Federal Aviation
Administration

2014 Commercial Space Transportation Forecasts

May 2014

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

About the FAA 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 Title 51 United States Code, Subtitle V, Chapter 509 (formerly the Commercial Space Launch Act). 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 website:

http://www.faa.gov/go/ast

Cover: The Orbital Sciences Corporation's Antares rocket is seen as it launches from Pad-0A of the Mid-Atlantic Regional Spaceport at the NASA Wallops Flight Facility in Virginia, Sunday, April 21, 2013.

Image Credit: NASA/Bill Ingalls

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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 2014 through 2023.

The 2014 Commercial Space Transportation Forecasts report is in two sections:

- *The COMSTAC 2014 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 *2014 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) trajectories beyond orbits around the Earth.

Together, the COMSTAC and FAA forecasts project an average annual demand of 30.1 commercial space launches worldwide from 2014 through 2023, down from 31.2 launches in the 2013 forecasts. The reports project an average of 16.3 commercial GSO launches and 13.8 NGSO launches for 2014 through 2023. Figure 1 shows the combined 2013 GSO and NGSO Historical Launches and Launch Forecast. Table 1 shows the number of payloads and launches projected from 2014 through 2023.

It is 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 2014 GSO and NGSO Historical Launches and Launch Forecasts

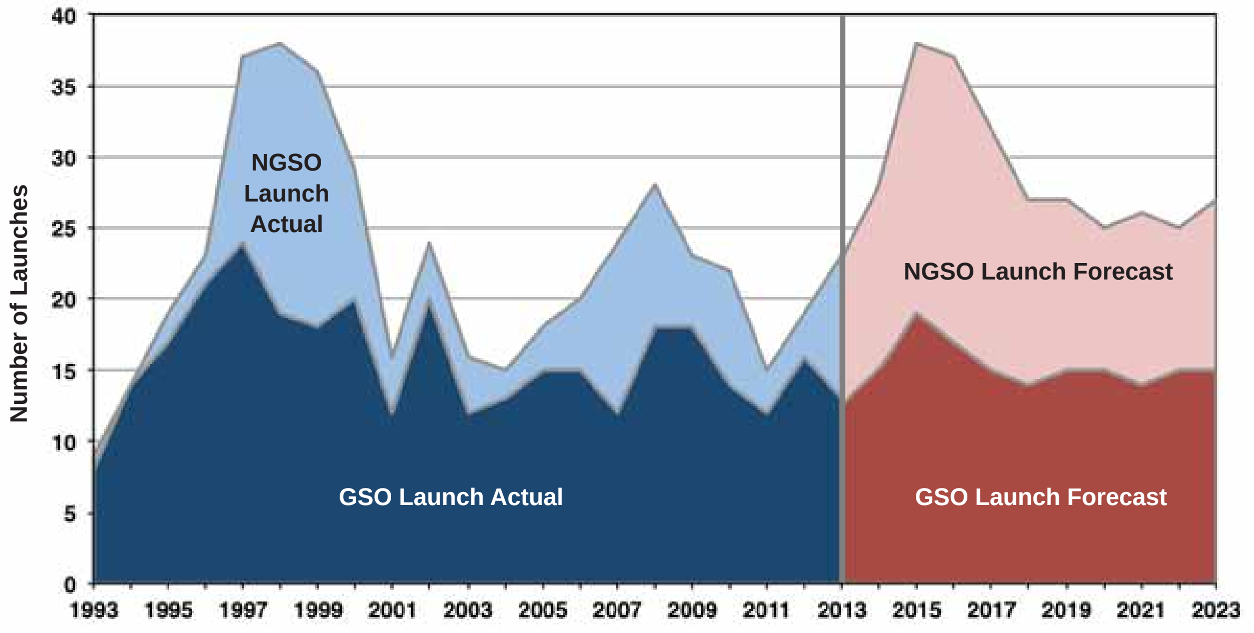


Table 1. Commercial Space Transportation Payload and Launch Forecasts

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total	Avg.
Payloads												
GSO Forecast (COMSTAC)	18	25	24	23	22	23	23	22	23	23	**226**	**22.6**
NGSO Forecast (FAA)	106	74	72	69	46	39	37	39	37	39	**558**	**55.8**
Total Satellites	**124**	**99**	**96**	**92**	**68**	**62**	**60**	**61**	**60**	**62**	**784**	**78.4**
Launches												
GSO Medium-to-Heavy	13	18	19	16	16	16	17	15	17	16	**163**	**16.3**
NGSO Medium-to-Heavy	13	18	16	14	13	10	10	10	10	10	**124**	**12.4**
NGSO Small	0	1	4	3	0	2	0	2	0	2	**14**	**1.4**
Total Launches	**26**	**37**	**39**	**33**	**29**	**28**	**27**	**27**	**27**	**28**	**301**	**30.1**

The GSO market remains stable with a projected demand of 22.6 satellites per year, virtually the same as last year. Figure 2 shows the 2014 GSO Historical Launches and Launch Forecast. Thirty-five percent of GSO satellites projected to launch from 2014 to 2023 are in the heaviest mass class (above 5,400 kilograms). At the same time, 14 percent of the satellites in the same period are in the lowest mass class (below 2,500 kilograms). In 2014, unaddressable launches remained at the comparably high level—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. 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.

The demand for commercial NGSO launches is expected to increase relatively significantly as major NGSO telecommunication constellations are replenished and NASA ISS commercial

Figure 2. 2014 GSO Historical Launches and Launch Forecast

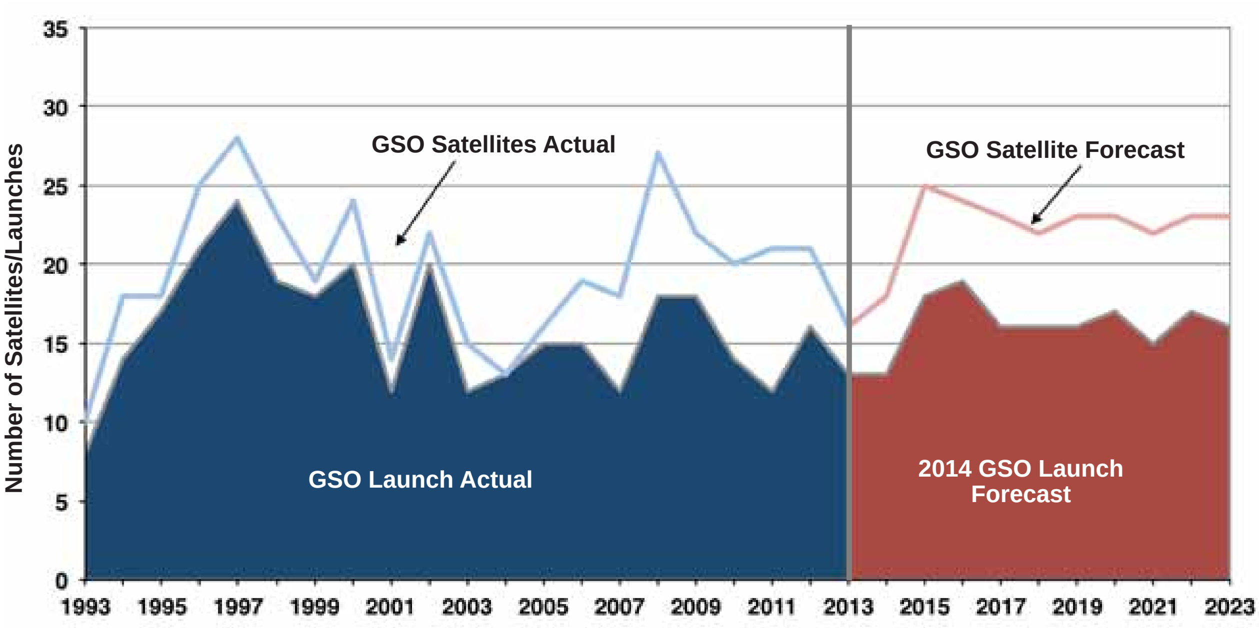
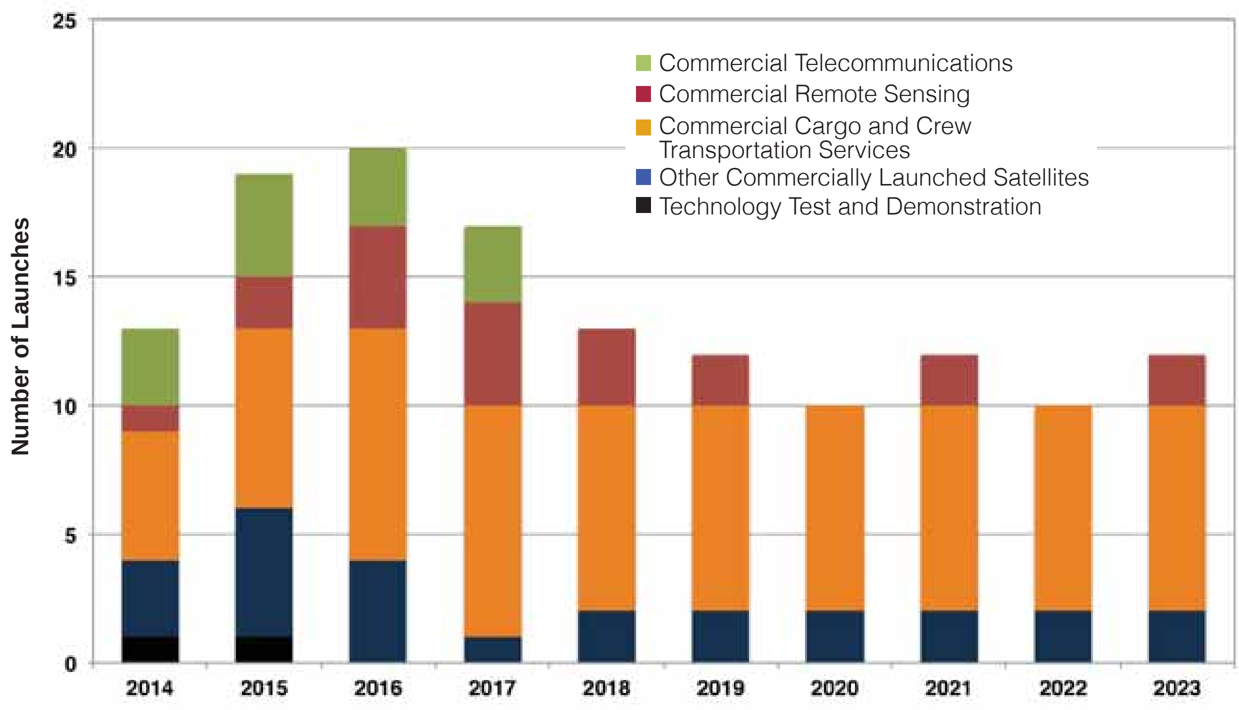


Figure 3. Projected NGSO Launches from 2014-2023



crew and cargo resupply missions become more regular. The annual average of NGSO commercial launches is expected to grow from an annual average of 6 launches a year over the last ten years to almost 14 launches annually. From 2014 to 2023, 558 payloads are projected to launch commercially, driving 138 launches with multi-manifesting. Ten more launches over the next decade are projected compared to last year's forecast of 128 launches. This increase is driven primarily by additional flights for commercial crew and cargo and commercial remote sensing. Figure 3 shows the projected NGSO launches for the next 10 years. The launches in the next 10 years are predominantly commercial launches to the ISS, which require medium-to-heavy vehicles. Ninety percent of all commercial NGSO launches during the forecast period will launch on medium-to-heavy vehicles. Compared to last year's report, the number of small launches has increased, and the number of medium-to-heavy launches has remained constant. The increase in small launches is due to the inclusion of Skybox Imaging's plans to use Minotaur C and LauncherOne to deploy its constellation. A number of new small launchers are being planned, and a number of intermediate launch vehicles have been introduced or will be introduced in the next few years. From 2014 to 2017 the report forecasts a number of small commercial satellites to be launched as Iridium, Globalstar, ORBCOMM, O3b, Planet Labs, Skybox all deploy their constellations. The number of small multimanifested satellites drops off towards the end of the forecast, but the number of launches remain relatively steady as NASA begins its commercial crew program.

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

COMSTAC 2013 COMMERCIAL GEOSYNCHRONOUS ORBIT LAUNCH DEMAND FORECAST

SUMMARY

The Commercial Space Transportation Advisory Committee (COMSTAC) for the Office of Commercial Space Transportation of the Federal Aviation Administration (FAA AST) compiled the 2013 Commercial Geosynchronous Orbit (GSO) Launch Demand Forecast (the Report). This year's Report is the 22nd 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 ten 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, satellite 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 addressable commercial GSO satellites that operators expect will be launched. The launch demand is determined by the number of addressable 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.

Figure 4. Forecast Commercial GSO Satellite and Launch Demand

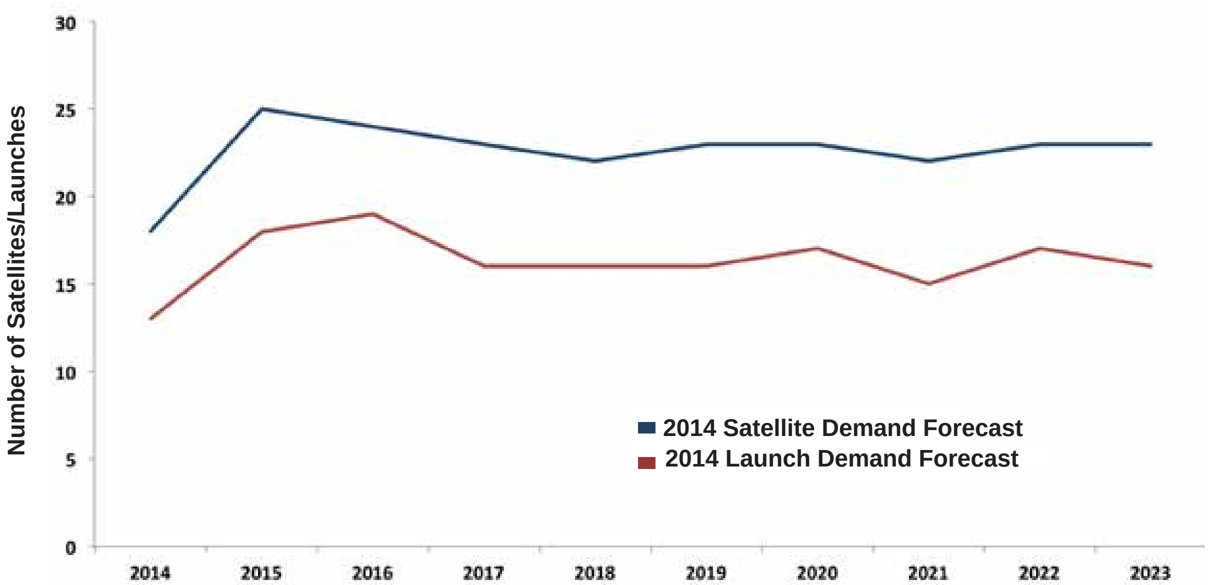


Table 2. Forecast Commercial GSO Satellite and Launch Demand

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total	Average
Satellite Demand	18	25	24	23	22	23	23	22	23	23	226	22.6
Launch Demand	13	18	19	16	16	16	17	15	17	16	163	16.3
Dual Launch Demand	5	7	5	7	6	7	6	7	6	7	63	6.3

The key findings of this report are:

- The 2014 COMSTAC GSO forecast projects 19 addressable commercial GSO satellites on 14 launches in 2014 and an annual average of 22.8 satellites on 16.5 launches for the period from 2014 through 2023.
- The number of addressable satellites launched in 2013 dropped from 2012, as a result of satellite delays and launch failures.
- While the average number of satellites to be launched in the next ten years is unchanged from last year's report, the number of launches has decreased, representing a combination of more dual-manifest launches and more unaddressable satellites.
- The satellite services market is generally robust, and new launch vehicle options have changed 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.

It is important to distinguish between forecast demand and the number of satellites that are actually launched. Satellite programs 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 with 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 19 satellites are projected to be launched in 2014, applying the realization factor adjusts this to a range of 15 to 21 satellites.

Table 3. 2014 GSO Forecast Team

Forecast Team Member	Affiliated Company
Raymond Wong	The Boeing Company
Peter Stier	Sea Launch
Alan Keisner	SpaceX
Chitta Ratana	Space Systems Loral
Kate Maliga	The Tauri Group
Keith Karuntzos	United Launch Alliance
Chris Kunstadter	XL Insurance

HISTORY OF THE REPORT

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. COMSTAC works with U.S. launch service providers, satellite manufacturers, and satellite service providers to develop the forecast. A Forecast Team of COMSTAC members and industry experts, listed in Table 3, compiled this year's Report.

One of the goals of FAA AST is to foster a healthy commercial space launch capability in the United States. In order to do this, FAA AST must understand the scope and trends of global commercial spaceflight demand. In addition, FAA AST must be able to plan for and allocate resources which may be necessary to carry out its responsibilities in licensing commercial U.S. space launches. This Report provides necessary data to FAA AST for these purposes.

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. This includes a projection of these organizations' launch plans as well as a broad, industry-wide estimate of total GSO launches. In addition, input is sought on a variety of factors that might affect satellite and launch demand.

The Forecast Team, using this input as well as 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 three years (2014–2016) of the ten-year forecast period. The combined comprehensive inputs as well as the above sources are then used to generate the longer-term demand forecast (2017 to 2023).

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 satellites 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 that are open to an 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 has increased from the 2013 forecast, as Chinese, Indian, Japanese and Russian government-owned or -supported aerospace companies continued packaging satellites, launches, financing and insurance for commercial satellites on a strategic, non-competitive basis. Figure 5 and Table 4 compare the numbers of addressable and unaddressable satellites since 1993.

