016-2021 time period. Therefore, we expect a total of 33 launches from 2012 to 2021 generated by the science and engineering segment.

Figure 19 provides a launch history and projected launch plan demands for science and engineering payloads.

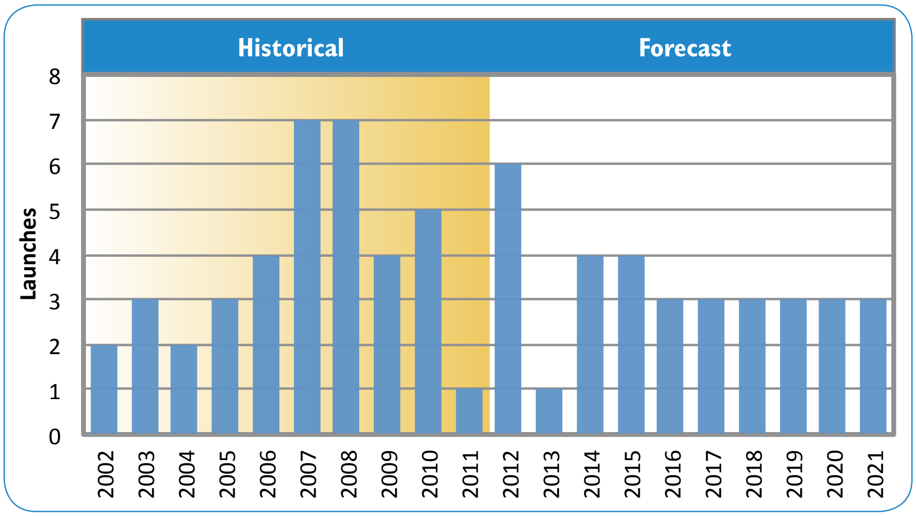

Figure 19. Science and Engineering Launch History and Projected Launch Plans

Piggyback Payloads

A piggyback payload is a spacecraft or satellite that is carried into space using excess launch capacity on a rocket. Small spacecraft (<100 kilograms) are often launched as piggyback payloads.

Examples of piggyback payloads launched in 2011 include Aprizesat 5 and Aprizesat 6. They were part of a larger number of piggyback payloads launched with the Sich 2 satellite on a Dnepr rocket.

Piggyback launching allows operators to place their spacecraft in orbit at significantly lower cost than launching a primary payload. As such, piggyback payloads do not create launch demand in this report.

The term piggyback payload is considered a synonym to a secondary payload. Sometimes the term is specifically used to characterize a subset of secondary payloads that, if added to or removed from a multiple payload launch manifest, do not affect the launch schedule of the primary payload on it.

However, piggyback payloads should be distinguished from hosted payloads (as described in detail in the GSO launch section of the report) that are not standalone spacecraft but rather use extra space on a satellite dedicated to another mission.

Commercial Cargo and Crew Transportation Services

Commercial cargo and crew transportation capabilities include commercial launches of cargo and humans to LEO. Specifically, commercial cargo and crew transportation includes NASA's COTS development, Commercial Resupply Services (CRS) to the ISS, and commercial crew development efforts. This section also describes non-ISS commercial human spaceflight and emerging activities related to Bigelow orbital facilities and Excalibur Almaz flights.

NASA COTS

In 2006, NASA announced the $500 million COTS program. COTS focuses on the development and demonstration of commercial cargo transportation systems. Under COTS, SpaceX developed the intermediate-class Falcon 9 launch vehicle and the Dragon spacecraft. Orbital developed the Cygnus spacecraft and medium-class Antares (formerly Taurus II) launch vehicle.

On December 8, 2010, SpaceX successfully completed their first COTS demonstration mission. This report includes the remaining COTS demonstration missions. In 2012, SpaceX was scheduled to have two additional demonstration missions with a second mission to the ISS. NASA has agreed to let SpaceX accelerate the third demonstration objectives on the upcoming second demonstration flight. Any objectives not met on this second demonstration mission will be addressed on the next COTS or ISS CRS mission. Orbital is planning an Antares test flight and COTS demonstration mission also in 2012.

NASA CRS

In 2008, NASA awarded two CRS contracts to SpaceX and Orbital. SpaceX won a contract valued at $1.6 billion for 12 flights through 2015, and Orbital won a $1.9 billion contract for 8 flights during the same period. Operational flights under these contracts expect to begin after successful completion of SpaceX's final COTS flight. In late 2012, SpaceX's Dragon flight is scheduled as the first CRS mission. Subsequently, three to six commercial cargo flights are expected annually through 2021.

NASA Commercial Crew

To stimulate commercial development of a crew transportation capability, NASA initiated the Commercial Crew Development (CCDev) effort in 2010 with $50 million of 2009 American Recovery and Reinvestment Act funding. CCDev focused on development of commercial space transportation concepts and enabling capabilities. Within the timeframe of the agreement, CCDev partners showed significant progress on long lead capabilities, technologies, and commercial crew risk mitigation tasks that accelerated their commercial crew transportation concept. The 2010 CCDev awardees were Blue Origin, Boeing, Paragon Space Development Corporation, Sierra Nevada Corporation, and United Launch Alliance (ULA).

In 2011, after completion of the initial CCDev effort, NASA continued investing in commercial crew transportation development with a second competition known as CCDev2. This follow-on effort further advances commercial crew space transportation system concepts, maturing the design and development of system elements such as launch vehicles and spacecraft. Blue Origin, Boeing, Sierra Nevada Corporation, and SpaceX won awards totaling $296.3 million. Additionally, NASA awarded unfunded agreements to provide limited technical assistance for advancement of commercial crew space transportation to ULA; Alliant Techsystems (ATK), who is partnering with EADS Astrium; and Excalibur Almaz, Inc. In 2012, NASA announced the next phase of commercial crew development, Commercial Crew Integrated Capability (CCiCAP). This new initiative is to facilitate industry's development of an integrated crew transportation system. CCiCap is expected to result in significant maturation of commercial crew transportation systems. NASA released the CCiCap announcement soliciting proposals on February 7, 2012.

NASA expects commercial crew transportation services to the ISS to begin by 2017. NASA's FY 2013 traffic model shows two commercial crewed flights to the ISS each year beginning in 2017. These flights are included in this year's report.

Figure 20 shows the distribution of ISS commercial cargo and crew flights from 2012-2021. One SpaceX COTS flight, one test flight of Orbital's Antares, and one Orbital COTS flight are also included.

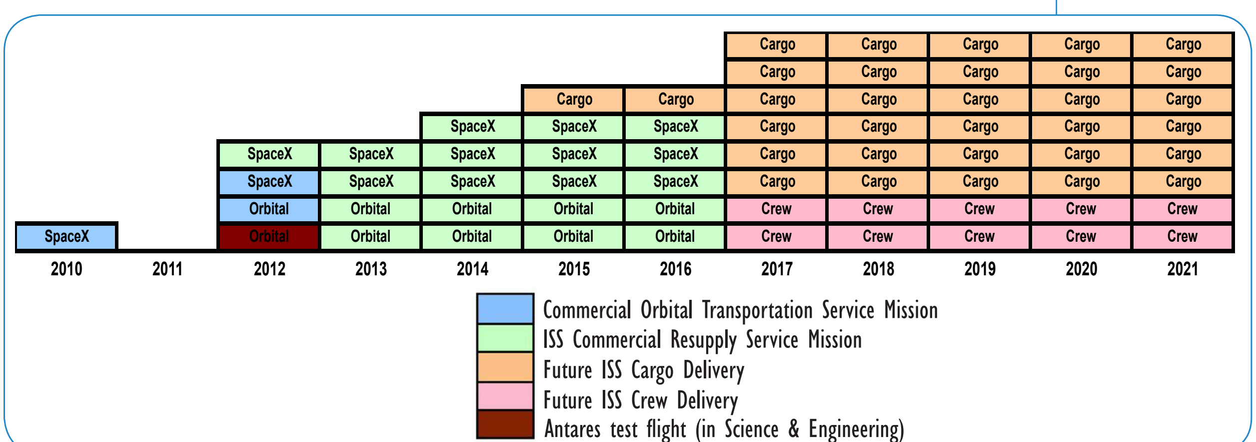

Figure 20. Forecast of COTS, CRS, and commercial crew missions

Table 22 describes NASA COTS, CRS, and CCDev awards.