Figure 5. Addressable and Unaddressable Satellites since 2005

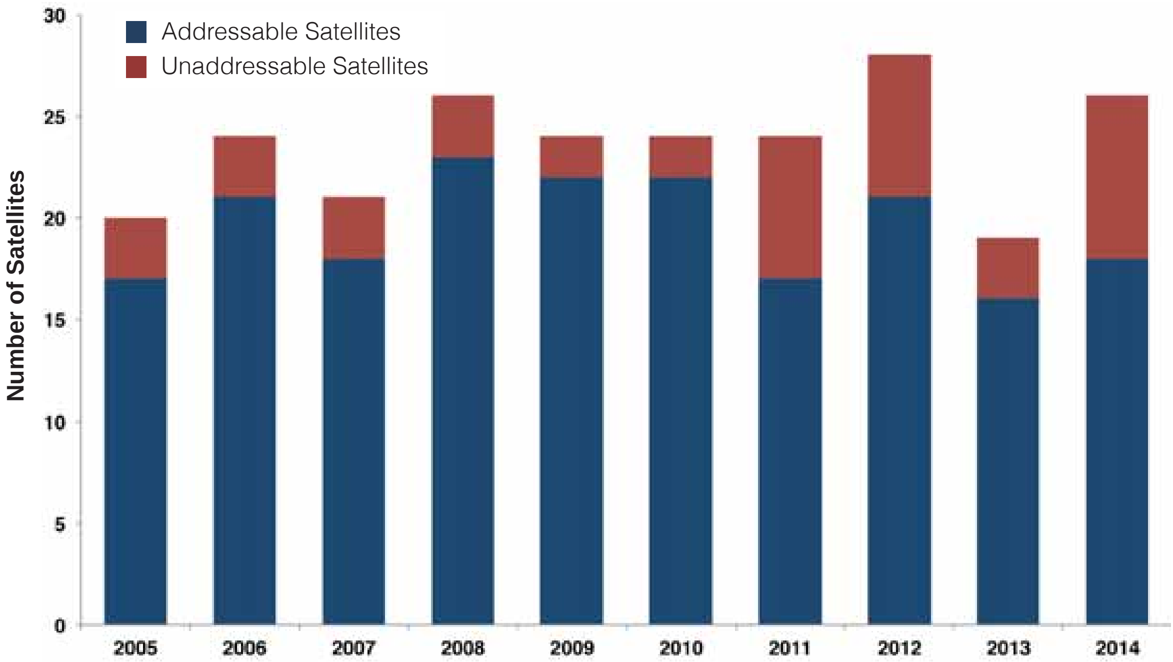


Table 4. Addressable and Unaddressable Satellites Since 2005

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Addressable	17	21	18	23	22	22	17	21	16	18
Unaddressable	3	3	3	3	2	2	7	7	3	8
Total	**20**	**24**	**21**	**26**	**24**	**24**	**24**	**28**	**19**	**26**

Mass Classes

One of the primary metrics 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.

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, SSL-1300
Intermediate	2,500 - 4,200 kg (5,510 - 9,260 lbm)	A-2100, IAI Amos, MELCO DS-2000, GEOStar, SSL-1300, Thales SB-4000
Heavy	4,200 - 5,400 kg (9,260 - 11,905 lbm)	Astrium ES-3000, BSS-702, IAI Amos, A-2100, DS-2000, GEOStar, SSL-1300, SB-4000
Extra Heavy	Above 5,400 kg (>11,905 lbm)	ES-3000, BSS-702, A-2100, SSL-1300, SB-4000

The upper limit of the smallest mass class was increased in 2008 from 2,200 kg to 2,500 kg. This adjustment captured the growth in mass of the smallest commercial GSO satellites 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. Unaddressable launches in this smallest class abound, with one to three medium class satellites being launched in most years.

One technical development that has affected the trend towards increasing satellite mass is the development of satellites using 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 be launched together.

Using electric propulsion increases the time required for orbit-raising—months rather than days. Nonetheless, in many cases, the benefits of the mass and launch cost savings outweigh the delay in achieving final orbital position.

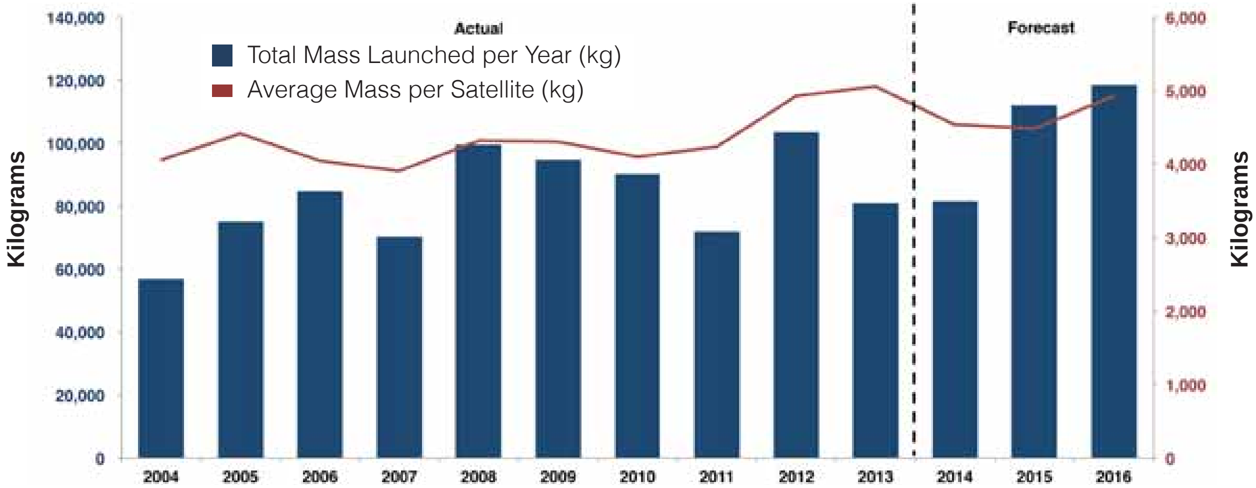
In 2012, Boeing signed a contract with Asia Broadcast Satellite (ABS) and Satmex for four all-electric design 702SP satellites. Since then, most other manufacturers of commercial communications satellites have indicated they already have—or will offer—that technology to their customers in the near future.

With the advent of all-electric propulsion satellites, this smaller mass class is expected to grow in the next three years.

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

	Actual									Forecast		
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total Mass Launched per Year (kg)	75,166	84,881	70,314	99,479	94,670	90,171	72,057	103,499	80,916	81,601	112,070	118,311
Average Mass per Satellite (kg)	4,422	4,042	3,906	4,325	4,303	4,099	4,239	4,929	5,057	4,533	4,483	4,930

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



Likewise, the heaviest mass class continues to dominate, with 56% of satellites launched in 2013 falling into this mass class. As the smallest mass class grows, the extra-heavy mass class is expected to decrease to 38% of the satellites projected for launch from 2014 through 2016.

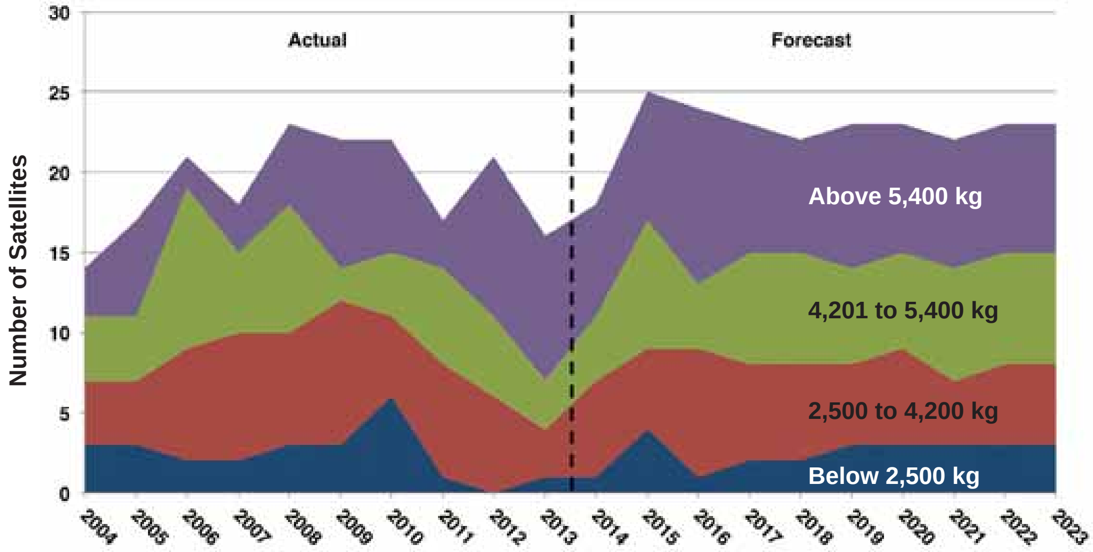
Figure 6 and Table 6 show the total mass launched per year and the average mass per satellite launched. The total mass launched per year correlates with the number of satellites launched per year. The average mass of satellites launched in the past nine years was over 4,000 kg, reaching a new high of over 5,000 kg in 2013. The average mass in 2014 is expected to reduce slightly. The 20 satellites scheduled for launch in 2014 have a mass of 89,968 kg, for an expected average satellite mass of 4,498 kg.

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

Table 7. Trends in Satellite Mass Class Distribution

	Actual									Forecast										Total 2014 to 2023	Avg. 2014 to 2023	% of Total 2014 to 2023
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023			
Above 5,400 kg	6	2	3	5	8	7	3	10	9	7	8	11	8	7	9	8	8	8	8	82	8.2	36%
4,201 - 5,400 kg	4	10	5	8	2	4	6	5	3	4	8	4	7	7	6	6	7	7	7	63	6.3	28%
2,500 - 4,200 kg	4	7	8	7	9	5	7	6	3	6	5	8	6	6	5	6	4	5	5	56	5.6	25%
Below 2,500 kg	3	2	2	3	3	6	1	0	1	1	4	1	2	2	3	3	3	3	3	25	2.5	11%
Total	**17**	**21**	**18**	**23**	**22**	**22**	**17**	**21**	**16**	**18**	**25**	**24**	**23**	**22**	**23**	**23**	**22**	**23**	**23**	**226**	**23**	**100%**

Figure 7. Trends in Satellite Mass Class Distribution



Dual-Manifesting

Several launch services providers are capable of lofting two satellites simultaneously into geosynchronous transfer orbit (GTO), and these capabilities are factored into the launch demand forecast. The demand analysis for launch vehicles must take into consideration this capability. Care must be taken in that inclusion into the forecast must be based upon the addressability of each of the satellites flown. A launch vehicle which has the launch services competitively procured for both satellites is included in the forecast and counted as dual launch. A vehicle which has only one of the two satellite launch services contracts competitively procured is also included in the forecast but counted as a single launch. A vehicle which has the launch services of both satellites directed to a specific launch service provider is not counted in the forecast as such services are not competitively procured.

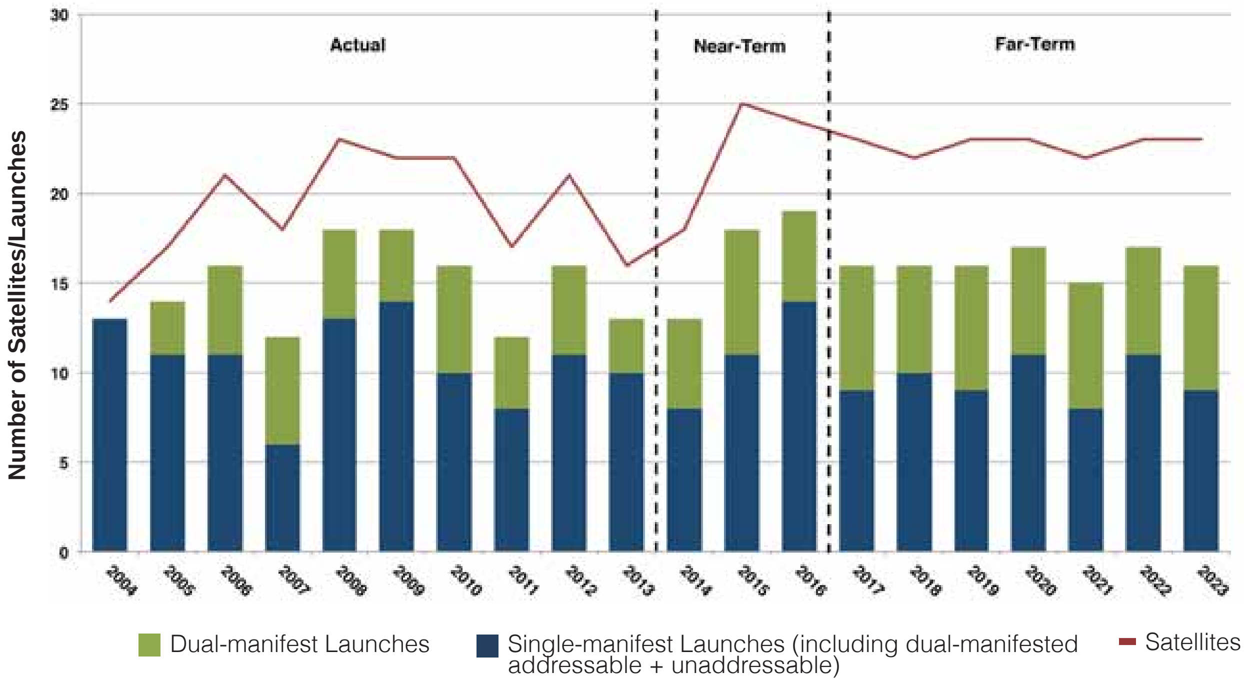
Arianespace's Ariane 5 vehicle has been launching dual-manifested, competitively-procured, commercial launch services missions for over ten years. The Forecast Team determined the near-term number of dual manifest launches on Ariane 5 by assessing the existing backlog of satellites through 2016. International Launch Services' Proton M vehicle has flown several dual-manifested missions, typically with at least one Russian-built (unaddressable) satellite. SpaceX's Falcon 9 has two orders to fly in dual configuration, pairing Boeing-built electric propulsion satellites for Asia Broadcast Satellite and SatMex.

Dual-manifesting for two satellites in the Heavy and/or Extra Heavy mass classes is not yet possible. Arianespace typically attempts to match satellites that together have a total mass approaching 10,000 kg. As Europe considers a follow-on vehicle for the Ariane 5, one option is the Ariane 5ME (Mid-life Evolution) which would raise the operational capability by 10% or more by 2018, thus enabling Ariane 5 ME to carry two large-class satellites.

The debut of SpaceX's Falcon Heavy launch vehicle will also permit dual manifesting of larger satellites. The introduction of electric propulsion technology over time however may partially reverse the trend of growth in overall satellite mass, allowing more dual manifesting on existing launch vehicles.

Figure 8 presents the 2014 single- and dual-manifest satellite and launch demand forecast from 2014 through 2023, and the actual launch statistics from 2004 through 2013. The Forecasting Team projects that after the next three years, the number of dual manifest launches within the addressable market area will stabilize at seven per year, despite the European Space Agency (ESA) developing the single-manifest Ariane 6, which will supercede the Ariane 5 in the next decade. While the retirement of the Ariane 5 would preclude Arianespace from contracting for larger dual manifest missions, the other launch service providers will have already developed and launched their own dual manifest solutions. However, this capability transition to other launch vehicles is not expected to impact the number of dual manifest launches over the rest of the decade. Figure 8 shows the satellite and launch demand forecast from 2014 to 2023 as well as actual launch statistics for 2004 through 2013.

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 2014 to 2016 show an increase in the number of satellites to be launched over the previous three years (2011-2013).

Table 8. Commercial GSO Satellite Near-Term Manifest

	2014			2015			2016		
Total	18			25			24		
Below 2,500 kg	1			4			1		
		GSAT 14	GSLV	DM	ABS 2A	Falcon 9		PSN 6	TBD
				DM	ABS 3A	Falcon 9			
				DM	Satmex 7	Falcon 9			
				DM	Satmex 9	Falcon 9			
2,500 - 4,200 kg	6			5			8		
	DM	Athena-Fidus	Ariane 5	DM	ARSAT 2	Ariane 5	DM	Amazonas 4B	Ariane 5
	DM	Amazonas 4A	Ariane 5	DM	GSAT 16	Ariane 5	DM	Brisat	Ariane 5
	DM	Optus 10	Ariane 5	DM	Hispasat AG1	Ariane 5		BulgariaSat	Falcon 9
	DM	ARSAT 1	Ariane 5	DM	Intelsat 34	Ariane 5		Thaicom 8	Falcon 9
	DM	GSAT 15	Ariane 5	DM	Sky Mexico 1	Ariane 5		JCSAT 15	TBD
		Thaicom 6	Falcon 9					JCSAT 16	TBD
								Palapa E	TBD
								Intelsat 36	TBD
4,201 - 5,400 kg	4			8			4		
		Turksat 4A	Proton M	DM	Sicral 2	Ariane 5	DM	DSN 1	Ariane 5
		Asiasat 8	Falcon 9	DM	Thor 7	Ariane 5		Mexsat 2	Ariane 5
		Asiasat 6	Falcon 9		Amos 6	Falcon 9		SES 10	Falcon 9
		Turkmen 1	Falcon 9		JCSAT 14	Falcon 9		Telstar 12V	H-IIA
					SES 9	Falcon 9			
					Eutelsat 9B	Proton M			
					Mexsat 1	Proton M			
					Turksat 4B	Proton M			
Above 5,400 kg	7			8			11		
	DM	ABS 2	Ariane 5	DM	BADR 7	Ariane 5	DM	Echostar XVIII	Ariane 5
	DM	Astra 5B	Ariane 5	DM	DirecTV 15	Ariane 5	DM	Echostar XIX	Ariane 5
	DM	MEASAT 3B	Ariane 5	DM	Eutelsat 8WB	Ariane 5	DM	Intelsat 29E	Ariane 5
	DM	Intelsat 30	Ariane 5	DM	NBN 1A	Ariane 5	DM	Intelsat 33E	Ariane 5
	DM	DirecTV 14	Ariane 5	DM	Star One C4	Ariane 5	DM	Jabiru 1	Ariane 5
		Eutelsat 3B	Zenit 3SL		Inmarsat 5F2	Proton M	DM	NBN 1B	Ariane 5
		Astra 2G	Proton M		Inmarsat 5F3	Proton M	DM	Sky Brasil 1	Ariane 5
					Intelsat 31	Proton M	DM	Star One D1	Ariane 5
								Viasat 2	TBD
								Eutelsat 65WA	TBD
								Inmarsat 5F4	

DM = Potential Dual-Manifested Satellites

* = Satellite proposed, not yet identified publicly

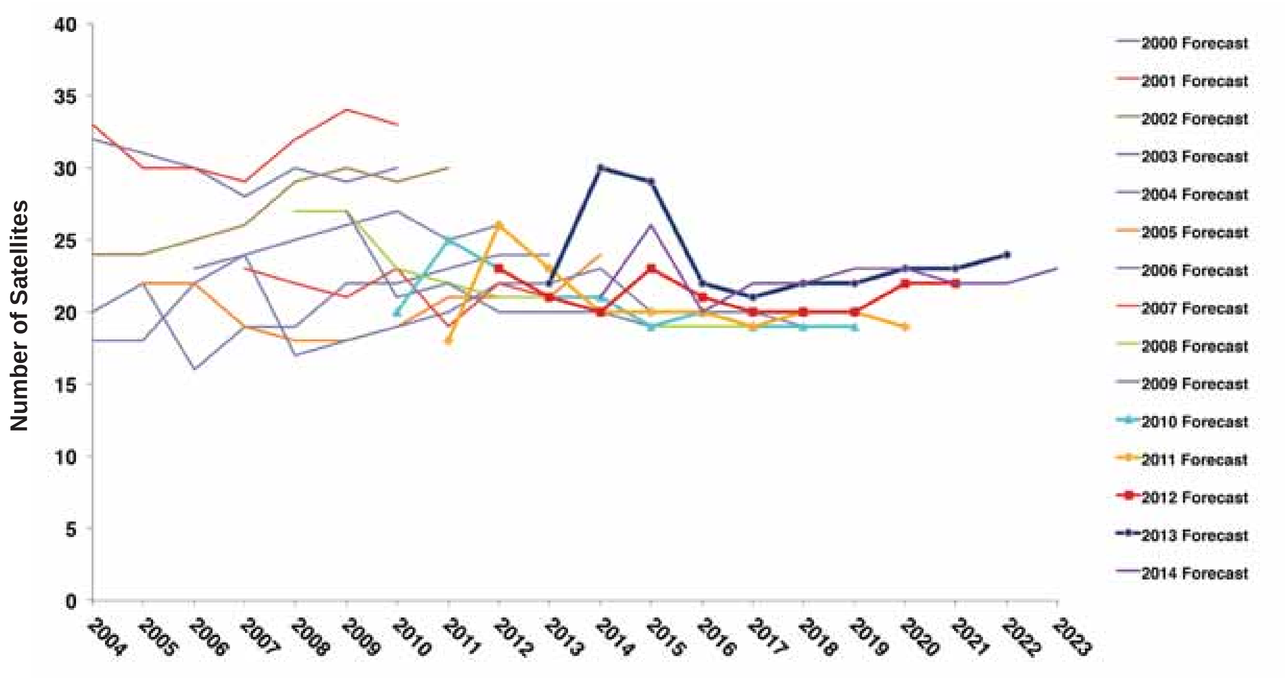
Comparison with Previous COMSTAC Forecasts

The current forecast continues the slight increase in average annual launches for the next ten years as seen in the 2013 Report. The average number of satellites from the 2004 to 2013 Reports was in a narrow range—between 20.5 and 21.8 satellites. The 2014 Report shows an average of 22.8 satellites to be launched each year, unchanged from the 2013 Report.