Table 22. NASA Commercial Crew and Cargo Awards

Program	Year of Space Act Agreement	Value of Space Act Agreement	Companies	Vehicles and Technologies
COTS	2006	$396 million	SpaceX	Cargo transportation system development (Falcon 9 launch vehicle and Dragon spacecraft)
COTS	2008	$288 million	Orbital**	Cargo transportation system development (Antares launch vehicle and Cygnus spacecraft)
CRS	2008	$1.5 billion	SpaceX	Dragon (12 flights)
CRS	2008	$1.9 billion	Orbital	Cygnus (8 flights)
CCDev	2010	$20 million	Sierra Nevada	Mature Commercial Crew Transportation System
CCDev	2010	$18 million	Boeing	Mature Commercial Crew Transportation System
CCDev	2010	$6.7 million	ULA	Mature Emergency Detection System
CCDev	2010	$3.7 million	Blue Origin	Mature Pusher Escape System and composite pressure vessel
CCDev	2010	$1.4 million	Paragon Space	Mature air revitalization system concept
CCDev2	2011	$112.9 million	Boeing	Crew Transportation System (CTS)-100 design maturation
CCDev2	2011	$105.6 million	Sierra Nevada	Dream Chaser design maturation
CCDev2	2011	$75 million	SpaceX	Mature Falcon 9/Dragon transportation system, developing an integrated, side-mounted launch abort system
CCDev2	2011	$22 million	Blue Origin	Mature Space Vehicle design, Pusher Escape System, and accelerate engine development for Reusable Booster System (RBS)
CCDev2	2011	Unfunded	ULA	Advancement of commercial crew space transportation
CCDev2	2011	Unfunded	ATK	Advancement of commercial crew space transportation
CCDev2	2011	Unfunded	Exalibur Almaz	Advancement of commercial crew space transportation

* Changes in the value of Space Act Agreements in this table compared with the same table in the 2011 COMSTAC Forecast are due to inclusion of COTS risk reduction augmentation milestones completed in 2011 and the addition of CCDev milestones for Boeing and Sierra Nevada Corp.

** In 2007, NASA terminated the Space Act Agreement with Kistler due to the company's technical and financial shortfalls. By that time, Kistler already spent about $32 million. The agency reopened bidding later that year for the remaining $175 million, which Orbital won.

Bigelow Aerospace

Nevada-based Bigelow Aerospace is dedicated to developing and deploying expandable space habitat technology to support a next generation space station that will service a variety of public and private customers. Bigelow launched two prototype spacecraft, Genesis I and Genesis II, on separate Russian Dnepr launch vehicles in 2006 and 2007, respectively. Bigelow used these missions to validate its habitat designs and engineering in an actual in-orbit environment.

Bigelow is now in the process of constructing full-scale expandable modules. Specifically, the company is developing the BA 330, which will offer 330 cubic meters of usable volume and can accommodate a maximum crew of up to six.

Bigelow is also exploring two newer systems: the 'Olympus' BA 2100, which has a much larger internal volume than the BA 330, and the BEAM, designed to be affixed to the ISS. NASA expects to decide in 2012 whether BEAM will eventually launch to the ISS.

Bigelow is also involved in crew transportation. Bigelow Aerospace became a member of the Boeing CCDev team working on the CST-100 reusable in-space crew transport vehicle. Bigelow maintains a strong relationship with SpaceX as well.

Bigelow has begun preliminary international outreach efforts. The company signed memorandums of understanding with national space agencies, companies, and governmental entities in the UAE, Netherlands, Sweden, Singapore, Japan, the United Kingdom, and Australia. Bigelow has also initiated a substantial expansion to its north Las Vegas manufacturing plant, adding 17,187 square meters (185,000 square feet).

Delays in space vehicle development under NASA's commercial crew program forced Bigelow Aerospace to cut its workforce from 115 to 51 people in late 2011. Despite this setback, the company resumed hiring in March 2012.

Although Bigelow Aerospace has ambitious plans, no launch contracts have been publicly announced. Such contracts will likely not be announced until the company can secure viable crew transportation, such as the Boeing CST-100 or SpaceX Dragon capsules. As a result, launch demand associated with Bigelow Aerospace is not included in this section. The Bigelow BEAM mission in 2015 is, however, included in the science and engineering section because it is a technology test and demonstration mission.

Excalibur Almaz

Excalibur Almaz, Incorporated (EAI), an independent U.S. company formed in 2006, has lease rights to Excalibur Almaz, Limited (EAL) hardware and technology. EAI is engaged in an unfunded Space Act Agreement with NASA for commercial crew transportation.

EAL uses elements of a legacy Soviet military space program known as Almaz. The system includes a three-person reusable return vehicle and a service module that can stay in orbit autonomously for one week or dock with the ISS. If NASA uses the system, the baseline vehicle will be the Atlas V. The baseline vehicle for non-NASA uses has not yet been selected.

EAL intends to begin flight tests of the Almaz hardware by 2013 and to launch its first revenue-generating flight as early as 2014. EAL's key partners are NPO Mashinostroyenia (the original developer of Almaz), United Space Alliance, EADS Astrium, and Japan Manned Space Systems Corporation.

If EAL's plans come to fruition on its current schedule, it could create additional demand for commercial launches. However, details regarding financing have not been provided publicly, and no launch contracts have been announced. As a result, launch demand associated with EAL is not included in this report.

Commercial Cargo and Crew Transportation Services Launch Demand Summary

Commercial cargo and crew transportation services make up 50 percent of launches in this report. If commercial vehicles begin launching Bigelow modules to the ISS or Bigelow space stations, the number of launches in this section could grow in the out-years. However, the 64 launches in this section carry significant financial and technical risk, because all of the launches are on new launch vehicles or new spacecraft that are being developed with NASA-appropriated funds. This launch projection represents NASA's current plans for commercial cargo and crew services to the ISS. Figure 21 provides a launch history (one COTS flight) and projected launch plans for commercial transportation services.

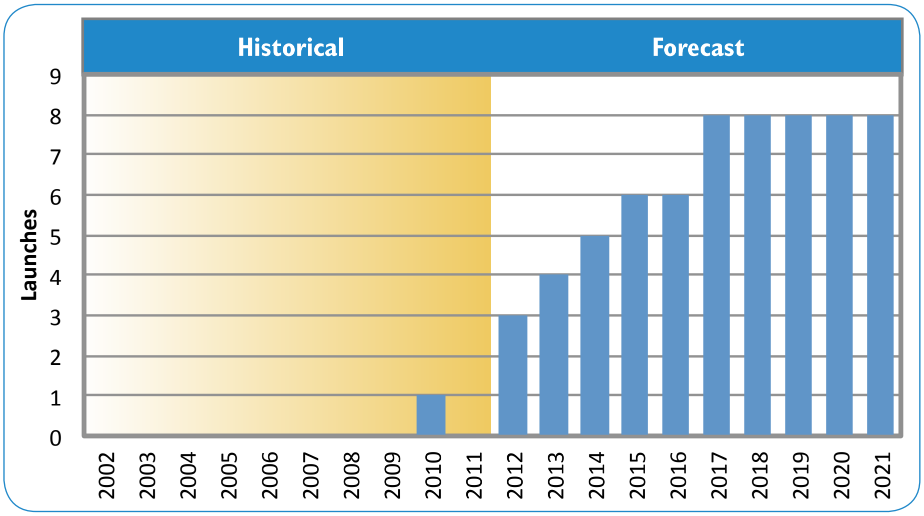

Figure 21. Commercial Cargo and Crew Transportation Services Launch History and Projected Launch Plans

Lunar Transportation

The Moon is a possible destination for future science and engineering missions. The Google Lunar X Prize, established in 2007, may create demand for commercial launch services for these kinds of missions.