The 2013 Report projected 21 satellites to be launched in 2013. The reduction to 16 satellites actually launched in 2013 reflects:

- Satellite and launch vehicle technical issues,
- Changing business climate for several operators who encountered financial issues, and
- Reclassification of several launches as unaddressable

Figure 9. Comparison of Annual Forecasts: 2004-2023



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 science missions have specific launch 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 free up launch slots 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

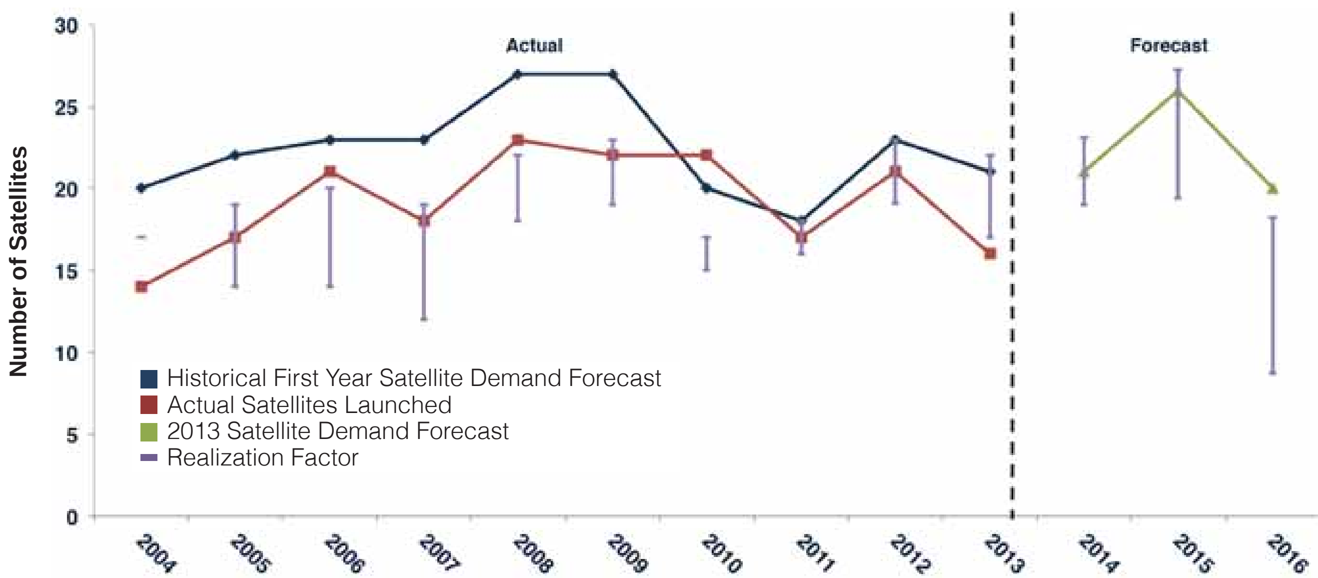
Over the history of this Report, the forecast demand for satellites and launches has almost always exceeded the number of satellites and launches actually accomplished in each of the first three years of a forecast period. To better estimate the number of near-term satellites that will be launched, the 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. Since 1993, the actual number of satellites launched in the first year of the forecast was 58% to 110% of the forecast number, with an average of 80%. For the past five years, the range was 80% to 110%, with an average of 91%. Based on this methodology, while 20 satellites are forecast for launch in 2014, the expected realization for 2014 is 16 to 22 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 48% to 105%, with an average of 77%. For the past five years, the range was 68% to 105%, with an average of 82%. Using the same methodology, while 27 satellites are forecast to be launched in 2015, the expected realization for 2015 is 18 to 28 satellites.

Figure 10. Realization Factor



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

As shown in Figure 10, the 2013 report forecast 20 satellites for launch in 2013, with a realization range of 14 to 22 satellites. 16 satellites were actually launched in 2013.

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

Demand for satellite services continues to be strong in certain regions, 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, especially the expansion into emerging markets that lack a fiber-based infrastructure;
- improved economic standards creating an expanded middle class with available discretionary incomes;
- adoption of common practices and standards;
- increased deregulation of the telecommunications sector and the use of new frequencies;
- development of cost-effective personal mobile voice, data, and broadband devices;
- consumer demand for data-rich content, such as UltraHD and 3D TV, that will require more bandwidth;
- demand for aeronautical broadband (e.g., WiFi on commercial aircraft)
- increased travel and cultural integration;
- adoption of commercial solutions by governments to supplement defense and military capabilities;
- revolution in software applications, creating new information portals for consumer.

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 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 growth 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.

Mobility

The global demand from enterprises and consumers for mobile communications has expande 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 operators JetBlue and United Airlines with DirecTV service for their passengers, rental car fleets featuring Sirius Satellite Radio, and emergency services such as OnStar expanding beyond General Motors vehicles. 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 SkyPerfect 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 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 communications. The U.S. Department of Defense has decreased its demand for commercially procured bandwidth with the drawdown of troops in Iraq and Afghanistan. However, satellite operators have been able to find other customers to make up for this drop. 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 SkyPerfect, South Korea's KT, and Singapore's SingTel/Optus.

Broadband Services

The broadband 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 Avanti in the UK and NewSat and NBN in Australia. INMARSAT is deploying 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. 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, and plans to rejuvenate that system.

INMARSAT continues to perform strongly with steady demand in its vertical enterprise markets as it deploys 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 successful and is considering system expansion 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 Service (DARS)

DARS remains an exclusively North American product since the merger of XM Satellite Radio and Sirius Satellite Radio. DARS revenue grew six percent this year, satellite radio growth tracks with car sales. In 2013, car sales in the United States were up 11 percent. 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 broadband 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.

Satellite Technologies

All-Electric Satellites

Advances in satellite propulsion technology are gaining traction in the market. Hybrid systems utilizing electric propulsion for north-south stationkeeping reduce fuel loads, resulting in lower separated mass than satellites with traditional all-chemical systems. These solutions have been in the market for almost two decades but are finding increased commercial appeal as payloads become larger and more complex. Hybrid systems capable of electric orbit raising offer even greater separated mass saving by augmenting a portion of the traditional chemical orbit raising with higher efficiency electric propulsion.

The all electric satellite technology, offered from major manufacturers like Boeing and SSL, is compelling for an operator looking to lower their capital expenditures (CAPEX) needed to build and launch a GEO commercial satellite. Because all electric satellites have significantly lower mass than traditional bi-propellant systems, two of these satellites can be launched on the same launch vehicle in a stacked configuration. Dual launches offer a potential savings of 20-50% from the launch costs alone and can help operators close business cases that did not seem feasible before.

A drawback to all electric satellites is orbit raising schedules of six months longer than conventional all-chemical satellites, but their lighter mass allows all-electric satellites to carry larger payloads on a smaller platform. Operators will need to evaluate the financial and schedule impacts between all-electric and traditional satellite offerings.

The impact from all-electric offerings for the launch market is still unclear. All-electric satellites are often designed for a stacked dual-launch configuration, which, in theory, would halve the number of launches for these satellites. However, some of the all-electric awards could be for new business opportunities that moved forward with help from the dual launch savings. As more all-electric satellites are ordered, this will provide clues on how operators plan to incorporate the satellites into their fleets.

Laser Communications

In the future, operators will have the capability to connect their GEO commercial satellites to terrestrial ground stations via laser links. As shown in tests by NASA and other space agencies, laser communications offers orders of magnitude higher data rates than traditional radio frequency communication and may prove useful for deep space exploration. Implementing a laser communication system will also save mass and reduce power on the satellite. For higher bandwidth applications like High Throughput Satellites (HTS), laser communications will help provide higher throughput, especially where spectrum is limited. However, because laser links can be attenuated by cloud cover, several ground terminals in diverse regions would be needed to guarantee the quality of service to the end-user.

The impact of laser communications on the launch vehicle market is probably minimal. Laser communications is not applicable to all satellite missions, and thus will be limited to applications involving large data transfers. Lasers will be enhancements to the existing payloads or add-ons to provide links for certain functions, rather than creating an entirely new market for laser communication satellites.

Spectrum Limitations and Orbital Slot Limitations

The lack of available spectrum at the commonly-used C- and Ku-band frequencies and orbital slots makes it challenging for new satellite operators to enter the market and for existing operators to expand their business unless they consider acquiring a competitor or developing alternative spectrum (such as Ka-band). This was demonstrated by Eutelsat's recent acquisition of Satmex, that allowed the company to control new orbital slots with access to fast-growing Latin American markets. In other instances, operators have co-operated on developing or preserving an orbital slot. In 2014, AsiaSat will place a satellite in Thaicom's 120°E longitude orbital position. In return, Thaicom will have access to the C-band transponders on the satellite. This agreement allowed Thaicom to preserve its orbital slot and provided expansion opportunities for AsiaSat.

Additional spectrum is available in the FSS (Fixed Satellite Services) Planned Bands, which were established by the ITU to create equitable access to spectrum and orbital slots especially for smaller, relatively-undeveloped countries. The Broadcasting Satellite Service (BSS) Planned Bands are widely used for one-way, direct-to-home television services (DirecTV and Dish in the US, and SES and Eutelsat in Europe), but the FSS Planned Bands have hardly been exploited. Through the exercise of the ITU Plan in the ITU Radio Regulations (Appendix 30B), these smaller countries can gain access to C- and Ku-band frequencies that are distinctly different from the commonly used ("unplanned") C- and Ku-band frequency sets.

With the launch of the Vinasat 1 and 2 satellites, Vietnam has become one of the early adopters of Planned C- and Ku-band. The Vinasat 1 and 2 spacecraft are located at 132° east longitude, which enables Vietnam's access to satellite communications without causing or receiving harmful interference from neighboring satellites.

Leveraging existing orbital locations and using Planned Bands can play an important role in the expansion of satellite communications. An orbital slot that is fully utilized for conventional unplanned C- and Ku-bands in the Northern Hemisphere can also be developed for the same unplanned bands in the Southern Hemisphere. In addition, the same slot can be developed for the Planned C- and Ku-bands. These strategies may provide a modest, medium-term stimulus in the launch market as new satellites are built for these areas. However, as spectrum and slots get increasingly congested, launcher demand is likely to shift to replacement satellites.

New Applications

4K and 8K UltraHD

The 4K version of UltraHD (UHD) TV provides four times the resolution of Full HD 1080p TV channels, and, as a result, transmission of 4K UHD will require a substantial increase in bandwidth (in comparison to HD TV), with some experts reporting that 50% more bandwidth will be required for UHD. Video compression techniques being developed as part of the latest video encoding and transmission standard (High Efficiency Video Coding or HEVC) are playing a key role in setting the bandwidth and data rates that will be required for reasonably reliable transmission of UHD. The 8K version of UltraHD TV provides 16 times the resolution of Full HD 1080p TV channels. While many are working on 4K programming and hardware, NHK of Japan is skipping 4K altogether and working on 8K technologies, with the goal of broadcasting the 2020 Tokyo Olympic Games in 8K.

The rollout of 4K video could cause an increase in the number of transponders that are required to deliver DTH video and broadcast and cable channel distribution. It is not yet clear if the DTH operators are actively planning to support 4K video. If cable operators decide to support 4K video, the broadcast and cable networks are likely to require additional C-band capacity, along with the use of HEVC and higher-order modulation schemes. How this will drive overall demand for satellites is uncertain. It remains to be seen if compression and modulation can keep pace with the 8K video rollout in the long term.

In-Flight Connectivity

There are many players in the in-flight WiFi market space. Whereas Panasonic, OnAir, Row 44, and others use satellites links, GOGO mainly uses an air-to-ground (ATG) network to connect its planes. Though the number of connected aircraft has increased, the take rates for in-flight connectivity are currently below expectations. This is forecasted to change as more passengers have smartphones or tablets and as rules are relaxed for the use of personal electronic devices during all phases of flight.

As the demand for in-flight connectivity increases, the service providers will have to choose between an ATG, satellite or hybrid ATG/satellite network. For satellites, they also must choose between L-band, Ku-band and Ka-band systems. INMARSAT's Global Express satellites, along with Viasat 2, may provide some of this required additional capacity. However, as the market increases, there will be more satellite orders to meet bandwidth demands for in-flight connectivity.

High-Throughput Satellites (HTS)

High-throughput satellites employ frequency re-use and spot beams to increase the satellite bandwidth over traditional, bent-pipe payloads. In recent years, the HTS market was driven by Ka-band, broadband applications to the consumer market, led by satellite orders from Hughes Network Systems and Viasat. Intelsat is replacing some of its FSS satellites with its high-throughput Epic satellites starting in 2015. Intelsat's goal is to reduce the price per megabit charged to the customer, while at the same time, increasing the revenue generating capacity of the Epic satellites over conventional ones at some of its prime orbital locations.

HTS systems are very compelling for providing additional bandwidth to customers at a lower price point than traditional offerings. As demand for data increases, such as for in-flight connectivity or cellular backhaul, HTS orders are likely to grow. These dedicated HTS systems would be similar to the Jupiter-2 and Viasat-2 satellites. For operators like Intelsat, a HTS system could reduce their fleet count by providing double or triple the capacity on-orbit over traditional FSS satellites. Other operators could add a high-throughput payload on a replacement satellite. Though orders for high-throughput payloads and satellites will increase, the net effect of this surge on the launch vehicle market is unclear.

On-Orbit Servicing

There have been several commercial forays into the satellite servicing market in recent years. In March 2014, ViviSat announced the booking of three missions to use its Mission Extension Vehicles (MEV), a platform that will connect to a GEO commercial satellite and take over attitude and control functions while the host satellite continues to operate its functional payload. ViviSat hopes to start the construction of these specialized vehicles by the end of 2014 pending completion of financing. In 2011, Canada's MacDonald Dettwiler and Associates (MDA) Corporation also announced plans for an in-orbit servicing vehicle with hopes of demonstrating the capabilities on Intelsat satellites. However, MDA changed its plans in 2012 in order to support government-sponsored satellite servicing initiatives.

Government agencies have also been active in this area. NASA launched its Robotic Refueling Mission in 2011, with the first phase demonstration successfully completed in 2013. Phase 2 demonstrations are expected to be carried out in 2014, and build upon the previous tests of robotic arms, tools and sensors. In 2012, the DLR Space Administration (Germany) announced plans to demonstrate in-orbit servicing and related technologies with the construction of a client and servicer vehicle as part of its DEOS project, to be launched in 2018.

The U.S. Defense Advanced Research Projects Agency (DARPA) Phoenix project is also focused on satellite servicing and new ways to access space. Phoenix's goal is to develop and demonstrate technologies that make it possible to inspect and robotically service co-operative space systems in GEO, and to validate new satellite assembly architectures. Phoenix has achieved promising Phase 1 results, and in 2013 it awarded prime contracts to eight companies for its Phase 2 efforts.

If successful, the start of on-orbit servicing and life extension missions may push out replacement orders for some GEO commercial satellites. Eventually, however, many of these satellites will still need to be replaced, and thus the overall launch vehicle demand may not change.

Competition from LEO Systems

The GSO market is seeing competition emerging from constellation systems deployed in LEO, particularly in the market for enterprise and consumer broadband services. Major GEO broadband service providers include:

- Intelsat with its open architecture Epic series of high throughput satellites for C-, Ku-, and Ka-band overlay for fixed and wireless broadband, media customized solutions, mobility sectors, and government applications on thick and thin route traffic;
- INMARSAT's Global Xpress Ka-band system as the first worldwide mobile satellite system providing broadband services to the maritime and aeronautical sectors;

- ViaSat with its series of high throughput satellites based on a new satellite architecture and innovative ground system that maximizes total bandwidth throughput to transform satellite broadband economics and the quality of the user experience for coverage of rural and remote areas in North America; and
- Echostar with its Jupiter platforms also providing broadband services coverage to North America.

Arabsat, Eutelsat, Avanti, Hispasat, SES, NBN, and Telesat also have or plan to have broadband Ka-band packages on FSS satellites or dedicated Ka-band spacecraft offering broadband services within their operating regions.

These GSO operators are being challenged by MEO operator O3b, which touts its next-generation global network as combining the reach of satellite with the speed of fiber, providing enterprise mobile backhaul, consumer and government customers with affordable, low-latency, high-bandwidth connectivity. O3b believes its competitive advantage lies in the low latency experienced with its MEO satellite system compared to that from GEO, which can be up to 4 times greater to improve the quality of the end user's experience. O3b notes that certain classes of services are more susceptible to the effects of network latency, including real time video and voice and voice messaging, and real time data uplink and downlink and transactional data. O3b notes that latency has a major impact on web commerce, with significant loss of e-commerce sales lost due to poor website performance when the purchaser experiences signal disruptions and loss of interactive connectivity.

End users perceive latency increases of a few hundred milliseconds in a negative way which can translate into loss of business for providers and advertisers. O3b also notes that major providers of web video streaming now using TCP transport, so the latency impact on the degraded user experience will be the same for Internet video streaming as it is for data file transfer. O3b believes the quality of the user experience from its MEO system will enable measurably improved voice quality, dramatically improving the response of interactive applications enabling such as interactive gaming, and reducing file download times by 60%.

O3b is beginning service with 8 satellites from MEO but intends to ultimately operate 20 satellites to backhaul broadband traffic to connect underserved and poorly served populations between 45 degrees north and 45 degrees south latitude. Competition will therefore be quite strong for consumers and government broadband users for applications such as web browsing, file sharing, VOIP, video on demand, video conferencing, internet television, and real time internet gaming and other services. Global capacity requirements are expected to reach 480 Gbps by 2021 with over 10 million consumer broadband via satellite subscribers. The race is on between GEO and LEO providers for end-users and revenues.

Hosted Payloads

Hosted payloads are payloads that are typically too small to justify a dedicated mission due to payload size, budget, 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, GPS and WAAS (Wide-Area Augmentation System), 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 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 SSL to host a Laser Communications Relay Demonstration 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.
- Inmarsat added hosted payloads to its three Boeing-built Inmarsat 5 Ka-band satellites.
- ESA, the European Commission, and Eurocontrol (the 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 is hosted aboard SES 5 (built by SSL) and the second on 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 include Boeing, Intelsat, Iridium, Lockheed Martin, Orbital, SES, and SSL.

Launch Service Providers

Competition has increased in the GEO communications satellite launch services market with new entrants debuting capabilities, existing providers investing to improve their product and service offerings, and others waiting in the wings to enter the marketplace. Communications satellite launch service awards will be based more than before on overall best value as perceived by satellite operators, with key factors being proven reliability, schedule assurance, manifest availability, available scheduling, and a compelling value proposition.

In the past twelve months, SpaceX has launched several satellites into GTO for commercial satellite operators. Falcon 9 can deliver ~4,850 kg into GTO from CCAFS. The company is developing the Falcon Heavy launch vehicle which will be capable of lofting ~21,200 kg into GTO from CCAFS when operational in 2015 to address the intermediate and heavy mass segments of the commercial satellite market.

Arianespace is seeking to improve its competitiveness in the commercial GTO marketplace with investments in Ariane 5 ME (Mid-life Extension) program, which will increase capacity from ~9,400 kg today to ~11,300 kg by 2018. This will enable Ariane 5 to carry two large satellites simultaneously as opposed to pairing one small/medium and one large satellite today. Additionally, ESA is funding development of Ariane 6 to be operational in 2021 to provide single satellite launch capability across the payload mass spectrum to be more price-competitive. Although capable of placing a medium mass payload into GTO from Kourou, the Soyuz vehicle appears to be dedicated to flying missions to LEO for now.

International Launch Services (ILS) continues to upgrade its Proton M/Breeze M vehicle to eventually be capable of lofting >6,900 kg into GTO from Baikonur. Introduction of a 5 meter payload fairing in 2016 will allow deployments of satellites with mass up to 5,850 kg. ILS has demonstrated dual payload capability several times. The company has recently instituted a series of quality management reforms, streamlined production at its Khrunichev facilities, and reduced payload processing times at Baikonur. The company hopes to increase its launch rate to 12-14 per year from its current rate of 6-8 per year. Proton M is to be phased out by 2020 as is Baikonur launch complex and replaced by the modular and less-costly Angara family of boosters launched from Russia's Far East. The Russian government recently announced a ~$50B investment in the space sector through 2020 to regain world class capabilities, including in affordable launch vehicles.

Sea Launch recently completed a return-to-flight mission following a failure in 2013. Sea Launch's parent organization, RSC Energia, has pledged its support for Sea Launch and, in cooperation with the Russian Space Agency, is in the process of creating a strategy that will expand the addressable market for the Zenit-3SLby increasing the Zenit-3SL's lift capacity to 6,700 kg and introducing fairing modifications. The Land Launch Zenit-3SLB/F remains in the market for lofting small/medium satellites to GTO from Baikonur.

Japan recently contracted with Canada's Telesat for a commercial launch of a GEO communications satellite, Telstar 12V, and India is considering launching commercial satellites to GTO. In September 2012, Mitsubishi Heavy Industries, Ltd (MHI) took responsibility for H-IIA's launch service operations. The H-IIA vehicle can loft up to 5800 kg to GTO. India's Space Research Organization (ISRO) plans to debut its new GSLV Mark III vehicle which is capable of lofting ~4,000 kg to GTO.

China remains very active in launching domestic and foreign satellites, with unaddressable launches for operators in countries such as Sri Lanka, Pakistan, and Laos. One satellite manufacturer in Europe has developed "ITAR-free" satellites to appeal to satellite operators to take advantage of the lower cost of Chinese launchers.

Lockheed Martin has begun to pursue reentry into the commercial GTO market using the Atlas V launch vehicle from its 50%-owned subsidiary, United Launch Alliance. Lockheed Martin hopes to leverage the large U.S. government backlog of ULA to offer the Atlas V at a competitive price, while touting the vehicle's reliability.

Others, including South Korea with its KSLV launch vehicle and Brazil and Ukraine with their Tsyklon-4 launch vehicle, have considered eventually entering the commercial GSO market.

Multilaunch Services Agreements

Larger commercial GSO satellite operators have used multi-launch agreements to secure favorable price discounts and launch slots. Some reservations may be options in that either no down payment is paid, or are placeholders without specifically-named satellites. Multi-launch services agreements will not have an impact on driving demand for launch services but will simply change the mix of launch services providers.

Cooperation and Partnerships

Satellite operators continue to pursue satellite and orbital slot sharing strategies to realize their business objectives. Partnerships provide access to orbital slots otherwise unavailable to some operators as well as local market access and relationships. Partnerships can also allow operators to share satellite infrastructure costs and close business plans that they might not be able to independently. There have been numerous examples of satellite/orbital slot partnerships, including Measat/Azercosmos, Measat/Newsat, Asiasat/Thaicom, Eutelsat/Nilesat, SES/Gazprom, and Intelsat/JSAT.

Several European and Russian satellite manufacturers recently announced the formation of joint-ventures to target the Russian and international satellite markets. Thales and ISS-Reshetnev formed a new company, Universum Space Technologies, to manufacture hardware in Russia that could match the exacting standards set by U.S. and European companies. The other joint venture, Energia Satellite Technologies, is a partnership between RSC Energia and Astrium. Energia SAT will focus on satellite services and the exchange of technologies and know-how in the manufacturing, assembly and test of equipment and satellite systems. The new companies will target several Russian government telecommunications programs in the near term, while raising their own technical and quality standards to compete in the future against U.S. and European builders.

Geopolitical Influences on Launch Vehicle Demand

Geopolitical factors may influence the U.S. licensed launch demand during the forecast period. At the time of this document, the Russo-Ukrainian conflict had escalated to the point whereby the United States and the European Union have imposed additional sanctions against Russia.

The impact to U.S. licensed launch demand of these sanctions may be a delay of satellite projects, or a realignment or change of commercial customers' launch providers.

Impact of International "Government to Government" Satellite Delivery in Orbit Sales

One of the factors influencing market demand for U.S. licensed launch activity is that of international governments brokering turnkey space solutions involving the purchase and financing of the manufacture, launch and insurance coverage of satellite programs.

Countries such as China, India and Russia have sold GEO communications and remote sensing satellites under "Delivery-In-Orbit" contracts with developing countries such as Angola, Belarus, Bolivia, Brazil, Egypt, Nigeria, Pakistan, Turkmenistan and Venezuela. These sales are often politically-driven, with satellites sometimes provided on a strategic, non-competitive basis in exchange for access, or for the direct barter of natural resources.

Characteristically targeted towards countries that do not have their own satellites in orbit, these procurements are approximately fifteen percent of global commercial GEO launches, thereby decreasing the overall addressable market of available launches for U.S. licensed launch vehicles.

This trend is expected to grow as the quality, reliability and heritage of these exporting countries' satellites and launch vehicles continue to develop and other commercial benefits such as technology transfer and engineer training programs continue to appeal to governments.

Regulatory Environment

A multi-year export control reform initiative to reform the nation's export control regime by the Departments of State, Commerce and Defense achieved an important milestone in April 2014 with publication in the Federal Register of the first in a series of final rules revising the U.S. Munitions List (USML) and the Commerce Control List (CCL).

In early 2013, the Department of Commerce's Bureau of Industry and Security (BIS) announced a proposed rule transferring certain commercial satellite, spacecraft and related items may now return to the Commerce Control List (CCL), rather than the Department of State's United States Munitions List (USML).

Currently, additional category revisions are working their way through the interagency review process, and Category XV (satellites) is likely next in the queue, with a final rule on reforms to controls and on satellite and space items may be issued in the summer of 2014.

While it is estimated that up to 90% of existing space items presently on the USML will be transferred to CCL, the inclusion of commercial hosted payloads under ITAR could go into effect for Department of Defense-funded secondary or hosted payloads. Additionally, certain additions to the CCL have been satellite components previously not covered.

Prior to this proposed ruling, several international spacecraft manufacturers had developed commercial satellite offerings that are not subject to U.S. export control regulations, without using 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.

Eight ITAR-free commercial GSO satellites were launched between 2005 and 2012, mostly on Long March launch vehicles. Table x lists the ITAR-free satellites that have been launched since 2005.

In perhaps what is the first sign of the impact of this proposed ruling, in June of 2013, Thales Alenia switched launch providers from Long March to Space Exploration's Falcon-9 for the launch of Turkmenistan's first telecommunications satellite after the likelihood of potentially being blocked by U.S. export rules from shipping the satellite to China for launch became more evident.

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
Apstar 7	APT	Long March	3/31/2012	TAS Spacebus 4000
Chinasat 12	China Satcom	Long March	11/27/2012	TAS Spacebus 4000

The European Union pressed ahead with its "EU Space Code of Conduct" to encourage satellite operators, launch agencies, and other users of space to recognize and respond to the growing threat from space debris. While the GSO population has not yet suffered catastrophic losses due to debris, the issue is being studied closely. All 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 the geosynchronous orbit, launch activity may be affected as operators consider their response.

Financial Markets

Uncertainty still impacts global financial markets, creating mixed results for financing satellite programs. Stock markets have exhibited recent volatility with investors nervous about the slowing growth of the Chinese economy, the continuing gridlock in economic policy in the U.S., and the impacts to the U.S. economy of budget sequestration, and the overall lower growth rates in satellite company earnings and revenue streams. Traditional equity investors remain hesitant towards commercial space startups. Debt markets for satellite financing remain strong as traditional investors remain risk averse.

Even established companies with strong balance sheets are experiencing difficulty securing new debt and equity financing. The pricing of Intelsat's IPO was reduced by 22%, from $23 per share to $18 per share, with share volume offered reduced by 11%. Proceeds will be used to pay down sizeable debt which may have kept some prospective investors on the sidelines. However, general reaction by institutional investors in the run-up to the IPO was positive. This attitude was driven by the fact that the investor community has a good understanding of the company's business model and of the FSS business in general, as the company's bonds have long been traded on public market exchanges. Also aiding investors is good insight into the company's strong backlog for earnings growth now that it is entering a period of substantially lower capital investment in new satellites, where free cash flow can be directed to reduce outstanding debt. Increased exposure through public equity stock trading on global exchanges will help with investor awareness.

Export credit agency (ECA) financing continued to play a strong role in contributing to satellite business sector growth. The U.S.-based Ex-Im Bank has financed 60% of U.S. commercial satellite exports over the past two years and is expected to maintain that level. Ex-Im Bank is ramping up its support for U.S. industry to meet aggressive competition from its European counterpart, Coface, which provides significant funding and guarantees for European satellite industry export sales worldwide. The loss of financing support for Iridium's next generation satellite system secured by a $1.8B loan guarantee from Coface was a watershed moment for Ex-Im Bank, which saw jobs and economic growth migrate to vendors in France and Italy as opposed to Lockheed in the U.S. Ex-Im Bank raised its participation in the satellite financing sector from $50M per year through 2009 to $1.4B in 2012. As an example of its renewed effort to support U.S. job creation, Ex-Im Bank provided a low-interest loan of $471M to ABS to cover construction of its two Boeing all-electric satellites, a large spacecraft from SSL, and launches on SpaceX Falcon 9 vehicles. This action in turn permitted ABS to securing bank financing as lenders were more comfortable knowing there was backing by the U.S. export credit agency. Additionally, the cost-competitiveness of the all-electric platform made the project risk more palatable to lenders, turning it from a classic equity risk into an acceptable debt risk. Ex-Im Bank also recently provided an $87M loan guarantee to Hispasat to purchase a satellite from Orbital Sciences Corp even as Coface supports the satellite's launch on the European Ariane launch vehicle. New ECAs are emerging in China and Russia, to win business for domestic contractors and to provide jobs and build technological capabilities.

Given the long lead-times associated with deploying GSO spacecraft, continued access to affordable capital will remain crucial for operators. Assuming a continued steady global economic recovery, certainty in the financial markets will provide confidence for investors to move forward in offering financing for satellite operators and services providers for business recapitalization and expansion.

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 40 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 good experience in space insurance over the past decade, as well as a recovery in financial markets, there is currently an abundance of available capacity for insuring satellite launches. This has pushed pricing to historically low levels, facilitating the placement of insurance for satellite programs. Nonetheless, adverse experience in space insurance in the past year has tempered the growth of capacity, and certain technologies have experienced increased pricing and constrained insurance. 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 2013 Report.

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

Satellite Operators:

- SES
- NewSat

Satellite Manufacturers:

- Boeing
- SSL
- Thales Alenia Space

Launch Service Providers:

- Arianespace
- Sea Launch
- United Space Alliance
- SpaceX

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 2014 survey does not reflect any major changes in respondents’ perception of the industry. In the financial category, there was a slight increase in the percentage of respondents who felt global economic conditions were having a negative impact on their business plans but operators were more optimistic regarding the impact of industry consolidation and the ability to compete with terrestrial services. Technical concerns showed improvement in some areas including the availability of launch vehicles that meet requirements and the reliability of satellite systems and launch vehicles.

Slight increases are reported in terms of the impact of competition with terrestrial services, regional or global economic conditions, and the consolidation of satellite service providers. Demand for satellite services is less of an issue than in 2013, though at 71 percent this remains a concern when it comes to planning and launching satellites. Introduction of new or upgraded launch vehicles also represents a continuing issue. Reflecting continuing global economic woes, the responses to financial concerns remained somewhat negative, though less of a concern than in 2013.

Operators continue to be satisfied with the variety of satellite systems available to them. However, there are concerns that the introduction of new satellite technologies is having a negative impact on plans. Operators also had mixed opinions about launch vehicles, with the introduction of new and upgraded vehicles having some negative impact. In addition, the availability of launch vehicle continues to be an issue. The dissatisfaction with launch vehicle reliability has increased dramatically since the 2011 survey when none of the operators expressed any concerns about launch vehicle reliability, but 2014 inputs do indicate that impressions are improving. This can likely be attributed to the recent string of Proton failures and the 2012 Sea Launch failure. All of the respondents responded either neutrally or favorably to the introduction of new/upgraded launch vehicles.

Table 10. 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	2014 vs. 2013
Ability to compete with terrestrial services	0%	14%	57%	29%	0%	**Increase**
Availability of affordable insurance	0%	33%	17%	50%	0%	**Decrease**
Availability of financing	0%	29%	71%	0%	0%	**Decrease**
Demand for satellite services	0%	71%	14%	14%	22%	**Decrease**
Regional or global economic conditions	0%	43%	14%	43%	0%	**Increase**
Consolidation of satellite service providers	0%	0%	57%	43%	0%	**Increase**
Availability of required operating licenses	29%	43%	29%	0%	0%	**Decrease**
Availability of export licenses	14%	43%	29%	14%	0%	**Decrease**
Availability of launch vehicles that meet your requirements	0%	43%	29%	29%	0%	**Decrease**
Availability of satellite systems that meet your requirements	0%	0%	75%	25%	0%	**Decrease**
Reliability of launch systems	0%	43%	57%	0%	0%	**Decrease**
Reliability of satellite systems	0%	43%	29%	29%	0%	**Decrease**
Introduction of new satellite technologies	29%	29%	29%	0%	14%	**Decrease**
Introduction of new or upgraded launch vehicles	29%	57%	0%	0%	14%	**Decrease**

2014 COMMERCIAL SPACE TRANSPORTATION FORECAST FOR NON-GEOSYNCHRONOUS ORBITS

INTRODUCTION

The 2014 Commercial Space Transportation Forecast for Non-Geosynchronous Orbits (NGSO) is developed by the Federal Aviation Administration's Office of Commercial Space Transportation (FAA AST). This report projects commercial launch demand for all space systems 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, the forecast 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).

The 2014 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.

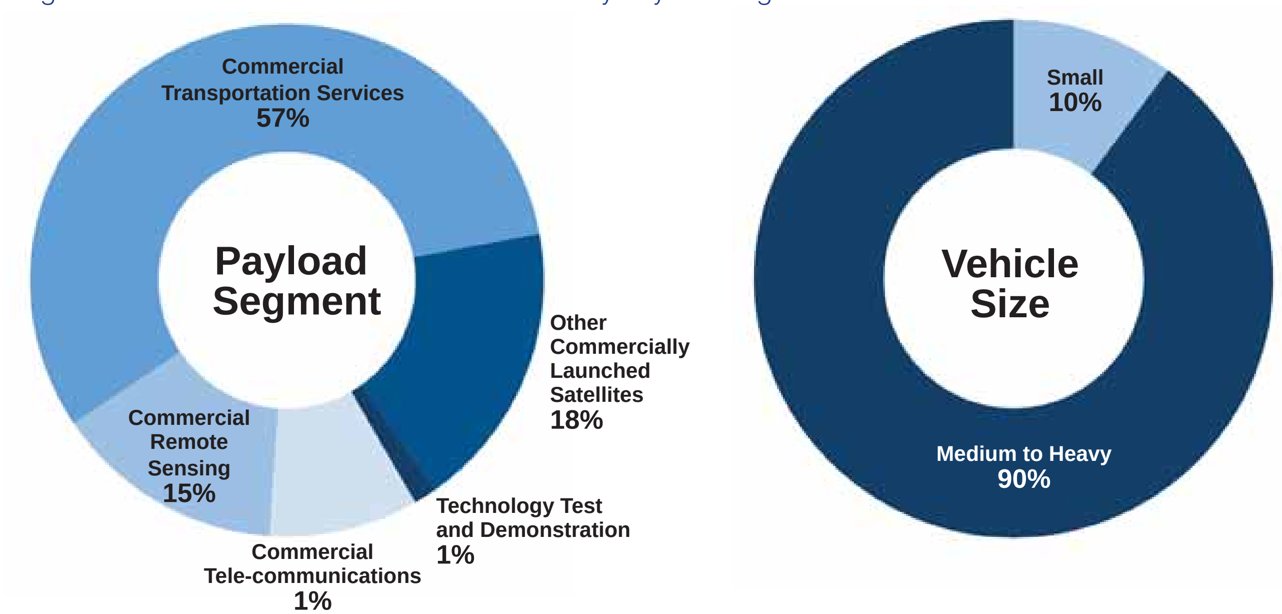
SUMMARY

The report projects an average demand of 13.8 launches per year worldwide during the period 2014 through 2023. The launch demand peaks in 2016, with 20 launches, due to the continued deployment of Iridium constellation, Skybox Imaging planning for 3 flights on Vigin Galactic's LauncherOne; 9 commercial crew and cargo launches to the ISS; and 4 launches for other payloads launched commercially. For the telecommunications sector, a drop in launch demand is expected in 2018, when telecommunication constellations, including Iridium, finish deployment. From 2014 to 2017 the report forecasts a number of small commercial satellites to be launched as Iridium, O3b, Planet Labs, Skybox all deploy their constellations. The number of small multimanifested satellites drops off towards the end of the forecast, but the number of launches remain relatively steady as NASA begins its commercial crew program.