The objective of the $30 million prize is to launch a privately developed robot to the Moon. After landing, the robot must traverse the surface for a distance of at least 500 meters (1,640 feet) and transmit high-definition images and video to Earth. Teams that are 90-percent privately financed may compete. There is a $20 million grand prize, a $5 million second prize, and a series of bonus prizes. Twenty-six teams from around the world have registered for the competition. The competition ends when all the prizes are claimed or by the end of 2015, whichever comes first.

As part of its Innovative Lunar Demonstrations Data program, NASA awarded contracts to six of the Google Lunar X Prize teams for data on lunar mission technical component demonstrations.

Other Payloads Launched Commercially

Other payloads launched commercially primarily include NGSO military payloads from countries that do not have an indigenous launch capability or payloads that do not fit into any other category:

- **Göktürk 1 through 4:** The four Göktürk satellites are electro-optical earth observation satellites for the Turkish Ministry of Defense. Italian firm Telespazio is the manufacturer. The satellites are projected to have a mass of up to 5,000 kilograms (11,000 pounds) and will require a medium to heavy launch vehicle. Göktürk 2 should launch in 2012 on a Chinese Long March 2D vehicle, while Göktürk 1 should launch in 2013. The Turkish Ministry of Defense expects Göktürk 3 and 4 to launch in 2015 and 2017, respectively. Turkey plans to commercially sell imagery obtained by Göktürk. Additional follow-on satellites are under consideration.
- **PAZ:** PAZ is a radar satellite that will be operated by Hisdesat. It represents part of the Spanish National Earth Observation Program (PNOTS) developed and managed jointly by the Ministry of Defense and the Ministry of Industry, Trade and Tourism. Imagery obtained by this satellite, which is based on the TSX-1 bus developed for Infoterra's TerraSAR-X and TanDEM-X, will be used for national security and commercial purposes. PAZ is scheduled to launch aboard a Dnepr vehicle in 2013.
- **ASNARO:** ASNARO is a remote sensing satellite for the Japanese Ministry of Economy, Trade, and Industry manufactured by the Nippon Electric Company. The satellite has a projected mass of 400 kilograms (882 pounds) and will likely launch as a secondary payload on a medium to heavy launch vehicle in 2013, likely a Dnepr.

Satellite and Launch Forecast Trends

From 2012 to 2021, nearly 300 payloads are projected to launch commercially, amounting to 128 launches after accounting for multi-manifesting. This projection is comparable to last year's report, which projected 130 launches from the 2011 to 2020 timeframe. Figures 22 and 22 show the payloads and launches projected from 2012 to 2021. Table 23 provides the specific numbers of payloads and launches for each segment.

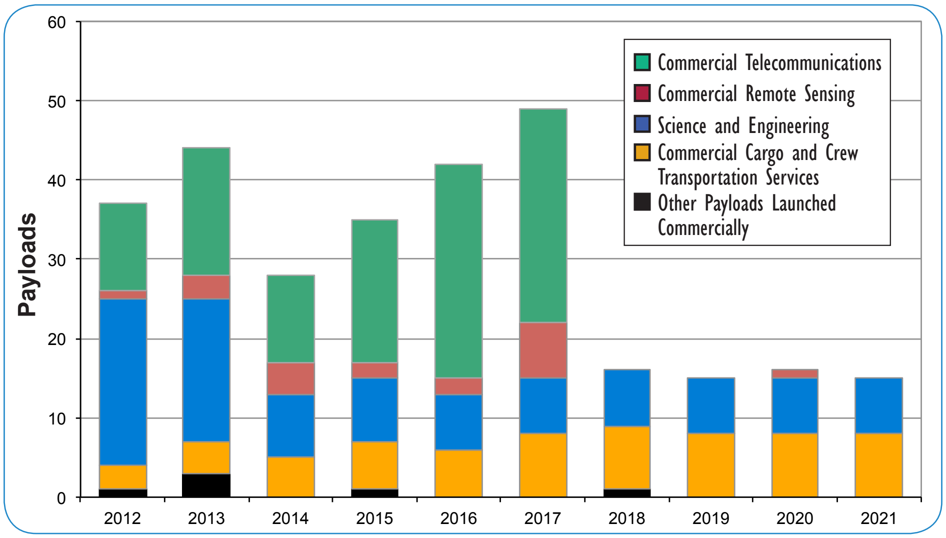

Figure 22. Payload Projections

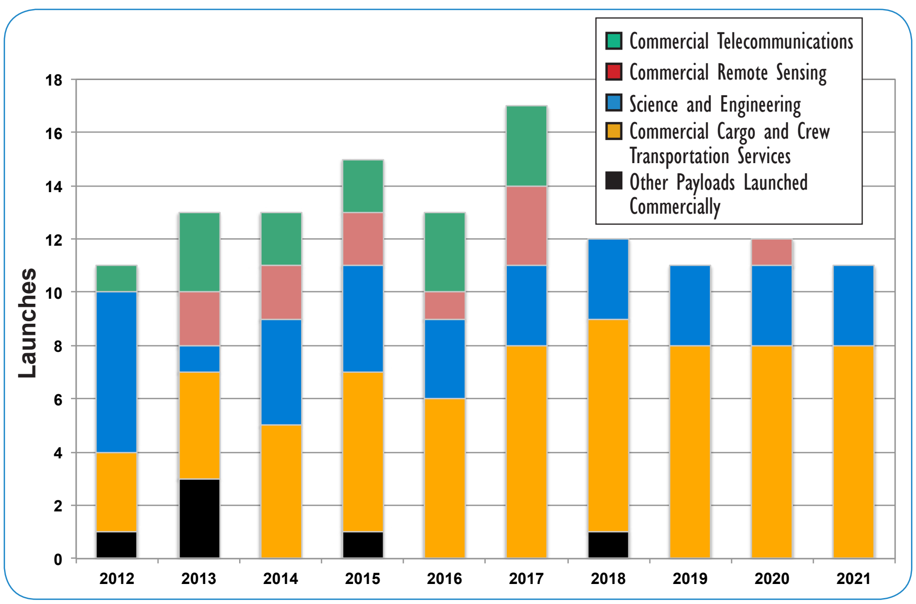

Figure 23. Launch Projections

Table 23. Payload and Launch Projections

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total	Avg.
Payloads												
Commercial Telecommunications	11	16	11	18	27	27	0	0	0	0	110	11.0
Commercial Remote Sensing	1	3	4	2	2	7	0	0	0	0	20	2.0
Science and Engineering	21	18	8	8	7	7	7	7	7	7	97	9.7
Commercial Cargo and Crew Transportation Services	3	4	5	6	6	8	8	8	8	8	64	6.4
Other Payloads Launched Commercially	1	3	0	1	0	0	1	0	0	0	6	0.6
Total Satellites	37	44	28	35	42	49	16	15	16	15	297	29.7
Launches												
Medium-to-Heavy Vehicles	10	12	13	15	12	16	11	10	11	10	120	12.0
Small Vehicles	1	1	0	0	1	1	1	1	1	1	8	0.8
Total Launches	11	13	13	15	13	17	12	11	12	11	128	12.8

Fifty percent of the predicted launches over the next 10 years are for commercial transportation services. As noted earlier, these launches carry significant financial and technical risk, because they take place on vehicles that are not yet operational and partly rely on government funding that is subject to annual appropriations.

Science and engineering launches account for 26 percent of launches over the next 10 years. These include a steady stream of basic and applied research payloads primarily from countries that do not have indigenous launch capabilities. They also include four launches of new technology test and demonstration missions: Orbital's Antares vehicle, SpaceX's Falcon Heavy, NASA's uncrewed test of the Orion MPCV on a Delta IV, and a test of Bigelow's BEAM module.

Eleven percent of the launches are for commercial telecommunications. Three launches are planned in 2013 to replace ORBCOMM and O3b satellites. There is another peak of telecom launches in 2016 and 2017 as Iridium replaces its satellites. There are no telecom launches from 2018 to 2021, after the replacement constellations are completed.