The average of 13.8 launches a year is an increase of little less than a launch a year compared to last year's forecast. This increase in forecasted launches is driven primarily by the inclusion of Skybox's plans and additional test flights for NASA's commercial crew program. The number of NGSO commercial launches is relatively small compared to the total number of NGSO launches per year. For the last 10 years, there has been an average of 46 NGSO launchers per year. Only 13 percent of these launches (approximately 6 launches per year) were commercial. The forecast predicts the annual commercial NGSO launch numbers will more than double the historical annual averages.

Launch demand is divided into 2 vehicle size classes, with an average of 12.4 medium-to-heavy vehicle launches per year and 1.4 small vehicle launches per year for 2014 to 2023. The launches in the next 10 years are predominantly commercial launches to the ISS which require medium-to-heavy vehicles. Ninety percent of all commercial NGSO launches during the forecast period will launch on medium-to-heavy vehicles. Compared to last year's report, the number of small launches has increased, and the number of medium-to-heavy launches has remained constant. The increase in small launches is due to the inclusion of Skybox Imaging's plans to use Minotaur C and LauncherOne to deploy its constellation. A number of new small launchers are being planned, and a number of intermediate launch vehicles have been introduced or will be introduced in the next few years. Historically, the relatively higher price of small vehicle launches, availability of multiple-manifest launch services and commercial payload brokerage and integration services for secondary payloads, as well as other factors discussed in the Satellite and Launch Forecast Trends section have resulted in the use of fewer small vehicle launches. If these dynamics change, there could be a bifurcation in launch demand between the demand for heavy vehicles for commercial crew and cargo and large satellites and a demand for smaller vehicles for the smaller (>100kg) remote sensing and telecommunication satellites. Figure 11 depicts the launch distribution by payload segment type and vehicle size.

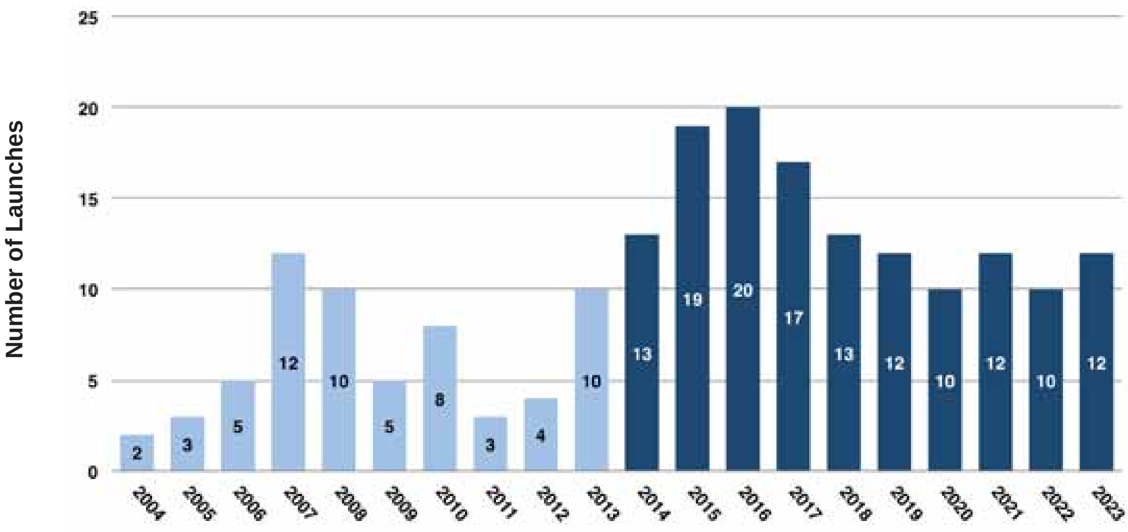
Figure 11. Distribution of Forecasted Launches by Payload Segment and Vehicle Size



Fifty-eight percent of the NGSO launches projected for the next 10 years are for commercial crew and cargo to the ISS. This marks a slight increase from a 57 percent share projected for this segment in the 2013 report, due to the inclusion of additional test flights for new spacecraft in NASA's commercial crew program. The commercial crew launches to the ISS are scheduled for spacecraft still in development, and all of these launches partly rely on government funding subject to annual appropriations; therefore, technical or financial issues could delay ISS crew launches further. After commercial crew and cargo flights to the ISS, Other Commercially Launched Satellites, which is predominantly government satellites launched commercially, is the second largest market, comprising 18 percent of the launch market. Commercial remote sensing market comprise 14 percent of the market with 20 predicted launches, 14 of the twenty launches are planned for small launch vehicles. Telecommunications satellites comprise 9 percent of the launch market, launching 27 percent of the forecasted payloads, all of them multi-manifested or launched as secondary payloads. Telecommunications market it is expected to significantly drop off in 2018 when the major NGSO telecommunications constellations, Iridium, Globalstar, ORBCOMM, and O3b, are deployed.

The annual launch rate during the next 10 years is considerably higher than in the previous decade (see Figure 12). Commercial space transportation; emerging commercial remote sensing; and telecommunications constellation replenishments drive this increase. Last year's report predicted 16 launches for 2013. Ten launches occurred, which was within our realization factor, but less than forecasted number. However, 10 commercial NGSO flights is almost double the 10-year historical average of 6 commercial NGSO flights annually.

Figure 12. Commercial NGSO Launch History and Projected Launch Plans



The near-term launch projection (2014-2017) is based on publicly announced launch demand. Table 1 identifies all NGSO satellites manifested for 2014 through 2017 that drive a launch. The report projects 13 NGSO launches for 2014 and 19 launches for 2015. However, applying a realization factor, the actual NGSO launches are more likely to be between six and eight in 2014 and 8 and 10 in 2015. 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 2014 and 2015. The mid- and far-term launch projections (2018-2023) are based on publically available information from satellite service providers, correspondence with service providers, and estimates of when the existing satellites will reach end of life and require replacement.

METHODOLOGY

This report is based on FAA AST research and discussions with the U.S. commercial space 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 offer:

- Commercial Telecommunications;
- Commercial Remote Sensing;
- Commercial Cargo and Crew Transportation Services, including cargo and human spaceflight;
- Other Commercially Launched Satellites; and
- Technology Test and Demonstration.

Future deployments of payloads that have not yet been announced are projected based on market trends, the status of payloads currently on 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 Other Commercially Launched Satellites market, the forecast used near-term primary payloads generating individual commercial launches in the model and estimated future years 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) 2015 ISS traffic model and manifested launches for cargo and human spaceflight.

Table 11. Near-Term NGSO Manifest of Identified Primary Payloads[2]

Service Type	2014	2015	2016	2017
Commercial Telecommunications Satellites	O3b (4) - Soyuz 2	Globalstar (6) - Soyuz 2	Iridium (10) - Falcon 9	Iridium (10) - Falcon 9
	O3b (4) - Soyuz 2	Iridium (2) - Dnepr	Iridium (10) - Falcon 9	Iridium (10) - Falcon 9
	ORBCOMM (8) - Falcon 9	Iridium (10) - Falcon 9	Iridium (10) - Falcon 9	Iridium (10) - Falcon 9
		ORBCOMM (8) - Falcon 9		
Commercial Remote Sensing Satellites	Worldview-3 - Atlas V 401	DMC3 (3) - PSLV	EROS C - Small TBD	TSX-NG - Medium TBD
		SkySat 4-9 - Minotaur C	SkySat-10 - LauncherOne	SkySat-13 - LauncherOne
			SkySat-11 - LauncherOne	SkySat-14 - LauncherOne
			SkySat-12 - LauncherOne	SkySat-15 - LauncherOne
Commercial Cargo and Crew Transportation Services[3]	Cygnus CRS Flight - Antares	Cygnus CRS Flight - Antares	Cygnus CRS Flight - Antares	Cygnus CRS Flight - Antares
	Cygnus CRS Flight - Antares	Cygnus CRS Flight - Antares	Cygnus CRS Flight - Antares	Cygnus CRS Flight - Antares
	Dragon CRS Flight - Falcon 9	Dragon CRS Flight - Falcon 9	Dragon CRS Flight - Falcon 9	Dragon CRS Flight - Falcon 9
	Dragon CRS Flight - Falcon 9	Dragon CRS Flight - Falcon 9	Dragon CRS Flight - Falcon 9	Dragon CRS Flight - Falcon 9
	Dragon CRS Flight - Falcon 9	Dragon CRS Flight - Falcon 9	Dragon CRS Flight - Falcon 9	Dragon CRS Flight - Falcon 9
		Dragon CRS Flight - Falcon 9	Dragon CRS Flight - Falcon 9	Dragon CRS Flight - Falcon 9
		Crew Test Flight - TBD	Crew Test Flight (Dream Chaser) - Atlas V	ISS Crew - TBD
			Crew Test Flight - TBD	ISS Crew - TBD
			Crew Test Flight - TBD	ISS Crew - TBD
Other Commercially Launched Satellites	ASNARO - Dnepr	SAOCOM 1A - Falcon 9	DragonLab 1 - Falcon 9	DragonLab - Falcon 9
	PAZ - Dnepr	Formosat 5 - Falcon 9	DubaiSat-3 - Dnepr	
	Google X PRIZE - LM 2C	Gökturk 1 - Vega	EnMAP - PSLV	
		Kompsat 3A - Dnepr	SAOCOM 1B - Falcon 9	
		Deimos - Dnepr		
Technology Test and Demonstration Launches	Orion MPCV Demo - Delta IV Heavy	Test Package - Falcon 9 Heavy		
Total Payloads (includes secondary)	**106**	**74**	**72**	**69**
Total Launches	**13**	**19**	**20**	**17**
Launch Realization Factor Applied	**6-8**	**8-10**		

[2] Near-term NGSO payloads and launches are based on information obtained from discussions with launch providers, satellite manufacturers, system operators, government offices, and independent analysts. Launch dates could vary between publicly available information and information gathered from other sources.

[3] The Commercial Cargo and Crew Transportation Services near-term NGSO manifest is based on the NASA 2014 ISS traffic model.

NGSO PAYLOAD MARKET SEGMENTS

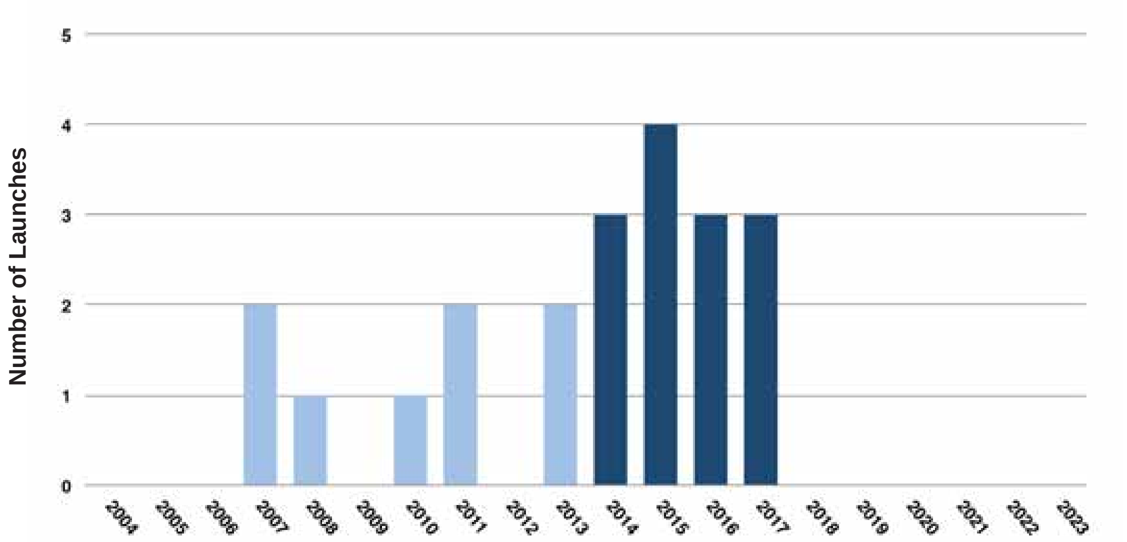
Commercial Telecommunication Satellites

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.

Telecommunications Launch Demand Summary

From 2014 through 2017, between three and four launches of NGSO telecommunications satellites will occur each year. There will be three launches in 2014, as ORBCOMM and the emerging MEO Ka-band broadband operator O3b launch their satellites, and there will be four launches in 2015 and three launches a year in 2016 and 2017, as Iridium replaces its satellites and Globalstar launches additional satellites. Globalstar and O3b are planning to launch on Soyuz 2 vehicles from Baikonur, Kazakhstan and French Guiana, respectively. The first two Iridium NEXT satellites are currently planned to launch on a Dnepr rocket in 2015. Two ORBCOMM and seven Iridium NEXT launches are planned for the Falcon 9 vehicle. Operators intend to finish the replacement of their constellations before 2018, so no telecommunications launches are projected for the subsequent years. Figure 13 provides a representation of telecommunications launch history and projected launch plans.

Figure 13. Commercial Telecommunications Launch History and Projected Launch Plans



2014	2015	2016	2017
O3b (4) - Soyuz 2	Globalstar (6) - Soyuz 2	Iridium (10) - Falcon 9	Iridium (10) - Falcon 9
O3b (4) - Soyuz 2	Iridium (2) - Dnepr	Iridium (10) - Falcon 9	Iridium (10) - Falcon 9
ORBCOMM (8) - Falcon 9	Iridium (10) - Falcon 9	Iridium (10) - Falcon 9	Iridium (10) - Falcon 9
	ORBCOMM (8) - Falcon 9		

Narrowband NGSO Telecommunications Systems

Narrowband LEO systems (see Table 12) operate at freqencies below 1GHz. 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, is partially operational with eight satellites on orbit five of which are operational, will reach its capacity when the full constellation is deployed. The AprizeStar deployment schedule is dependent on the availability of funding and revenue generated by the satellites currently on orbit.

Table 12. Narrowband Systems

System/ Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
		Number (on orbit/ operational)	Mass kg (lb)			
Operational						
ORBCOMM/ ORBCOMM Inc.	Orbital Sciences Corp. (1st Gen.); SNC (2nd Gen.)	41/27	43 (95) (1st Gen.) 142 (313) (2nd Gen.)	LEO	1997	System operational with 41 satellites on orbit. In 2012, a prototype second generation satellite was launched to orbit as a secondary payload on a Falcon 9/Dragon ISS mission. In accordance with ISS safety requirements, the satellite was deployed at a lower altitude than initially planned in an effort to optimize the safety of the ISS and its crewmembers.
Under Development						
AprizeStar (LatinSat)/ Aprize Satellite	SpaceQuest	8/5	10 (22)	LEO	2002	Planned 12- to 30-satellite system, with intermittent launches based on availability of funding. Two satellites are planned for launch in 2014. The company expects to continue launching two AprizeSat satellites every year or two for as long as Dnepr cluster launches are available.

Wideband NGSO Telecommunications Systems

Wideband LEO systems (see Table 13) 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 13. Wideband Systems

System/ Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
		Number (on orbit/ operational)	Mass kg (lb)			
Operational						
Globalstar/ Globalstar, Inc.	SS/Loral (1st Gen.) Thales Alenia Space (2nd Gen.)	68/54	447 (985) (1st Gen.) 700 (1,543) (2nd Gen.)	LEO	1998	Constellation on orbit and operational. Eight replacement satellites launched in 2007. Eighteen second generation satellites launched on three Soyuz rockets in 2010 and 2011. Six more second generation satellites were launched aboard a Soyuz vehicle in 2013. Six additional satellites ordered from Thales Alenia Space in September 2012, to launch in 2015.
Iridium/ Iridium Communications Inc.	Motorola (Iridium) Thales Alenia Space (Iridium NEXT)	90/72	680 (1,500) Iridium 800 (1,763) Iridium NEXT	LEO	1997	Constellation on orbit and operational. Five spare satellites launched in February 2002; two additional spares launched June 2002. Next generation system under development by Thales Alenia Space. Multiple launches of Iridium NEXT constellation are projected to begin in 2015.

Broadband NGSO Telecommunications Systems

Broadband systems (see Table 14) reside in NGSO and provide high-speed data services at Ka- and Ku-band frequencies. O3b Networks Ltd. accomplished an initial deployment of its first four satellites in 2013.

Table 14. Broadband Systems

System/ Operator	Prime Contractor	Satellites		Orbit Type	First Launch	Status
		Number (on orbit/ operational)	Mass kg (lb)			
Under Development						
O3b/O3b Networks Ltd.	Thales Alenia Space	4/4	700 (1,540)	MEO	2013	The first four satellites of the constellation launched in 2013. Eight more are scheduled for deployment in 2014.

Federal Communications Commission Telecommunication Licenses

Table 15 shows Federal Communications Commission (FCC) telecommunications licenses issued to the commercial NGSO telecommunications satellite operators. 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.

Table 15. FCC Telecommunication Licenses

Licensee	Year of Filing	Remarks
ORBCOMM	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	2001	Authorized Iridium to operate feeder uplinks in the 29.1-29.25 Mobile-Satellite Service (MSS).
Iridium Satellite LLC	2002	Granted assignment of licenses and authorizations pertaining to the operation of the Iridium Mobile Satellite Service System.
ORBCOMM	2008	FCC authorization for the ORBOMM second generation satellites to operate within the United States
Globalstar	2011	FCC authorization to operate its second-generation satellites within the United States
AprizeStar	2012	FCC authorization to operate satellites Aprizesat 1 through 10.
Skybox Imaging	2012	FCC authorization for Skysat 1 and Skysat 2 to transmit telemetry signals and remote-sensing data in the 8025-8400 MHz frequency band and to receive command signals on center frequencies of 2081 MHz and 2083 MHz.
O3b	2012	License to operate a gateway in Haleiwa, Hawaii.
Planet Labs	2013	FCC authorization for Planet Labs to transmit image and telemetry data to fixed earth stations using the 8025-8400 MHz frequency band, and receive command signals in the 2025-2110 MHz band.
O3b	2013	License to operate a gateway in Vernon, Texas.

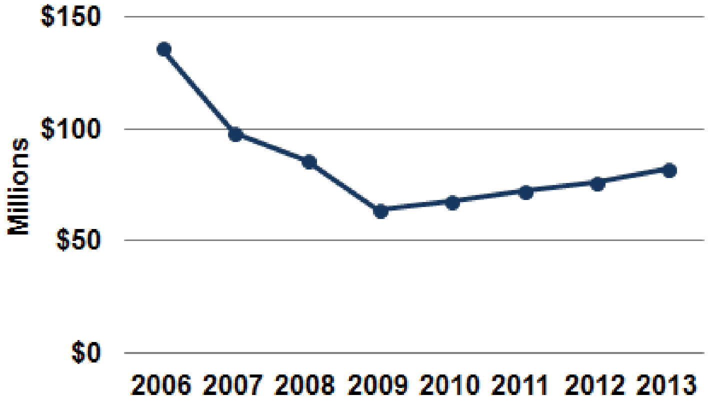
Globalstar

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 augmenting its on-orbit satellite constellation.

Globalstar's first generation satellite constellation consisted of 52 satellites: 48 operational satellites plus 4 on-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 on-orbit constellation, Globalstar launched its final eight first generation replacement satellites on two Soyuz vehicles in May and October 2007. The addition of these satellites 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 and developed a simplex service product called the Satellite Pour l'Observation de la Terra

Figure 14. Publicly Reported Globalstar Annual Revenue



(SPOT) Satellite Global Positioning System (GPS) Messenger. In July 2009, Globalstar uploaded a second generation SPOT Satellite GPS Messenger software upgrade to the existing constellation.

Arianespace, through its Starsem affiliate, launched 24 Globalstar second generation satellites. The first 6 satellites were launched into orbit in 2010, the next 12 launched in 2011, and the remaining 6 in February 2013. All launches were from Baikonur, Kazakhstan 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 on-orbit testing.

Thales Alenia Space (TAS) developed and built the 25 second generation satellites (including one ground spare) for Globalstar. Together with the 8 replacement satellites launched in 2007, Globalstar has a 32-satellite system since the initial deployment of its new constellation concluded.

Globalstar reported it is in negotiations with TAS 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. An order for manufacturing of the first six was placed with TAS in September 2012, tentatively to launch in 2015. Currently, there is no launch contract for these additional satellites, and any launch would be contingent on the health of the satellites on orbit. Therefore, this report does not project additional launches beyond 2015.

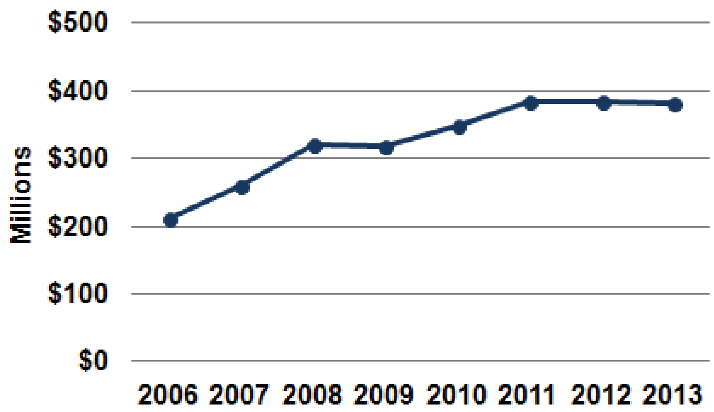
Figure 14 shows the decline in Globalstar's revenues from 2006 to 2009 and a rise beginning in 2010, due to higher revenues from the SPOT Satellite GPS Messenger service and simplex data services and improvements in duplex and simplex services after second generation satellite deployment. Because of 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.

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 TAS 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 a 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 that SpaceX will be the primary launch provider for Iridium NEXT. Iridium also signed a contract with International Space Company Kosmotras (provider of the Dnepr launch vehicle) to be a supplemental provider of launch services for Iridium NEXT. The company reportedly plans to launch 72 satellites (66 to enter active service and 6 to serve as on-orbit spares) during a 3-year period scheduled to begin in 2015. The first two Iridium NEXT satellites are currently planned to launch on a Dnepr rocket in 2015. The rest of the Iridium NEXT constellation will launch on approximately 7 Falcon 9 launches carrying 10 satellites each. Nine Iridium NEXT satellites will remain ground spares. Iridium revenues are presented in Figure 15.

Figure 15. Publicly Reported Iridium Annual Revenue



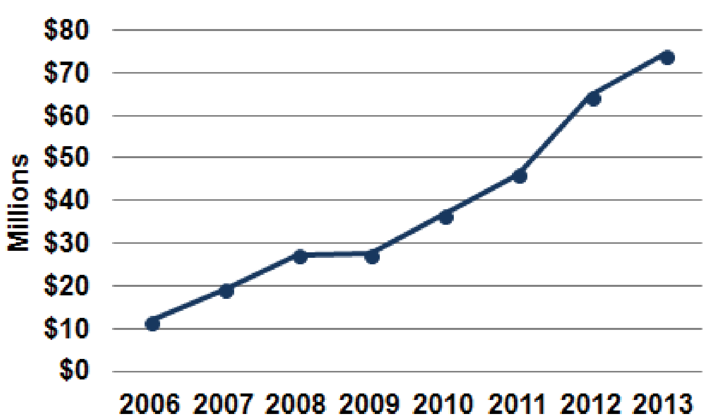
ORBCOMM

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 VesselSat 1 and

Figure 16. Publicly Reported ORBCOMM Annual Revenue



VesselSat 2. 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. Seventeen satellites of the 18-satellite second generation constellation are either under construction or awaiting launch. All satellites in the constellation include AIS payloads. ORBCOMM ordered the satellites in 2008 from Sierra Nevada Corporation (SNC), with subcontractors Boeing and ITT Corporation. In 2011, ORBCOMM announced its plan to use SpaceX's Falcon 9 vehicle to launch the onstellation.

A prototype ORBCOMM OG2 satellite was carried by the SpaceX Falcon 9 vehicle as a secondary payload on a cargo resupply mission to the ISS in October 2012. The launch met its primary objective of sending the Dragon spacecraft to the ISS, but did not deploy the ORBCOMM satellite into the desired orbit due to an anomaly on one of the Falcon 9's first stage engines. To remain fully compliant with the safety plan approved for Dragon delivery to the ISS, SpaceX did not have the Falcon 9 execute the second burn necessary to deliver the ORBCOMM satellite into a higher orbit.

In 2014, the remaining OG2 satellites will begin to launch aboard Falcon 9 vehicles in 2014. Between 8 and 12 satellites will be launched in 2014, and the remainder of the 18-satellite constellation are likely to launch in 2015.

ORBCOMM revenues are presented 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 satellites weighing 10 kilograms (22 pounds) each, launched as secondary payloads on Russian Dnepr vehicles: two satellites a year in 2002, 2004, 2009, 2011, and 2013. The 2 original satellites launched in 2002 are no longer in orbit. Two more satellites are expected to be deployed by another Dnepr multi-manifest launch in 2014. Three of the eight satellites on orbit are not operational. The company needs to launch 5 more satellites to complete the constellation, as well as any replacement satellites needed. In the years following 2014, the company expects to continue launching two AprizeSat satellites every year or two for as long as Dnepr cluster launches are available. Any additional satellites are likely to launch as secondary payloads and not generate demand for a launch.

O3b

O3b Networks, headquartered in St. John, Jersey, Channel Islands, plans to provide broadband connectivity to underserved parts of the world with support and funding from high profile investors, including major GEO commercial satellite operator SES, Google, Liberty Global, and HSBC.

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. More satellites can be added as needed to meet demand.

Offering to bridge the gap between current satellites and fiber optic cables, O3b

Networks plans to provide fiber-like trunking capacity to telecommunications operators and backhaul directly to 3G Cellular and WiMAX towers. Prior to the launch of its first four satellites in 2013, O3b had been successful in having its capacity booked by regional telecommunications companies and Internet service providers. O3b Networks teamed with VSAT satellite services provider Harris CapRock to deliver connectivity solutions to maritime clients, including Royal Caribbean Cruises.

TAS is under contract to build 16 communications satellites for O3b. O3b has a launch services agreement with Arianespace for two more Soyuz launches from French Guiana. Each Soyuz will deploy four O3b satellites in MEO in the equatorial plane.

Telecommunications Satellite Fleet Replacement after 2022

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 (see Table 16). However, the majority of these satellites are still on 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 2022. 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 2014 - 2023 period, they will likely be launched as piggyback payloads, unlikely to generate demand for a dedicated launch.

Table 16. Commercial Telecommunications 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 on orbit, partially operational	15 years
Iridium	5 years	Most of the satellites on orbit, operational	10 years (design), 15 years (projected)
ORBCOMM	4 years	Most of the satellites on orbit, operational	More than 5 years
Aprize Satellite	N/A	8 on orbit, 6 in service, launching more to complete system	10 years
O3b Network	N/A	4 satellites in orbit, partially operational. Launching 8 more to complete system	10 years

Commercial Remote Sensing Satellites

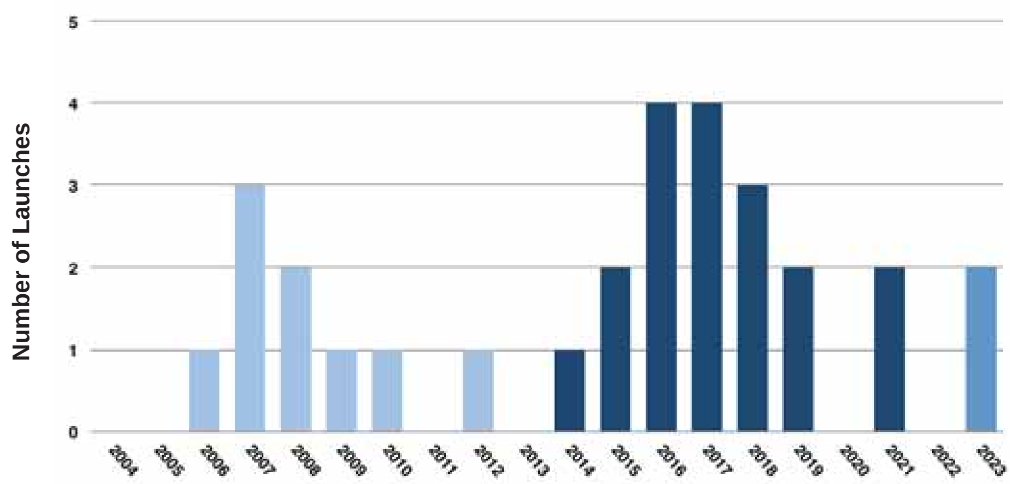
Remote sensing refers to any orbital platform with sensors trained on Earth to gather data across the electromagnetic spectrum for geographic analysis, military use, meteorology, climatology, or other uses. The remote sensing industry generally comprises three markets:

- Aerial imagery
- Satellite imagery
- Value-added services, including geographic information systems (GIS)

GIS consists of images obtained from aircraft or satellites integrated with layers of information, usually customized according to user needs. It constitutes the largest part of the industry both in terms of demand and revenue generation.

The satellite imagery market is composed of companies that acquire and operate their own remote sensing satellites. These include Airbus Defense and Space, BlackBridge, DigitalGlobe, DMC International Imaging, ImageSat, MDA Geospatial Services, Planet Labs, and Skybox Imaging. New companies like BlackSky Global and PlanetiQ are entering the market. For all of these companies, GIS products and services are the main generator of revenue. In some cases, imagery obtained from government satellites is made available to customers through a GIS company. For example, imagery from two Pleiades satellites operated by the French government is made available through Airbus Defense and Space. In other cases, the operation of remote sensing satellites, the imagery obtained from them, and the sales of GIS products and services is managed through a public-private partnership (PPP). The TerraSAR-X and TanDEM-X satellites are managed by a PPP that includes the German Space Agency (DLR) and Airbus Defense and Space.

Figure 17. Commercial Remote Sensing Launch History and Projected Launch Plans



2014	2015	2016	2017
Worldview-3 - Atlas V	DMC3 (3) - PSLV	EROS C - Small TBD	TSX-NG - Medium TBD
	SkySat 4-9 - Minotaur C	SkySat-10 - LauncherOne	SkySat-13 - LauncherOne
		SkySat-11 - LauncherOne	SkySat-14 - LauncherOne
		SkySat-12 - LauncherOne	SkySat-15 - LauncherOne

This forecast captures only commercial remote sensing satellite companies that procure internationally competed launches and FAA licensed launches. It does not include organizations that depend on a particular launch provider, either because of a commitment to a national industrial base or through a previously established agreement with the launch provider. In those instances, the launch is not considered internationally competed.

The major companies operating or actively developing remote sensing satellites across the globe are profiled in Table 17. These satellites have been or are likely to be launched commercially.

Table 17. Commercial Remote Sensing Systems

System	Operator	Manufacturer	Satellites	Mass kg (lb)	Highest Resolution (m)	Revisit Time (hrs.)	Launch Year
Operational & Under Development							
CICERO	GeoOptics	TBD	CICERO 1-12	TBD	TBD	TBD	2017
Deimos Perseus	Dauria Aerospace and Elecnor Deimos	Dauria Aerospace	Perseus O 1-8	<10 (22)	22	24	2015
DMC3	DMC International Imaging Ltd.	SSTL	DMC3 1-3	350 (771)	1	24	2014
Dove	Planet Labs	Planet Labs	Dove 1-100	<10 (22)	3-5	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 2016
GeoEye	DigitalGlobe	General Dynamics Lockheed Martin	GeoEye-1 GeoEye-2	907 (2,000) 2,087 (4,601)	0.41 0.34	50-199 50-199	2008 2016
IKONOS	DigitalGlobe	Lockheed Martin	IKONOS	816 (1,800)	1	<72	1999
PlanetIQ	PlanetIQ	TBD	PlanetIQ 1-12	75 (165)	N/A	N/A	TBD
OmniEarth	OmniEarth	Draper Labs/ Dynetics/ Harris	OmniEarth 1-18	500 (1,102)	TBD	24	TBD
QuickBird	DigitalGlobe	Ball Aerospace	QuickBird	909 (2,004)	0.6	60-134	2001
RADARSAT	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 2018
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	2013 2014
TerraSAR-X and TanDEM-X	BMBF/DLR/ Astrium	Astrium	TerraSAR-X TanDEM-X TerraSAR-NG	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

Licenses issued by the U.S. National Oceanic and Atmospheric Administration

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 35 remote sensing licenses issued or amended since 1993 (see Appendix). Seven licenses were issued in 2013 and two in early 2014 (see Table 18).

Table 18. NOAA Remote Sensing Licenses Issued in 2013

Licensee	Date License Granted or Updated	Remarks
Southern Stars	2/18/2013	License issued for operation of cubesat SkyCube.
Saint Louis University	6/20/2013	License issued for operation of cubesat COPPER.
Nanosatisfi	TBD	License issued for operation of cubesat Ardusat 1.
University of Alabama Huntsville	9/17/2013	License issued for operation of cubesat ChargerSat-1.
Teledyne Brown Engineering	11/5/2013	License issued for MUSES.
University of Hawai`i at M⌧noa	TBD	License issued for Hawai'iSat-1.
Planet Labs, Inc.	9/26/2013	License issued for Flock-1 constellation, consisting of 28 3U cubesat satellites.

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 two per year through the forecast period. The significant increase in the average from last year's projection of less than a launch a year reflects the inclusion of Skybox Imaging launches in this year's forecast. Skybox acquired funding to support its initial constellation of 12 satellites, and the successful launch of its first satellite late in 2013. Peaks in the number of launches can be seen during 2016 and 2018, reflecting projected deployment of satellites operated by Airbus Defense and Space, ImageSat, and Skybox. Figure 17 provides a launch history and projected launch plans for commercial remote sensing satellites.

Commercial remote sensing satellites in the near-term portion of this report (2014-2017) have been announced by their respective companies, are under construction, and are scheduled for a launch. Satellites projected for the latter portion of the report (2018-2023) are based on published statements regarding the service lives of satellites currently operating on orbit.

DigitalGlobe

Established in 1992, DigitalGlobe is a commercial high-resolution remote sensing satellite operator and GIS provider headquartered in Longmont, Colorado. The company operates imaging satellites and provides GIS products using satellite and aerial imagery. Following a merger with GeoEye, Inc. on January 31, 2013, DigitalGlobe currently operates five remote sensing satellites: IKONOS, GeoEye-1, QuickBird, WorldView-1, and WorldView-2. WorldView-3 will launch in 2014 aboard an Atlas V 401 vehicle. Another satellite, GeoEye-2, is currently under construction and will be stored as a ground spare.

DigitalGlobe’s first satellite, QuickBird, was launched in 2001 and is projected to continue operating until late 2013. WorldView-3 is expected to have a service life of up to 12 years. DigitalGlobe’s two other satellites, WorldView-1 and WorldView-2, are expected to reach end of operational life in the second quarter of 2018 and the first quarter of 2021, respectively.

The U.S. National Geospatial-Intelligence Agency (NGA) partially funded the development of the current generation of DigitalGlobe (including the former GeoEye) satellites. In 2010, NGA awarded both DigitalGlobe and GeoEye 10-year contracts worth up to $7.35 billion as part of the EnhancedView program. These contracts intended to extend NGA’s ability to tap imagery from the private sector and help guarantee the availability of commercial remote sensing products into the decade. In July 2012, due to planned cuts to the EnhancedView budget, DigitalGlobe and GeoEye announced plans to merge, a process completed in January 2013.

DMC International Imaging

DMC International Imaging, Ltd. (DMCii), based in the United Kingdom, operates the Disaster Monitoring Constellation (DMC) on behalf of governments that provide the satellites. DMCii is a wholly owned subsidiary of Surrey Satellite Technology Ltd. (SSTL). The constellation’s primary purpose is to distribute imagery for commercial and humanitarian purposes.

The original DMC constellation (Alsat-1, Beijing-1, BilSat, Nigeriasat-1, and UK-DMC1) became fully operational in 2006, with satellites evenly distributed in a single sun-synchronous orbit (SSO). Four additional satellites were launched between 2009 and 2011, and the current retinue of operating satellites include China’s Beijing-1, Nigeria’s Nigeriasat-2 and NX, Spain’s DEIMOS-1, and the United Kingdom’s UK-DMC2. The satellites orbit at an altitude of 700 kilometers (435 miles). Nigeria’s satellites Nigeriasat-2 and NX were launched in 2011 and represent 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 the imaging capacity aboard a three-satellite constellation called DMC3. The lease allows 21AT to obtain timely imagery without procuring and operating a constellation themselves. The constellation, designed and manufactured by SSTL, will be owned and operated by DMCii and is projected to launch in 2015 aboard an Indian PSLV-XL vehicle. Each DMC3 satellite will provide one-meter panchromatic and four-meter multispectral imaging.

Airbus Defense and Space

Airbus Defense and Space (Airbus) operates the French remote sensing constellation, Satellite Pour l’Observation de la Terre (SPOT) and the German synthetic aperture radar (SAR) remote sensing missions TerraSAR-X and TanDEM-X. It also handles sales of imagery obtained by two Pléiades satellites operated by CNES, the DEIMOS-1 satellite operated by DMC International Imaging on behalf of the Spanish government, and Formosat-2 operated by the government of Taiwan.

The TerraSAR-X and TanDEM-X missions are public private partnerships between the German Aerospace Centre (DLR), the German Federal Ministry of Education and Research and Airbus. DLR operates the two identical satellites and is responsible for the scientific use of the data. Airbus holds the exclusive commercial exploitation rights for imagery acquired by TerraSAR-X and TanDEM-X.

The TerraSAR-X Mission is performed by two satellites, TerraSAR-X and TanDEM-X, each contributing a part of the imaging resources. The TanDEM-X Mission uses the same two satellites to perform close formation flight with distances of 200m. The two satellites will fly in this formation until 2015. The goal of the TanDEM-X Mission is to generate a homogeneous, high-quality global Digital Elevation Model.

The first TerraSAR-X satellite launched aboard a Russian Dnepr vehicle in 2007. The second TerraSAR-X satellite was launched in 2010, also aboard a Dnepr. Airbus expects these satellites to function five years beyond 2018.

Work is currently underway for a second generation of SAR satellites called TerraSAR-X Next Generation. The launch is planned for launch in 2018. No launch vehicle has been been selected. DLR and Airbus are also discussing a next generation of satellites beyond the 2018 timeframe to replace the first generation TerraSAR-X 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.