The commercial remote sensing industry is characterized by relatively stable satellite replacement schedules. A peak in the number of launches can be seen in 2017, reflecting projected deployment of satellites operated by MDA and DigitalGlobe.

A comparison of the launch demand in the 2012 report against the 2011 report is shown in Figure 24. The biggest change between the two occurs in the 2014 to 2017 timeframe, largely due to better fidelity on Iridium's plans for replacing their current constellation.

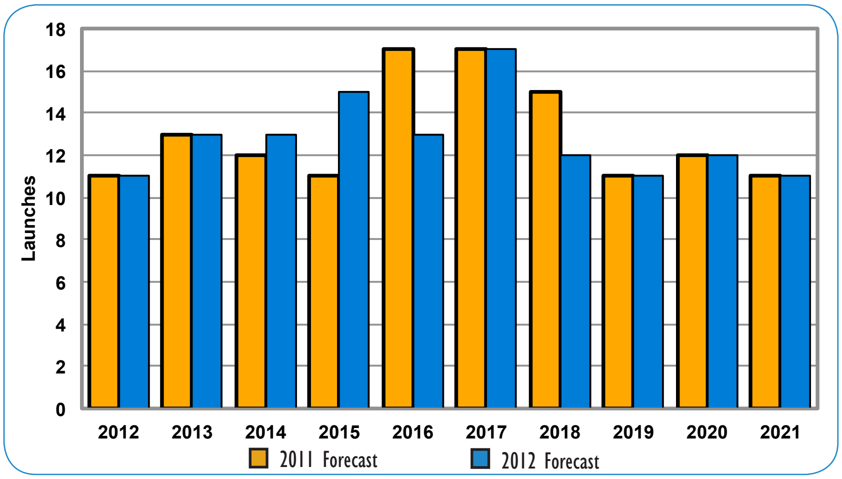

Figure 24. Comparison of Past Launch Projections

Table 24 shows the mass distributions of known manifested payloads over the next four years. In most of the mass classes, the number of payloads remain stable when compared to last year's report, except for the number of satellites with a mass below 200 kilograms (441 pounds). This category increased from 10 to 41 payloads in this year's report. This increase is attributed to the high number of science and engineering payloads listed on publicly available launch manifests. The number of payloads with a mass of 601 to 1,200 kilograms (1,324 to 2,646 pounds) also increased from 30 to 38. This change is attributed to finalizing the design and mass characteristics of the Iridium satellites launching in 2015.

Table 24. Distribution of Payload Masses in Near-Term Manifest

	2012	2013	2014	2015	Total	Percent of Total
< 200 kg (<441 lbs)	17	19	4	1	41	29.3%
200-600 kg (441-1,323 lbs)	8	11	11	0	30	21.4%
601-1,200 kg (1,324-2,646 lbs)	6	9	4	19	38	27.1%
> 1,200 kg (> 2,646 lbs)	6	5	9	11	31	22.1%
Total	37	44	28	31	140	100%

Note: Table 24 includes only satellites with known mass. Therefore the total number of satellites examined in a year differs from the forecast.

There are 128 launches projected, comprising 8 small vehicles and 120 medium- to heavy-class vehicles. This demand averages 0.8 launches annually on a small-class launch vehicle and 12.0 launches annually on medium- to heavy- launch vehicles. The 2011 report included 130 total launches composed of 19 small and 111 medium- to heavy-class launches. Reevaluation of the methodology to calculate science and engineering launches led to a decrease in the amount of small vehicles predicted. The projected medium- to heavy-class launches increased from last year, primarily because NASA added eight cargo resupply flights to the manifest for 2012 to 2021. Launch demand divided among launch vehicle mass classes is depicted in Figure 25.

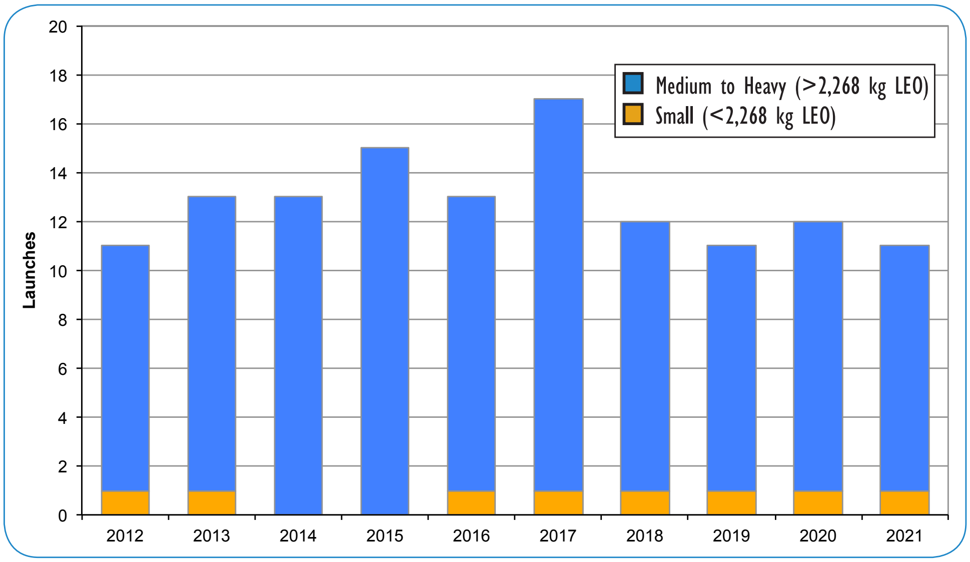

Figure 25. Launch Vehicle Projections

Consistent with previous years, the commercial telecommunications segment, led by wideband LEO systems, leads the anticipated payload market. One hundred-ten telecommunications payloads expect to require 14 multiple-manifested launches in the next 10 years (see Table 25). The projected number of launches for the science and engineering and commercial transportation services market segments is 33 and 64, respectively. Commercial transportation spacecraft all require medium- to heavy-class launch vehicles. Science and engineering uses a mix of medium- to heavy-class and small-class launches, and multiple payloads frequently co-manifest on the same launch. Commercial remote sensing satellites are projected to launch on 11 medium- to heavy-class launch vehicles and 1 small-class launch vehicle.

Table 25. Distribution of Launches among Market Segments

		Launch Demand		
	Payloads	Small	Medium-to-Heavy	Total
Commercial Telecommunications	110	0	14	14
Commercial Remote Sensing	20	1	10	11
Science and Engineering	97	7	26	33
Commercial Cargo and Crew Tranportation Services	64	0	64	64
Other Payloads Launched Commercially	6	0	6	6
Total	297	8	120	128

Launch Vehicles Typically Used for NGSO Missions

During the forecast period, several changes will occur in the availability of launch vehicles for customers seeking to launch to NGSO on commercially procured vehicles. Some new vehicles will be introduced, while others will retire.

In the U.S., SpaceX is scheduled to launch revenue-generating flights of the Falcon 9 in 2012. Orbital will introduce its Antares medium-class vehicle, with revenue-generating flights beginning in 2013. In both cases, these flights will be conducted under NASA's CRS contracts. In addition, Lockheed Martin Commercial Launch Services will be providing upgraded variants of the Athena launch vehicle, with launches expected early in the forecast period.

In Europe, Arianespace's Vega small-class launch vehicle performed a successful inaugural flight in February 2012. China is working on a small-class vehicle called the Long March 6, which may be offered commercially. The first launch of this vehicle is expected early in the forecast period. Japan plans to inaugurate its Epsilon small-class launch vehicle in 2013, while South Korea continues to develop its Korean Space Launch Vehicle system, which includes the small-class Naro-1 vehicle. The Naro-1, previously known as the Korean Space Launch Vehicle (KSLV)-1, has launched twice since 2009; both launches ended in failures.

The Department of Defense (DoD) plans to retire the Minotaur series of vehicles by 2017. In Russia, the Angara 1, a light version of the anticipated Angara series, will replace the Kosmos-3M, Tsyklon, and Rockot launch vehicles.