The Centre National d'Etudes Spatiales (CNES), France's space agency, was majority shareholder of SPOT Image until 2009, when responsibility for the system transferred to EADS Astrium; in 2011 the company formed the Geo Information Division to specifically manage the SPOT satellites and data sales. EADS Astrium has since acquired and built SPOT-6 and SPOT-7, the former launched in 2013 and the latter planned for a 2014 launch. In 2014, through mergers, EADS Astrium became part of Airbus Group. The SPOT constellation consists of three satellites, SPOT-4, launched in 1998, SPOT-5, launched in 2002, and SPOT-6, launched in 2012. SPOT-7 is planned for launch in 2014 aboard an Indian PSLV vehicle. The launch of SPOT-7 is not included in the forecast because it was not internationally competed; like SPOT-6, SPOT-7 will be launched aboard a PSLV as a result of a partnership between CNES and the Indian Space Research Organization (ISRO).

BlackBridge

Berlin-based BlackBridge operates the RapidEye constellation of five satellites, and GIS imagery. RapidEye AG changed its name to BlackBridge in November 2013. The company has additional offices in Luxembourg, Canada, and the United States.

The RapidEye satellites provide wide-area, repetitive coverage and 5-meter-pixel-size multi-spectral imagery. MacDonald, Dettwiler and Associates (MDA) was the prime contractor for the development of the satellites, responsible for design and implementation. MDA subcontracted Surrey Satellite Ltd (SSTL) in the UK to supply the bus and integrate the satellites whereas Jena-Optronik from Germany provided the camera payloads. All five satellites were launched aboard a Dnepr launch vehicle from Baikonur, Kazakhstan on August 29, 2008. The constellation is expected to remain in service until at least 2019, four years beyond the designed service life.

Though planning for the next generation of satellites is underway, BlackBridge has not released details publicly. During 2014, the company expects to provide details about its future satellite development plans. The forecast assumes that BlackBridge will secure funding for a replacement constellation with a launch projected in 2018, a year before the anticipated end of life of the original satellites.

BlackSky Global, LLC

U.S.-based BlackSky Global was issued a NOAA license authorizing deployment of an “Earth observation satellite system.” The system, which is planned for launch in 2015, will feature one or more satellites in a polar orbit with an altitude of between 450 km and 600 km. Because no technical details are public, the BlackSky system is not included in the forecast.

Dauria Aerospace/Elecnor Deimos

In October 2013, Dauria Aerospace and Elecnor Deimos announced a joint partnership to build and operate a constellation of 8 satellites capable of frequently capturing multispectral imagery of the same area, supplemented by onboard automated identification of ground features. The highest resolution possible is expected to be about 22 meters. Each member of the constellation, called Perseus-O, will consist of a 6U cubesat arrangement. Perseus-O satellites will be launched as secondary payloads during 2015, though no launch vehicle has been selected yet. Dauria Aerospace has also built Perseus-M1, Perseus-M2, and DX-1, and these non-commercial remote sensing satellites will be launched as secondary payloads aboard Dnepr vehicles in 2014. Eleconor Deimos also operates the Deimos-1 cubesat currently on orbit, and will operate the much larger Deimos-2 (300 kg), which will be launched in 2014 aboard a Dnepr as the primary payload.

GeoOptics

GeoOptics is an environmental and weather data services company that will launch small satellites into polar orbit caryrying the data sensor technology called GPS-Radio Occultation (RO). RO technology measures temperature, air pressure and water vapor with near-perfect accuracy—and unlike any other data form in orbit today—for use in operational weather forecasting and space weather applications, as well as climate monitoring. With this in-orbit sensor infrastructure GeoOptics will be collecting mass amounts of atmospheric and environmental data for use in computational models in Numeric Weather Prediction (NWP) forecasting and climatological models. These models will ultimately feed data analytics for clean tech, financial, insurance, agribusiness and defense and many other industries, as well as science and research organizations, worldwide.

The company plans to launch satellites beginning in 2015 toward a full operational constellation of 24 satellites over the next few years. Launches will be conducted through a combination of available secondary launch vehicles. Because the company has not yet secured enough financing for the space-based segment, these launches are not included in the forecast.

ImageSat International NV

Israel-based ImageSat, founded as West Indian Space in 1997 and officially a Curacao 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. (IAI) 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 launch vehicle and should continue to operate until at least 2015, five years beyond its projected service life. EROS B launched aboard a Start-1 in 2006 and should continue to operate until 2022.

IAI is currently building the EROS-C satellite. Though no launch year has been selected, it is expected that EROS-C will be launched in 2016 or2017 aboard a small vehicle. EROS-C is designed to have a service life of about ten years.

MacDonald, Dettwiler and Associates

MDA owns and operates RADARSAT-2. The company is a commercial provider of advanced geospatial information products derived from the high-resolution RADARSAT-1 (no longer in service) and RADARSAT-2 satellites. It also markets and sells data derived from commercial optical satellites and from aerial systems.

RADARSAT-1 was launched on November 4, 1995, aboard a Delta II launch vehicle. The satellite, which was operated by the Canadian Space Agency (CSA), was retired in 2013. RADARSAT-2 launched aboard a Starsem Soyuz intermediate vehicle on December 14, 2007 and remains healthy. RADARSAT-2 features a SAR system capable of producing imagery with 1-meter resolution.

To provide space-based radar data continuity, the Government of Canada, through the CSA, proposed the three-satellite RADARSAT Constellation Mission (RCM). In March 2010, the CSA authorized MDA to perform the Phase C design phase of the RCA program, after MDA successfully completes Phases A and B. In January 2013, CSA signed a CAD $706-million contract with MDA for the construction, launch and initial operations of the three RCM satellites. MDA secured a launch reservation with Space Exploration Technologies (SpaceX) in July 2013 for the launch of all three satellites aboard a Falcon 9 vehicle.

OmniEarth

U.S.-based OmniEarth is partnering with Draper Laboratory, Dynetics, and Harris Corporation to develop a constellation of 18 small remote sesning satellites. These satellites will provide multispectral imagery products covering the entire planet, with a revisit time of one day. The satellites will be able to downlink up to 1.2 gigabytes per second of data and store 1 terabyte of data onboard, a unique capability in commercial satellite remote sensing. OmniEarth is currently seeking financing to fund development of the constellation, which is expected to cost about $250 million. Since financing is not yet finalized and no launch plans have been announced, the 18 satellites have not been included in this year's forecast.

PlanetIQ

PlanetiQ, established in 2012, plans to operate 18 microsatellites to provide weather, climate, and space weather data. The satellites are not equipped with imaging sensors; instead, they will collect atmospheric data including temperature, pressure and water vapor by measuring the bending of signals broadcast from global navigation satellite systems (like the U.S. Navstar Global Positioning System) using RO.

The mass of each satellite is 75 kilograms. The current plan is to launch 12 satellites by

2017 with 18 total by 2019. PlanetiQ is currently raising funds to support initiation of the constellation build in summer 2014.

Planet Labs, Inc.

Planet Labs, Inc., based in California, is a remote sensing and GIS company focused on producing and operating fleet of 100 very small satellites. Because the satellite platforms consist of three stacked cubesats (3U), the sensor focal length is not capable of producing images with resolutions higher than 3 to 5 meters, which is still adequate for environmental monitoring, change detection, and other applications. The large number of very small satellites ensures global coverage for a relatively small investment. Planet Labs raised $52 million in 2013.

Planet Labs (called Cosmogia from 2010 to early 2013) built four prototype Dove satellites, launched as secondary payloads in 2013. In January 2014, 28 Dove satellites, collectively called Flock-1, were launched aboard an Antares vehicle provided by Orbital Sciences Corporation. The satellites were stored within the Cygnus cargo transfer vehicle that berthed with the International Space Station (ISS) on January 12. Once attached to the ISS, the satellites were transferred to the Japanese Kibo module, where a special dispenser was used to eject the satellites one by one into orbit the following month. Shortly after deployment of Flock-1, Planet Labs announced that 72 additional satellites will be deployed between February 2014 and February 2015, bringing the total number to 100. The company indicated plans to use U.S. and Russian vehicles launched from different launch sites in order to deploy satellites into different orbits, thus ensuring global coverage.

The forecast includes 100 satellites deployed during 2014-2015, followed by 25 satellites each year throughout the forecast period to replenish the constellation since each satellite has a service life of 2 to 4 years. However, none of these satellites are expected to drive a launch since it is likely all satellites will be deployed as secondary payloads.

Skybox Imaging

Skybox Imaging, Inc., based in Mountain View, California, is a new entrant to the commercial satellite remote sensing industry. The company obtained a NOAA license for SkySat-1 on April 20, 2010, and has applied to amend the license to include a second satellite, SkySat-2. A third satellite is also planned before the company’s 12-satellite polar-orbiting constellation begins deploying in 2015. Skybox manufactures and operates its own satellites and will provide frequently updated imagery and video online.

SkySat-1 launched in 2013 aboard a Dnepr vehicle along with several other satellites. SkySat-2 and SkySat-3 are projected to launch as secondary satellites aboard a Soyuz 2 and a Dnepr, respectively. Six SkySat satellites will follow in 2015, launched together aboard an Orbital Sciences Corporation Minotaur-C. Skybox has also been in discussions with Virgin Galactic for the launch of satellites aboard LauncherOne, a new small-class launch vehicle. Since this vehicle can only carry one SkySat at a time, the forecast projects that six SkySat satellites will be launched individually in 2016 and 2017. Two notional satellites per year in 2019, 2021, and 2023 are anticipated to replenish the constellation, since each satellite has a service life of 6 years.

Commercial Cargo and Crew Transportation Services

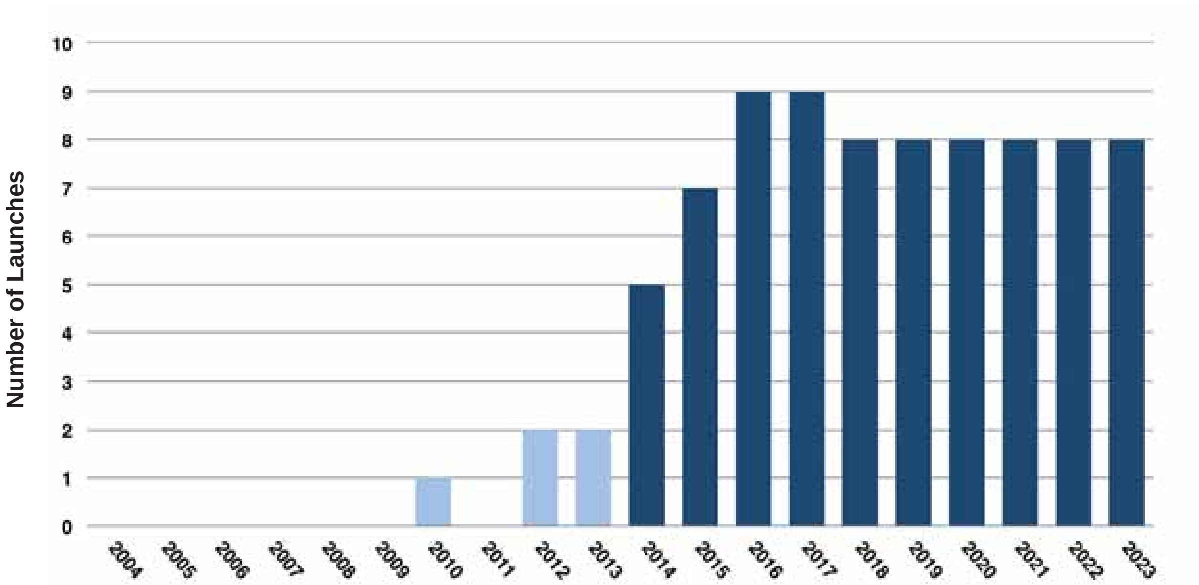
Commercial cargo and crew transportation capabilities include commercial launches of cargo and humans to LEO and external trajectories to the Moon or other solar system destinations. Specifically, commercial cargo and crew transportation captures commercial crew and cargo services in support of NASA's mission and other private industry efforts that may require cargo and crew flights, such as space stations, tourism, privately sponsored scientific expeditions, and the prospecting and mining of non-terrestrial resources.

Commercial Cargo and Crew Transportation Services Launch Demand Summary

Seventy-eight commercial cargo and crew launches are projected from 2014 to 2023, as compared to 74 launches in last year's report. All the launches forecasted in the next ten years are in support of commercial crew and cargo resupply to the ISS. The increase in flights projected from last year's forecast is due to several factors. Among them are launch delays of Orbital's first Antares CRS flight and SpaceX's third CRS flight from 2013 into 2014 and a slight increase in the projected number of test and operational flights under NASA's commercial crew program. Figure 18 provides a launch history and projected launch plans for commercial cargo and crew transportation services.

Figure 19 shows the distribution of ISS commercial cargo and crew flights from 2014 to 2023. Note that the first test flights of Falcon 9 and Antares were not funded by NASA and are captured in the forecast section entitled Technology Test and Demonstration Launches.

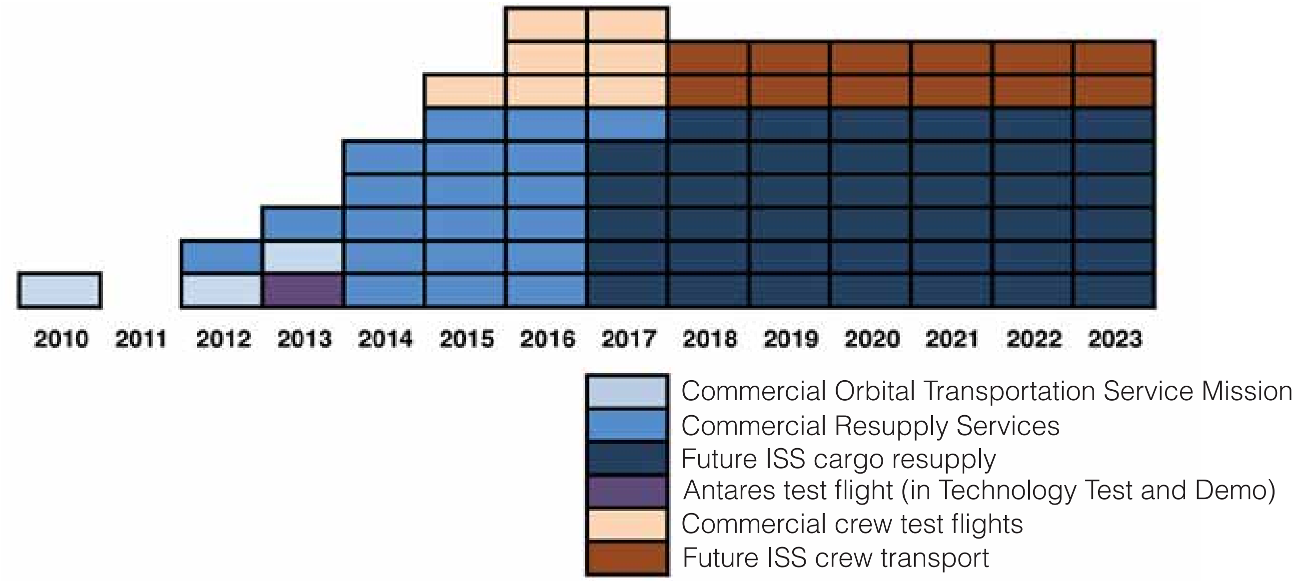
Figure 18. Commercial Cargo and Crew Transportation Services Launch History and Projected Launch Plans



NASA COTS

In 2006, NASA announced the COTS program. COTS focused on the development and demonstration of commercial cargo transportation systems. Total Space Act Agreement (SAA) funding under this program was $889 million. Under COTS, SpaceX developed

Figure 19. NASA Commercial Crew and Cargo Projections



[4] *Sources: NASA ISS Flight Plan, March 28, 2013, and NASA FY 2014 Budget Estimates: NASA Mission Launches (FY 2013-2020)*

the intermediate Falcon 9 launch vehicle and the Dragon spacecraft. Orbital Sciences Corporation developed the Cygnus spacecraft and the medium-class Antares launch vehicle. SpaceX completed its COTS milestones in 2012. Orbital's test flight of Antares launched on April 21, 2013, carrying a Cygnus mass simulator. The company conducted its COTS demonstration mission in September 2013, featuring a fully operational Cygnus that berthed with the ISS. The successful completion of this mission concluded NASA's COTS program.

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 began in October 2012, with the successful launch of SpaceX's Dragon resupplying the ISS. Orbital's resupply missions began in January 2014. Subsequently, approximately six commercial cargo flights are expected each year through 2023.

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. 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 advanced 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 $315 million. Additionally, NASA awarded unfunded

Table 19. 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	Dragon
COTS	2006	$207 million	Kistler[5]	K-1
COTS	2008	$288 million	Orbital	Cygnus
CRS	2008	$1.6 billion	SpaceX	Dragon (12 flights)
CRS	2008	$1.9 billion	Orbital	Cygnus (8 flights)
CCDev	2010	$20 million	Sierra Nevada Corp.	Dream Chaser
CCDev	2010	$18 million	Boeing	CST-100
CCDev	2010	$6.7 million	United Launch Alliance (ULA)	Atlas V human rating
CCDev	2010	$3.7 million	Blue Origin	Launch abort systems
CCDev	2010	$1.4 million	Paragon Space	Life support
CCDev2	2011	$112.9 million	Boeing	CST-100 design maturation
CCDev2	2011	$105.6 million	Sierra Nevada Corp.	Dream Chaser design maturation
CCDev2	2011	$75 million	SpaceX	Crewed Dragon development
CCDev2	2011	$22 million	Blue Origin	Launch abort systems
CCDev2	2011	Unfunded	ULA	Atlas V human rating
CCDev2	2011	Unfunded	ATK/Astrium	Liberty development
CCDev2	2011	Unfunded	Excalibur Almaz	Spacecraft development
CCiCAP	2012	$460 million	Boeing	CST-100 crewed maturation
CCiCAP	2012	$440 million	SpaceX	Crewed Dragon maturation
CCiCAP	2012	$212.5 million	Sierra Nevada Corp.	Dream Chaser crewed maturation
CPC	2012	$10 million	Boeing	Crew Certification
CPC	2012	$10 million	Sierra Nevada Corp.	Crew Certification
CPC	2012	$10 million	SpaceX	Crew Certification

[5] *In 2007, NASA terminated the Space Act Agreement with Kistler due to the company's technical and financial shortfalls.*

agreements to provide limited technical assistance for advancement of commercial crew space transportation to ULA; Alliant Techsystems (ATK); 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. Boeing, SpaceX, and Sierra Nevada Corporation won awards totaling over $1.1 billion. In December 2012, NASA awarded $30 million in Certification Products Contracts (CPC) to Boeing, Sierra Nevada, and SpaceX. Under this contract, each of these companies will work toward certifying its spacecraft as safe to carry humans to the ISS. The next award of funding by NASA is planned for mid-2014. Seven orbital test flights are expected between 2015 and 2017 before operational flights take place in late 2017. The initial test missions will not be licensed because they will be considered government flights.

Table 19 describes NASA COTS, CRS, and CCDev Awards.