New vehicles expected to become available within the next two to three years include Athena (U.S.), Epsilon (Japan), and Long March 6 (China). These vehicles are designed to launch several micro- and small-class payloads at a time. However, the GSO forecast projects a trend toward higher mass class payloads. For NGSO, the per-kilogram cost to orbit for a small-class launch vehicle tends to be higher than that for a larger capacity vehicle, which may make these new small-class launch vehicles too expensive for many micro-satellite customers. Therefore, many small NGSO satellites may go as piggy-back payloads on larger vehicles leaving small-class launch vehicles with the smaller market of time-critical delivery of payloads in orbit.

Microsatellite Launch

Microsatellites are defined as payloads with a mass of less than 91 kilograms (200 pounds). These satellites are typically grouped together with a larger primary payload and placed in orbit on a shared launch vehicle (multi-manifesting).

Payloads of this mass class alone normally do not generate demand for a launch; however, a large cluster of microsatellites can justify a launch independently from a larger mass class payload.

The emergence of a microsatellite launch vehicle, with competitive launch costs, may cause microsatellite payloads to shift from the multi-manifest approach to individual launch. This would result in a larger number of launches.

Emergence of an affordable launch vehicle may find a niche for dedicated launches of satellites on the lower end of the microsatellite category: nanosatellites (satellites with masses of 10 kilograms or less).

In recent years, a number of organizations initiated development of launch vehicle concepts targeting the orbital launch of microsatellites, such as Dynetics, Interorbital Systems, Generation Orbit Launch Services, Microcosm, Starfighters, XCOR, and Virgin Galactic.

Emergence of this market is uncertain and may affect the number of launches during the report period. If a new microsatellite vehicle is developed and sufficient demand is demonstrated, launch projections for this segment can be included in future editions of the Commercial Space Transportation Forecast for NGSO report.

Risk Factors That Affect Satellite and Launch Demand

A large number of financial, political, and technical factors can impact the Commercial Space Transportation Forecast for NGSO report. The emergence of new markets, such as commercial human spaceflight, can be difficult to forecast with certainty. The NASA COTS program is an example of government promotion of a new commercial market that may not have been imaginable a decade ago. Launch failures are an example of an uncertainty factor that can dramatically impact launch rates.

The demand projection is the number of satellites that operators expect to launch in a given year. This demand is typically larger than the number of satellites actually launched. Some of the factors that contribute to the difference between forecasted and realized launches include:

Financial Uncertainty

- **U.S. national and global economy:** Strong overall economic conditions historically foster growth and expansion in satellite markets. Similarly, relatively weak currency exchange rates in one nation generally create favorable circumstances for exporters and buyers in a given marketplace. Global satellite manufacturers and purchasers have shown strong interest in taking advantage of the highly attractive values offered by the historically low U.S. dollar exchange rates. However, as the dollar rises in value, this trend will reverse.
- **Investor confidence:** After investors suffered large losses from the bankruptcies of high-profile NGSO systems in the early 2000s, confidence in future and follow-on NGSO telecommunications systems have abated.
- **Business case changes:** The satellite owner or operator can experience budget shortfalls, change strategies, or request technology upgrades late in the manufacturing stage, all of which can contribute to schedule delay. An infusion of cash from new investors can revive a stalled system or accelerate schedules.
- **Corporate mergers:** The merging of two or more companies may make it less likely for each to continue previous plans and can reduce the number of competing satellites that launch. Conversely, mergers can have a positive impact by pooling the resources of two weaker firms to enable launches that would not have occurred otherwise.
- **Terrestrial competition:** Satellite services can complement or compete with ground-based technology, such as cellular telephones or communications delivered through fiber optic or cable television lines. Aerial remote sensing also competes with satellite imagery. Developers of new space systems have to plan ahead extensively for design, construction, and testing of space technologies, while developers of terrestrial technologies can react and build to market trends more quickly and might convince investors of a faster return on investment.

Political Uncertainty

- **Increase in government purchases of commercial services:** For a variety of reasons, government entities have been purchasing more space-related services from commercial companies. For example, the DoD continues to purchase significant remote sensing data from commercial providers.
- **Regulatory and political changes:** Export compliance, FCC licensing, NOAA licensing, or international licensing requirements can delay progress on a satellite program. U.S. Government policy regarding satellite and launch vehicle export control has hindered U.S. satellite manufacturers and launch vehicle operators working with international customers. This causes delays as well as cancellations of satellite programs. Changes in FCC or NOAA processes, export control issues associated with space technology, and political relations between countries can all affect demand.
- **Increase in government missions open to launch services competition:** Some governments keep launch services contracts within their borders to support domestic launch industries. However, the ESA has held international launch competitions for some of its small science missions, and some remote sensing satellite launches have been competed. While established space-faring nations are reluctant to open up to international competition, the number of nations with new satellite programs but without space launch access slowly increases.

Technical Uncertainty

- **Satellite lifespan:** Many satellites outlast their planned design life. The designated launch years in this report for replacement satellites are often estimates for when a new satellite will be needed. Lifespan estimates are critical for timing the replacements of existing NGSO satellite systems given the high capital investment required to deploy a replacement system.
- **Need for replacement satellites:** Although a satellite might have a long lifespan, it can be replaced early if it is no longer cost-effective to maintain; or an opportunity might arise that allows a satellite owner or operator to exceed the competition with a technological advancement. Higher resolution commercial remote sensing satellites are an example of this factor.
- **Launch vehicle technical issues:** Launch vehicle manufacturers and operators may have manufacturing, supplier, or component issues or experience launch anomalies or failures. Any of these issues can delay the availability of a launch vehicle or cause a delay at the launch pad. Launch delays can have a cascading effect on subsequent launches. Some missions have specific launch windows (for example, science windows), and missed that window may result in lengthy delays.

- **Satellite technical issues:** Satellite manufacturers may have factory, supplier, or component issues that delay the delivery of a satellite. The likelihood of delays due to technical issues rises as satellite systems become more complex. Anomalies, whether on the ground or in orbit, can affect the delivery of satellites until potential fleet issues (for example, commonality with parts on a satellite awaiting launch) are resolved. Delays in delivery of spacecraft to the launch site can impact the scheduling of launches.
- **Multi-manifesting:** Multi-manifesting, while limited to a few launch vehicles, is dependent on several satellites being delivered on time. Payload compatibility issues may also cause manifesting challenges.
- **Weather:** Inclement weather, including ground winds, flight winds, cloud cover, lightning, and ocean currents can cause launch delays, though these typically are short term (on the order of days).
- **Failure of orbiting satellites:** From the launch services perspective, failure of orbiting satellites can require launching ground spares or ordering new satellites. This only amounts to a small effect on the market, however. A total system failure has not happened to any NGSO constellation.
- **Orbital debris and collision avoidance:** Though relatively rare, launch delays can also occur when conjunction analysis determines that orbital debris has a high probability of introducing risk to the mission.

APPENDIX 1: VEHICLE SIZES AND ORBITS

Small launch vehicles are defined as those with a payload capacity of less than 2,268 kilograms (5,000 pounds) at 185 kilometers (100 nautical miles) altitude and a 28.5-degree inclination. Medium to heavy launch vehicles are capable of carrying more than 2,269 kilograms at 185 kilometers altitude and a 28.5-degree inclination.

Commercial NGSO systems use a variety of orbits:

- Low Earth orbits (LEO) range from 160-2,400 kilometers (100–1,500 miles) in altitude, varying between a 0 degree inclination for equatorial coverage and a 101 degree inclination for global coverage.
- Medium Earth orbits (MEO) begin at 2,400 kilometers (1,500 miles) in altitude and are typically at a 45-degree inclination to allow global coverage with fewer high-powered satellites. However, MEO is often a term applied to any orbit between LEO and GSO.
- Elliptical orbits (ELI, also known as highly elliptical orbits, or HEO) have apogees ranging from 7,600 kilometers (4,725 miles) to 35,497 kilometers (22,000 miles) in altitude and up to a 116.5-degree inclination, allowing satellites to "hang" over certain regions on Earth, such as North America.
- External or non-geocentric orbits (EXT) are centered on a celestial body other than the Earth. They differ from ELI orbits in that they are not closed loops around Earth, and a spacecraft in EXT will not return to an Earth orbit. In some cases, this term is used for payloads intended to reach another celestial body (for example, the Moon).

APPENDIX 2: HISTORICAL NGSO MARKET ASSESSMENTS

In the last decade of launch activity, there have been significant changes in the amount of payloads and launches forecasted each year, with payloads and launches remaining steady from 2003 to 2006, then beginning to increase in 2007. Overall, the 2012 NGSO report projects demand consistently higher than the average of 5.6 launches per year over the last 10 years.

In the last two decades of commercial NGSO satellite launch activity, the telecommunications market put large constellations of satellites into orbit within a few years, creating a short spurt of intense launch activity. This was the case in 1997 to 1999, when the three major systems, Globalstar, Iridium, and ORBCOMM, launched. The 2012 NGSO report shows a slightly more compressed schedule of launches, as each of these systems is replaced with new satellites. Globalstar plans to complete their constellation in 2012, and a new O3b constellation will be launching at the same time as ORBCOMM plans its major launch campaign over the next several years. The Iridium NEXT deployment schedule does not fully overlap with the other constellations as it did in the late 1990s.

The science and engineering and commercial remote sensing satellite markets create consistent launch demand according to historical figures. Since 1996, there has always been at least one science and engineering satellite launched commercially, with a maximum of 14 satellites launched in one year (2007). The commercial remote sensing market has low launch demand that is more sporadic than science and engineering.

The number of payloads launched by market sector and the total commercial launches that were internationally competed or commercially sponsored from 2002 through 2011 are provided in Table 26. Small vehicles performed 24 launches

Table 26. Historical Payloads and Launches*

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Payloads											
Commercial Telecommunication	9	0	2	0	0	8	6	2	6	14	47
Commercial Remote Sensing	0	1	0	0	1	3	6	1	1	0	13
Science and Engineering	6	6	7	7	4	14	8	6	7	4	69
Commercial Cargo and Crew Transportation Services	0	0	0	0	0	0	0	0	1	0	1
Other Payloads Launched Commercially	0	0	0	0	0	0	0	0	0	0	0
Total Satellites	15	7	9	7	5	25	20	9	15	18	130
Launches											
Medium-to-Heavy Vehicles	2	1	1	0	2	10	4	2	7	3	32
Small Vehicles	2	3	1	3	3	2	6	3	1	0	24
Total Launches	4	4	2	3	5	12	10	5	8	3	56

* Includes payloads open to international launch services procurement and other commercially sponsored payloads. Does not include dummy payloads, piggyback payloads, or satellites that are captive to national flag launch service providers (i.e., U.S. Air Force or NASA satellites, or similar European, Russian, Japanese, or Chinese government satellites that are captive to their own launch providers). Only primary payloads that generate a launch are included, unless combined secondary payloads generate the demand.

during this period, while medium to heavy vehicles conducted 32 launches. From 1994 to the end of 2006, the historical number of launches between vehicle classes was roughly equal. This roughly even split is not expected to continue, as an increasing number of launches use medium to heavy vehicles. The 2012 NGSO report estimates that the larger vehicle class will continue to conduct the most launches.

Historical satellite and launch data from 2002 through 2011 are shown in Table 27. Secondary and piggyback payloads on launches with larger primary payloads were not included in the payload or launch tabulations.

Table 27. Historical NGSO Payload and Launch Activities (2002-2011)

Summary	Market Segment	Date	Satellite	Launch Vehicle	
			2011		
18 Satellites 14 Telecommunication 4 Science & Engineering 3 Launches 3 Medium-to-Heavy	Telecommunication	7/13/11	Globalstar 2nd Gen. 7-12 (6 sats)	Soyuz 2	Medium-to-Heavy
			AprizeStar 5-6 (2 sats)[1]		
	Science & Engineering	12/28/11	Globalstar 2nd Gen. 13-18 (6 sats)	Soyuz 2	Medium-to-Heavy
		8/17/11	Sich 2 RASAT Edusat BPA-2	Dnepr	Medium-to-Heavy
			2010		
15 Satellites 6 Telecommunication 1 Remote Sensing 7 Science & Engineering 1 Transportation 8 Launches 7 Medium-to-Heavy 1 Small	Telecommunication	10/19/10	Globalstar 2nd Gen. 1-6 (6 sats)	Soyuz 2	Medium-to-Heavy
	Remote Sensing	6/20/10	TanDEM X	Dnepr M	Medium-to-Heavy
	Science & Engineering	4/7/10	Cryosat 2	Dnepr M	Medium-to-Heavy
		6/1/10	SERVIS 2	Rockot	Small
		6/9/10	Falcon 9 Demo Flight	Falcon 9	Medium-to-Heavy
		6/14/10	Prisma (2 sats) Picard[2]	Dnepr M	Medium-to-Heavy
		11/5/10	Cosmos-SkyMed 4	Delta II	Medium-to-Heavy
	Transportation	12/8/10	Dragon COTS Demo 1	Falcon 9	Medium-to-Heavy
			2009		
11 Satellites 2 Telecommunication 1 Remote Sensing 8 Science & Engineering 5 Launches 2 Medium-to-Heavy 3 Small	Telecommunication		AprizeStar 3-4[3]		
	Remote Sensing	10/8/09	Worldview 2	Delta II	Medium-to-Heavy
	Science & Engineering	7/13/09	RazakSat	Falcon 1	Small
		7/29/09	DubaiSat 1 DEIMOS UK DMC 2 Nanosat 1B	Dnepr	Medium-to-Heavy
		3/17/09	GOCE	Rockot	Small
		11/2/09	SMOS Proba 2	Rockot	Small

1 AprizeStar 5 & 6 deployed on launch with Sich 2 et al.
2 Picard deployed on launch with Prisma Main & Target
3 AprizeStar 3 & 4 deployed on launch with DubaiSat 1

Table 27. Historical NGSO Satellite and Payload Activities (2002-2011) (Continued)

Summary	Market Segment	Date	Satellite	Launch Vehicle	
2008					
20 Satellites 6 Telecommunication 6 Remote Sensing 8 Science & Engineering 10 Launches 4 Medium-to-Heavy 6 Small	Telecommunication	6/19/08	Orbcomm Replacement 1-5 Orbcomm CDS-3	Cosmos 3M	Small
	Remote Sensing	8/29/08 9/6/08	RapidEye 1-5 GeoEye-1	Dnepr 1 Delta II	Medium-to-Heavy Medium-to-Heavy
	Science & Engineering	3/27/08 4/16/08 6/19/08 7/22/08 8/3/08 9/28/08 10/1/08 10/24/08	SAR Lupe 4 C/NOFS UGATUSAT SAR Lupe 5 Trailblazer[F] Falcon 1 Mass Simulator THEOS Cosmo-SkyMed 3	Cosmos 3M Pegasus XL Cosmos 3M Falcon 1 Falcon 1 Dnepr 1 Delta II	Small Small Small Small Small Medium-to-Heavy Medium-to-Heavy
2007					
25 Satellites 8 Telecommunication 3 Remote Sensing 14 Science & Engineering 12 Launches 10 Medium-to-Heavy 2 Small	Telecommunication	5/30/07 10/21/0	Globalstar Replacement 1-4 Globalstar Replacement 5-8	Soyuz Soyuz	Medium-to Heavy Medium-to-Heavy
	Remote Sensing	6/15/07 9/18/07 12/14/07	TerraSAR-X WorldView 1 RADARSAT 2	Dnepr Delta II Soyuz	Medium-to-Heavy Medium-to-Heavy Medium-to-Heavy
	Science & Engineering	4/17/07 4/23/07 6/7/07 6/28/07 7/2/07 11/1/07 12/8/07	Egyptsat SaudiComsat 3-7 Saudisat 3 AGILE AAM Cosmos-SkyMed 1 Genesis II SAR Lupe 2 SAR Lupe 3 Cosmo-SkyMed 2	Dnepr PSLV Delta II Dnepr Cosmos 3M Cosmos 3M Delta II	Medium-to-Heavy Medium-to-Heavy Medium-to-Heavy Medium-to-Heavy Small Small Medium-to-Heavy
2006					
5 Satellites 1 Remote Sensing 4 Science & Engineering 5 Launches 2 Medium-to-Heavy 3 Small	Remote Sensing	4/25/06	EROS B	START 1	Small
	Science & Engineering	7/28/06 12/27/06 7/12/06 12/19/06	Kompsat 2 Corot Genesis 1 SAR Lupe 1	Rockot Soyuz 2 1B Dnepr Cosmos	Small Medium-to-Heavy Medium-to-Heavy Small
2005					
8 Satellites 8 Science & Engineering 3 Launches 3 Small	Science & Engineering	6/21/05 10/8/08 10/27/05	Cosmos 1 Cryosat Beijing 1 Mozhayets 5 Rubin 5 Sinah 1 SSETI Express Topsat	Volna[F] Rockot[F] Cosmos	Small Small Small

F Launch Failure

Table 27. Historical NGSO Satellite and Payload Activities (2002-2011) (Continued)

Summary	Market Segment	Date	Satellite	Launch Vehicle	
2004					
9 Satellites 2 Telecommunication 7 Science & Engineering 2 Launches 1 Medium-to-Heavy 1 Small	Telecommunication		LatinSat (2 sats)[4]		
	Science & Engineering	5/20/04 6/29/04	Rocsat 2 Demeter AMSat-Echo SaudiComSat 1-2 SaudiSat 2 Unisat 3	Taurus Dnepr	Small Medium-to-Heavy
2003					
9 Satellites 1 Remote Sensing 8 Science & Engineering 4 Launches 1 Medium-to-Heavy 3 Small	Remote Sensing	6/26/03	OrbView 3	Pegasus XL	Small
	Science & Engineering	6/2/03 9/27/03 10/30/03	Mars Express Beagle 2 BilSat 1 BNSCSat KaistSat 4 NigeriaSat 1 Rubin 4-DSI SERVIS 1	Soyuz Cosmos Rockot	Medium-to-Heavy Small Small
2002					
15 Satellites 9 Telecommunication 6 Science & Engineering 4 Launches 2 Medium-to-Heavy 2 Small	Telecommunication	2/11/02 6/20/02	2002 Iridium (5 sats) Iridium (2 sats) LatinSat (2 sats)[5]	Delta II Rockot	Medium-to-Heavy Small
	Science & Engineering	3/17/02 12/20/02	GRACE (2 Sats) SaudiSat 1C Unisat 2 RUBIN 2 Trailblazer Structural Test Article	Rockot Dnepr	Small Medium-to-Heavy

4 Launched on same mission as Demeter et al.

5 Launched on same mission as SaudiSat 2 et al.

APPENDIX 3: SCIENCE AND ENGINEERING PAYLOADS

Further information regarding the payloads, launched and forecasted, listed in this report can be found below. Payloads are listed in alphabetical order.

BPA-2, -3 (Blok Perspektivnoy Avioniki-2): The Ukrainian experimental instrumentations BPA-2 and -3 are designed to remain attached to a Dnepr's third stage to test navigation equipment for launch vehicles, spacecraft, and civilian aircraft. They are an experiment for technology development related to aircraft and spacecraft navigation developed by Kharton-Arkos, the manufacturers of the Dnepr control system.

Dove-1: This low-cost imaging satellite will demonstrate that a constrained cubesat of 3U (1U = 10 centimeters by 10 centimeters by 10 centimeters) can host a small camera even if built with non-space components. It will also transmit health data and images to the ground.

CASSIOPE: The Cascade, Smallsat, and Ionospheric Polar Explorer (CASSIOPE) spacecraft, manufactured by MDA, is scheduled to launch near the end of 2012 on a Falcon 9 launch vehicle. The payload has a mass of about 500 kilograms (1,100 pounds). The satellite will space-qualify high-performance payload components that will be used in the CASCADE mission, also developed by MDA. The CASCADE mission will enable a service business that offers users in remote areas the ability to move thousands of gigabits of data on a daily basis to and from anywhere on Earth.

CINEMA-1, -2, -3: Cinema-1 is being developed by the University of California Berkeley and will launch as an auxiliary payload aboard an Atlas V vehicle in 2012. CINEMA-2 and -3 will have masses of 4 kilograms (9 pounds) each and are being developed by the University of California Berkeley, Kyung Hee University of South Korea, Imperial College London (ICL), and NASA Ames Research Center. The satellites will conduct research, using magnetometers provided by ICL, and conduct space weather measurements.

Delfi-n3Xt: TNO, a Dutch partner, is in cooperation with The Delfi University of Technology and the University of Twente (both in the Netherlands) to build this satellite. The satellite, which will have a mass of 5 kilograms (11 pounds), is to provide systems engineering experience, scientific writing experience, and various other skills to the students participating in the design and development of Delfi-n3Xt. The satellite will also test various micro-technologies for space applications, which were developed by sources in the Dutch space sector.

DragonLab Missions: Although SpaceX expected to introduce its DragonLab platform in 2013, the mission was rescheduled to 2014 due to the rigorous amount of testing, inspections, and simulations needed of the software. The DragonLab spacecraft is intended for commercial customers and is based on the same design as the Dragon capsule. DragonLab will also be equipped with a temporary orbital laboratory that can host pressurized and unpressurized experiments. The spacecraft is expected to be recoverable and reusable. SpaceX anticipates one DragonLab mission per year.

DubaiSat-2: The second remote sensing satellite, from Emirates Institution for Advanced Science and Technology located in the UAE, is scheduled to launch as the primary payload in a multi-manifested launch aboard a Dnepr vehicle in the fourth quarter of 2012. It has a mass of about 300 kilograms (661 pounds) and will provide improved resolution and faster download speeds.

EDUSAT: This small, 10-kilogram (22-pound) scientific satellite is the product of high school students in Italy. The satellite is designed to test a communications link and measure the Earth's magnetic field. It was launched as part of the multi-manifested launch on the Dnepr launch vehicle on August 17, 2011.

EnMap: The spacecraft has a mass of 810 kilograms (1,786 pounds) and is a product of DLR. It will study a range of ecological parameters, including agriculture, forestry, soil, and geology using its hyperspectral instruments. The mission is expected to last five years.

FORMOSAT-5: This satellite, with a mass of 525 kilograms (1,157 pounds), will have a variety of missions once it is launched. It will be equipped with an optical payload for remote sensing and a number of science payloads. The optical payload will provide panchromatic images with a 2-meter (6.5-foot) resolution and multispectral images with a 4-meter (13-foot) resolution. An Advanced Ionospheric Probe will be one of the science payloads on the spacecraft.

FUNcube-1: This satellite will have a mass of less than 1 kilogram (2 pounds) and is aimed at drawing the interest of students at both primary and secondary levels. The friendly user interface allows students to access and monitor information on the satellite such as battery voltages and temperatures, spin rate, and attitude (spacecraft position in 3-D space).

GOMX-1: Students from Aalborg University in Denmark will depend on a Dnepr launch vehicle to take their 2-kilogram (4-pound) amateur radio payload into SSO. The satellite will include a camera designed to take color images of Earth. Additionally, it will include a receiver that will be tested and have its performance characterized.

KOMPSAT-3A: Also known as KOMPSAT-3's "brother satellite," KOMPSAT-3A will include the ability to obtain images in the infrared spectrum and panchromatic images, allowing for temperature change monitoring. KOMPSAT-3A is being developed by South Korea's Korean Aerospace Research Institute (KARI).

KOMPSAT-5: KOMPSAT-5 is a 1,280-kilogram (2,816-pound) satellite with a SAR platform. Originally scheduled for launch in 2011, the payload is now scheduled for a single-manifest Dnepr launch in 2012. The satellite will provide images up to 1-meter resolution for use in geographic information applications, environmental monitoring, and disaster response. KARI and European manufacturer Thales Alenia Space manufactured the satellite, with Alcatel Alenia Space responsible for producing the X-band SAR sensor.

NEE-01 Pegaso: The first satellite designed and manufactured by Ecuador, NEE-01 will be equipped with imaging and video recording hardware. The video will be accessible to Ecuadorian students via live Internet feeds. In addition, the satellite will test a thermal and radiation shield.

Orion MPCV: NASA's Multi-Purpose Crew Vehicle is tentatively scheduled to launch uncrewed in 2014 on a Delta IV-Heavy. The capsule will separate and reenter, eventually landing in the Pacific Ocean.

RASAT: This Turkish scientific payload has a mass of 95 kilograms (209 pounds) and is designed to test space hardware in outer space conditions, while creating a heritage for follow-on Turkish missions. It is also serving a practical application by updating existing maps with its 7.6-meter (25-foot) peak resolution imaging equipment.

SAOCOM-1A, -1B: SAOCOM-1A is part of Argentina's SAR Observation & Communication (SAOCOM) satellite program and will operate jointly with Italian satellites to provide information for emergency management. The satellite will capture high-resolution images, and when paired with the solid sate recorder on board, will be able to store images and share them via its high bit rate downlink system. The second Argentine satellite, SAOCOM-1B, will also communicate with Italian satellites to provide information for emergency management.

STSat-3 (Science and Technology Satellite-3): This South Korean-designed payload, with a mass of 150 kilograms (330 pounds), is planned for launch in 2012. STSat-3's primary purpose is to test technologies related to bus structure, battery performance, and onboard computer performance. It will test these components by providing infrared images of the galaxy and aiding in land classification research and monitoring of water quality.

Sich-2: This imaging satellite will provide 8-meter resolution imagery to support Ukraine's cartography, disaster monitoring, and agriculture needs. Sich-2 was launched with a cluster of other satellites aboard a Dnepr rocket in 2011.

SWARM 1, 2, 3: The SWARM constellation consists of three satellites and is designed to improve knowledge of the Earth's interior composition and climate. The ESA selected EADS Astrium to develop and build the constellation of three satellites. The satellites will measure the strength and direction of the Earth's magnetic field from a polar orbit.

UKube-1: This cubesat, which will have a mass of 3 kilograms (7 pounds), is being developed by the United Kingdom. The UK Space Agency held a proposal competition and chose four payloads to launch aboard UKube-1 as experiments. Included in the four experiments is a new sensor technology experiment, which is to take pictures of Earth while serving as an experimental testbed for radiation damage in space. Also included is a demonstration on how radiation can be used as a source to randomly generate numbers. Finally, there is an advanced satellite communication application project. UKube-1 will also allow for the testing of two other experiments, not included here, which are in test phases.

UniSat-5: The payload is the sixth satellite designed and manufactured by students and professors from the School of Aerospace Engineering at the University of Rome. It has a mass of about 12 kilograms (26 pounds). Students from Morehead State University also contributed to the design and manufacturing of the satellite. UniSat-5 will test equipment in space conditions and allow for microgravity experimentation of various projects.

UWE-3: The third satellite out of the University of Würzburg will test adaptations of Internet protocols to the space environment while maintaining the ability to control its attitude, a new feature among the UWE satellites.

WNISat-1: This payload, having a mass of about 10 kilograms (22 pounds) and occupying a volume of 27 cubic centimeters, is set to monitor the atmosphere and ice conditions in the routes of the Arctic Sea. The satellite will also monitor carbon dioxide in the atmosphere using visible and near-infrared cameras to capture details.

APPENDIX 4: ACRONYMS

21AT	Twenty First Century Aerospace Technology Company Ltd.
3GIRS	Third Generation Infrared Surveillance
ADF	Australian Defence Force
ATK	Alliant Technologies
ATV	Automated Transfer Vehicle
BB	Broadband services
BEAM	Bigelow Expandable Activity Module
CASSIOPE	Cascade, Smallsat, and Ionospheric Polar Explorer
CCAFS	Cape Canaveral Air Force Station
CCDev	Commercial Crew Development
CCiCAP	Commercial Crew Integrated Capacity
CHIRP	Commercially Hosted Infrared Payload Flight Demonstration Program
CNES	Centre National d'Études Spatiales (French space agency)
COMSTAC	Commercial Space Transportation Advisory Committee
CONAE	National Commission on Space Activity (Argentinian space agency)
COTS	Commercial Orbital Transportation Services
CRS	Commercial Resupply Services
CSA	Canadian Space Agency
CSLI	CubeSat Launch Initative
DARS	Digital Audio Radio Services
DBS	Direct Broadcasting Services
DE	Germany
DK	Denmark
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German space agency)
DMC	Disaster Monitoring Constellation
DMCii	DMC International Imaging, Ltd.
DOD	Department of Defense
DOT	Department of Transportation
DTH	Direct-To-Home
EA	Excalibur Almaz
EADS	European Aeronautic Defence and Space Company
EC	European Commission
ECA	Export Credit Agency
EDRS	European Data Relay System
EGNOS	European Geostationary Navigation Overlay Service
ELaNa	Educational Launch of Nanosatellites

ELI	Highly Elliptical Orbit
EROS	Earth Remote Observation Satellite
ESA	European Space Agency
EU	European Union
EXIM	Export-Import Bank
EXT	External or Non-Geocentric Orbit
FAA/AST	Federal Aviation Administration, Office of Commercial Space Transportation
FCC	Federal Communications Commission
FSS	Fixed Satellite Services
FY	Fiscal Year
GHz	Gigahertz
GIS	Geographic Information Systems
GmbH	Gesellschaft mit beschränkter Haftung (German LLC)
GPS	Global Positioning System
GSAT	Geo-Stationary Satellite (India)
GSO	Geosynchronous Orbit
GTO	Geosynchronous Transfer Orbit
HEO	Highly Elliptical Orbit
HPA	Hosted Payload Alliance
HTV	H-II Transfer Vehicle
IAI	Israel Aerospace Industries Ltd.
ICL	Imperial College London
ILS	International Launch Services
ISS	International Space Station
IT	Italy
ITAR	International Traffic in Arms Regulations
ITT	International Telephone & Telegraph
JP	Japan
KARI	Korea Aerospace Research Institute
KSLV	Korean Space Launch Vehicle
LCRD	Laser Communications Relay Demonstration
LEO	Low Earth Orbit
LLC	Limited Liability Company
MARS	Mid-Atlantic Regional Spaceport
MDA	MacDonald, Dettwiler and Associates Ltd.
MEO	Medium Earth Orbit
MPCV	Multi Purpose Crew Vehicle
MSS	Mobile Satellite Services

NASA	National Aeronautics and Space Administration
NGA	National Geospatial-Intelligence Agency
NGSO	Non-Geosynchronous Orbits
NL	Netherlands
NOAA	National Oceanic and Atmospheric Administration
O3b	Other Three Billion Networks, Ltd.
OHB	Orbitale Hochtechnologie Bremen
Orbital	Orbital Sciences Corporation
PNOTS	Spanish National Earth Observation Program
PPP	Public-Private Partnership
PSLV	Polar Satellite Launch Vehicle
RCM	RADARSAT Constellation Mission
SAOCOM	SAtélite Argentino de Observación COn Microondas
SAR	Synthetic Aperture Radar
SBAS	Satellite-Based Augmentation Systems
SpaceX	Space Exploration Technologies Corporation
SPOT	Satellite Pour l'Observation de la Terre
SS/L	Space Systems/Loral
SSTL	Surrey Satellite Technology Limited
STSAT	Science and Technology Satellite
TanDEM-X	TerraSAR Digital Elevation Measurement X-band
TBD	To Be Determined
TSX	TerraSAR X-band
UA	Ukraine
UAE	United Arab Emirates
UCISAT	University of California, Irvine Satellite
UHF	Ultra-High Frequency
UK	United Kingdom
ULA	United Launch Alliance
UNIDROIT	International Institute for Unification of Private Law
USAF	United States Air Force
WAAS	Wide Area Augmentation System