Bigelow Aerospace

Nevada-based Bigelow Aerospace is developing expandable space habitat technology to support a variety of public and private activities including commercial space stations in LEO and human spaceflight missions beyond LEO. Its manufacturing plant, which occupies 31,731 square meters, is located in North Las Vegas, Nevada. Bigelow Aerospace has launched two prototype spacecraft, Genesis I and Genesis II, on separate Russian Dnepr launch vehicles in 2006 and 2007, respectively. Bigelow Aerospace used these missions to validate its habitat designs and engineering in an actual on-orbit environment.

Bigelow Aerospace is currently developing the Bigelow Expandable Activity Module (BEAM), a technology pathfinder system for the ISS. In December of 2012, NASA awarded Bigelow Aerospace a $17.8 million contract to develop the BEAM, which will launch on the eighth SpaceX CRS flight in 2015. The BEAM is scheduled for a nominal two-year technology demonstration period, wherein ISS crewmembers will gather data on the performance of the module. The BEAM mission period may be extended by NASA, and at the end of its life, the BEAM will be jettisoned from the ISS and will burn up during reentry.

Bigelow Aerospace has also been continuing work on full-scale expandable modules. Specifically, the company is developing the BA 330, which will offer 330 cubic meters of internal volume and can accommodate a crew of up to six, and the BA 2100 or 'Olympus', which will provide roughly 2,100 cubic meters of internal volume. In 2013, Bigelow Aerospace announced that it could modify the BA 330 in a number of ways depending on mission needs. The BA 330-DS would be designed for missions beyond LEO requiring additional radiation shielding. The BA 330-MDS would be designed for surface installations on the Moon. Finally, Bigelow Aerospace is considering a version of the BA 2100 that could carry spacecraft as well as crew, using a large airlock to facilitate transfers. These modules can be linked together to form space stations, and can also be linked together with any of a variety of tugs that the company intends to provide, including a Standard Transit Tug, a Solar Generator Tug, a Docking Node Transporter, and a Spacecraft Capture Tug.

Bigelow Aerospace is also involved in crew transportation. The company is a member of the Boeing CCDev team working on the CST-100 reusable in-space crew transport vehicle.

Bigelow Aerospace has also completed a substantial expansion to its north Las Vegas manufacturing plant. The company's new 180,572 square foot addition now increases the size of Bigelow Aerospace facilities to a total of 341,551 square feet.

Currently, with the exception of the BEAM launch aboard the eighth CRS flight, 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.

Planetary Resources

In April 2012, Planetary Resources, Inc., a company formed by Space Adventures founder Eric Anderson and X PRIZE Chairman Peter Diamandis, introduced its plans to mine near-Earth asteroids for raw materials. In its initial efforts, Planetary Resources is focusing on telescopes designed to identify resource-rich targets. It has entered into an agreement with

Virgin Galactic to launch several constellations of Arkyd-100 Series LEO space telescopes on Virgin Galactic's LauncherOne. LauncherOne is still under development with commercial flights estimated to begin in 2016. The company's A3 cubesat and Arkyd-100 telescope will be launched as secondary payloads during the forecast period.

Other Sources of Future Launch Demand

Several other efforts have been pursued in recent years that will require commercial crew and cargo transportation, or may in the future. Some of these, Inspiration Mars Foundation and Space Adventures, have enough funding to press forward with mission planning and even hardware development. Other efforts like Excalibur Almaz and Golden Spike have raised limited funds. At this time, no launch contracts have been announced, so launch demand associated with these companies is not included in the forecast.

Blue Origin

Blue Origin is a U.S-based company pursuing development of a crewed suborbital transportation system called New Shepard and an orbital crewed system consisting of a Reusable Orbital Space Vehicle (SV) launched aboard a two-stage Orbital Launch Vehicle (OLV). The SV will be designed to carry seven people. The reusable OLV first stage will be powered by a cluster of BE-3 liquid rocket engines. In 2013, the company successfully tested the BE-3, which burns liquid hydrogen and liquid oxygene and produces about 100,000 pounds of thrust. The company has not yet released a schedule for test launches.

Excalibur Almaz

Excalibur Almaz, Limited (EAL), an Isle of Man company, uses elements of a legacy Soviet military space program known as Almaz. EAL's key partners are NPO Mashinostroyenia (the original developer of Almaz), Airbus Group, and Japan Manned Space Systems Corporation. The system includes four three-person reusable return vehicles (RRV) and two Salyut-type Almaz orbital space stations that can stay on-orbit autonomously for one week or dock with the ISS. One of the RRVs will be equipped as an unmanned microgravity laboratory to assist with science flights to LEO. NASA awarded EAL an unfunded SAA for commercial crew transportation as part of CCDev2 activities, and was the first company to complete all of its SAA milestones. If in the future NASA decides to use the system, the baseline vehicle will be the Atlas V. In June 2012, the company announced plans to ferry passengers to and from lunar orbit, with tickets costing around $155 million. EAL intended to begin flight tests of Almaz by late 2014 and to launch its first revenue-generating flight as early as the fourth quarter of 2015. However, details regarding financing have not been provided publicly, and no launch contracts have been announced.

Golden Spike Company

The Golden Spike Company formed to offer private human expeditions to the surface of the Moon by 2019 or 2020. The company's president is former NASA Associate Administrator for Science Alan Stern. Golden Spike estimates the cost for a two-person lunar surface mission will start at $1.4 billion for the first mission, and $1.6 billion for increasingly ambitious subsequent missions. Golden Spike contracted with Northrop Grumman for the design of a new lunar lander capable of carrying two crewmembers.

Inspiration Mars Foundation

The Inspiration Mars Foundation originally hoped to mount a privately funded crewed Mars flyby mission originally planned for 2018. By early 2014, this objective slipped to 2021 and now includes NASA’s Space Launch System (SLS) as part of its architecture. The project aims to take advantage of a planetary alignment that will allow a Mars flyby and return in 501 days. The foundation plans to use a single SLS launch to send a Dual Use Upper Stage (DUUS) and a modified Cygnus module into LEO. The SLS and DUUS are currently being developed by NASA. The Cygnus module is provided by Orbital Sciences Corporation as a cargo transport to ISS. A second launch, using a smaller vehicle like an Atlas V or Delta IV, will send a crew of two aboard an NASA’s Orion spacecraft. Inspiration Mars Foundation Chairman Dennis Tito will fund mission development for the first two years, during which time additional fundraising and support will be garnered.

Space Adventures

Space Adventures, a broker for space tourism and expeditions, indicated in 2011 that it was in the late planning stages for a three-person expedition to circumnavigate the Moon. Two of the individuals will pay for their seats, while a third will be a Roscosmos cosmonaut. This effort will include two separate launches, one of a Proton-M carrying a Block-DM lunar transfer stage, and one of a Soyuz with two crew members. The ticket price for each of the seats is rumored to be about $150 million. The company has indicated that at least one ticket has been sold and that the other is in final negotiations.

Other Commercially Launched Satellites

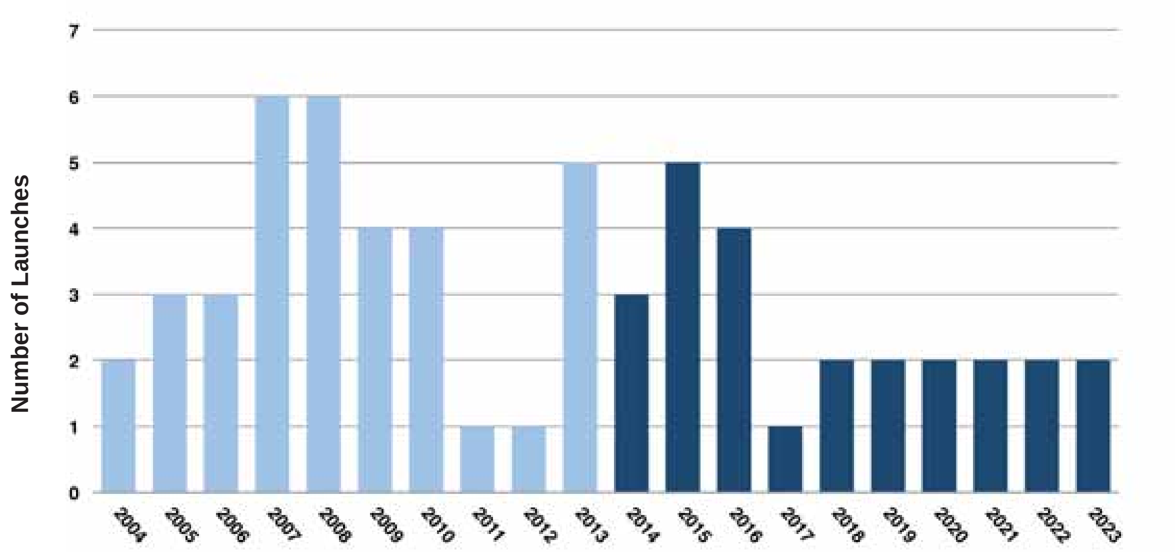
This section contains predominantly government satellites launched commercially. It also includes university payloads that are scientific, education, or outreach. Though many government missions do not commercially procure or obtain commercial licenses for their launches, there are select missions that do, particularly by governments without domestic launch capabilities.

In previous reports, Other Commercially Launched Satellites were discussed in the sections "Science and Engineering – Basic and Applied Research" and "Other Payloads Launched Commercially." For clarity, these sections were combined to provide a more complete picture of the market of commercial launches procured by governments. Government Earth observation and remote sensing programs and other scientific missions are significant customers of commercial launch services to NGSO.

Other Commercially Launched Satellites Demand Summary

The market characterization of the near term (2014-2017) includes 13 manifested launches. For the period 2018-2023, the application of a forecasting method projects 12 launches for an average of 2 in each of the 6 out years. Figure 20 provides a launch history and projected launch plan demands for Other Commercially Launched Satellites.

Figure 20. Other Commercially Launched Satellites Launch History and Projected Launch Plans



2014	2015	2016	2017
ASNARO - Dnepr	SAOCOM 1A - Falcon 9	DragonLab 1 - Falcon 9	DragonLab - Falcon 9
PAZ - Dnepr	Formosat 5 - Falcon 9	DubaiSat-3 - Dnepr	
Google X PRIZE - LM-2C	Gökturk 1 - TBD	EnMAP - PSLV	
	Kompsat 3A - Dnepr	SAOCOM 1B - Falcon 9	
	Deimos - Dnepr		

- **ASNARO 1:** ASNARO is a remote sensing satellite for the Japanese Ministry of Economy, Trade, and Industry manufactured by the NEC. The satellite has a projected mass of 400 kilograms (882 pounds) and will launch on a Dnepr in 2014.
- **DragonLab:** DragonLab is the configuration of the Dragon spacecraft intended for commercial customers that will operate independently of missions to the ISS. DragonLab will function as an 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 starting in 2016.
- **DubaiSat-3:** A follow-on to the DubaiSat-2, launched last year, from the Emirates Institution for Advanced Science and Technology located in the UAE, it is scheduled to launch as a primary payload in a multi-manifested launch aboard Dnepr vehicles in 2016. The satellite has a mass of about 300 kilograms (661 pounds) and will provide improved resolution and faster download speeds.
- **EnMAP:** The German Aerospace Center, DLR, plans to launch the EnMap spacecraft in 2016 on a PSLV vehicle. The spacecraft has a mass of 810 kilograms (1,786 pounds) and 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:** Formosat-5 is a remote sensing satellite for Taiwan’s National Space Organization. It is expected to launch in 2015 on a Falcon 9 vehicle. The satellite is built by Airbus. With a mass of 525 kilograms (1,157 pounds), the satellite 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.
- **Gökturk-1:** Gökturk-1 is an electro-optical earth observation satellite for the Turkish Ministry of Defense. Italian firm Telespazio is the manufacturer. The satellite is projected to have a mass of up to 5,000 kilograms (11,000 pounds) and is expected to launch in 2015 (originally planned for 2014) on a Vega launch vehicle.
- **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. South Korea’s Korean Aerospace Research Institute (KARI) is developing KOMPSAT-3A, which will launch in 2015 (delayed from 2014) on a Dnepr vehicle.
- **PAZ:** PAZ is a radar satellite that will be operated by Hisdesat. It represents part of the Spanish National Earth Observation Program 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 2014.
- **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 state 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. The satellites will launch separately on Falcon 9 vehicles in 2015 and 2016.

- **SARah:** SARah is a German Federal Armed Forces satellite-based radar reconnaissance system. The three synthetic aperture radar (SAR) satellites are a follow-on to Germany's SAR-Lupe system, which is schedule to operate until 2017. Two of the SARah satellites are enhanced reflector technology that was developed for SAR-Lupe and will be built by OHB Systems AG. The third satellite will build by Astrium GmbH using phased array technology similar to TerraSAR-X and TanDEM-X. These satellites are planned for launch on two Falcon 9 missions in 2017 and 2018.

Method for Forecasting Launch Demand

This forecast revised the model for payloads and launches related to basic and applied scientific research that was applied in the 2012 NGSO report. The methodology features a five-year average that includes three prior years and two projected years (for this report, 2010-2014) with equal weight. This simple model is applied to payloads as well as launch vehicles pertaining to basic and applied scientific research beginning in 2017, the mid, and far out-years. This makes the out-years of the projection more sensitive to emerging trends identified in the near-term through research. Because launches of other payloads, from countries without indigenous launch capabilities, are infrequent, the model does not apply a forecasting method to this segment. This does not mean the actual demand is gone, but rather these types of payloads are irregular and efforts to forecast their occurrence in the out-years can lead to an overstatement of launch demand.

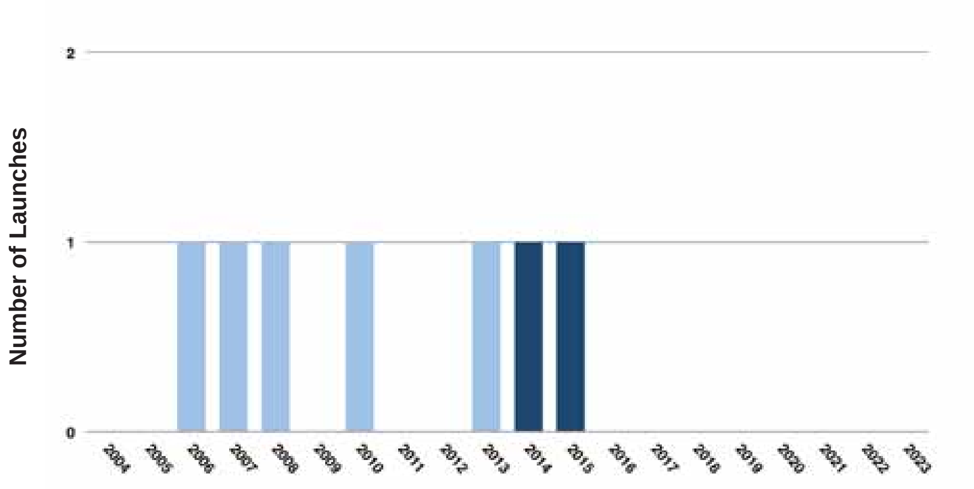
Technology Test and Demonstration Launches

Technology test and demonstration launches was previously part of Science and Engineering section. Technology test and demonstration launches are conducted to test primarily new launch vehicles such as Antares, Falcon 9, or Falcon Heavy. By their nature, they are uncommon, and one-off events. Placing technology test and demonstration launches in a separate section provides easy identification of these one-off events.

Figure 21 provides a launch history and projected launch plans for technology test and demonstration launches.

The inaugural launch of SpaceX's Falcon Heavy launch vehicle is now planned for launch in 2015. The report also includes the technology test and demonstration launch of the Orion Multi Purpose Crew Vehicle (MPCV), planned to launch aboard a Delta IV Heavy in late 2014.

Figure 21. Technology Test and Demonstration Launch History and Projected Launch Plans



2014	2015	2016	2017
Orion EFT-1 - Delta IV Heavy	Test - Falcon Heavy		

Microsatellites

Progress in electronics and other satellite component miniaturization has enabled spacecraft weighing as little as 0.01 to 10 kilograms, known as femto-, pico-, and nanosatellites. Table 20 presents the range of small satellite mass classes.

While pico- and femtosatellites are rare, micro- and nanosatellites, and specifically, a subset of nanosatellites called cubesats, constitute a substantial share of payloads launched commercially.

Cubesats are a distinctive group of small satellites in the nanosat mass class. Cubesats are miniaturized satellites measuring 10x10x10 centimeters and weighing 1 kilogram, also know as 1 unit (1U). Satellite units can be combined to create double- or triple-unit (2U or 3U) cubesats with measurements of 10x10x20 centimeters (2U) or 10x10x30 centimeters (3U), respectively. They can offer the standard functions of a normal satellite, including deployment of solar panels, antennas, and booms. By the end of 2013, over 200 cubesats have launched, and more cubesats are either ready to launch or in various phases of planning, development and production, or launch preparation.

The original cubesat concept was introduced in 2003 as a low-cost university educational satellite platform and gradually became the standard for most university satellites. Universities are still the main organization building these spacecraft. As cubesats become more capable, government and private industry have become more interested in launching and operating them. For example, spacecraft manufacturers build these satellites to space-qualify equipment for future use on larger satellites.

Because of their size, individual cubesats often perform just one function at a time. However, constellations of cubesats can potentially work together to provide greater functionality. A cubesat constellation would require enough cubesats that if one or two

Table 20. Small Satellite Mass Classes

Class Name	Kilograms (kg)	Pounds (lb)
Femto	0.01 - 0.1	0.02 - 0.2
Pico	0.1 - 1	0.2 - 2
Nano	1 - 10	2 - 22
Micro	10 - 200	22 - 441
Mini	200 - 600	441 - 1,323
Small	600 - 1,200	1,323 - 2,646

failed, it would not be mission critical. Beside universities, government agencies have become interested in developing cubesat constellations.

Cubesats are usually launched as piggyback payloads using excess launch capacity on launch vehicles deploying larger primary payloads. Some cubesats are deployed in orbit, usually from the International Space Station (ISS) after being delivered to it as cargo.

In 2003 - 2013, both non-commercial and commercial launch vehicles launched a total of 201 cubesats worldwide (see Table 21). The majority of cubesats were launched for non-profit (mostly university) missions (see Figure 22).

At present, cubesats by themselves do not present launch demand. In the commercial space launch industry, launch providers are interested in creating space for smaller secondary payloads to drive the launch price down or increase profits. There have been an increasing number of cubesats launched over the past decade with a record number launched in 2013. More of them are expected to launch in the future, however, this increase is not expected to affect launch demand in the short term. The market situation may change when commercial suborbital reusable vehicles and small orbital launch vehicles (commercial and non-commercial) introduce new nanosat launch opportunities, including those for cubesats.

Historically, a variety of launch vehicles have launched cubesats (see Figure 23). Over the past decade, the Russian Dnepr launch vehicle has launched the largest number. Other vehicles, such as Atlas V (U.S.), Falcon 9 (U.S.), Minotaur (U.S.), PSLV (India), and Vega (Europe) vehicles have been launching more cubesats lately.

In 2013, a record number of 92 cubesat class satellites were launched, including 59 cubesats on 2 launch vehicles launched about only 30 hours apart. Those missions were a U.S. Air Force mission on Minotaur I and a Russian Dnepr mission, both launched in November.

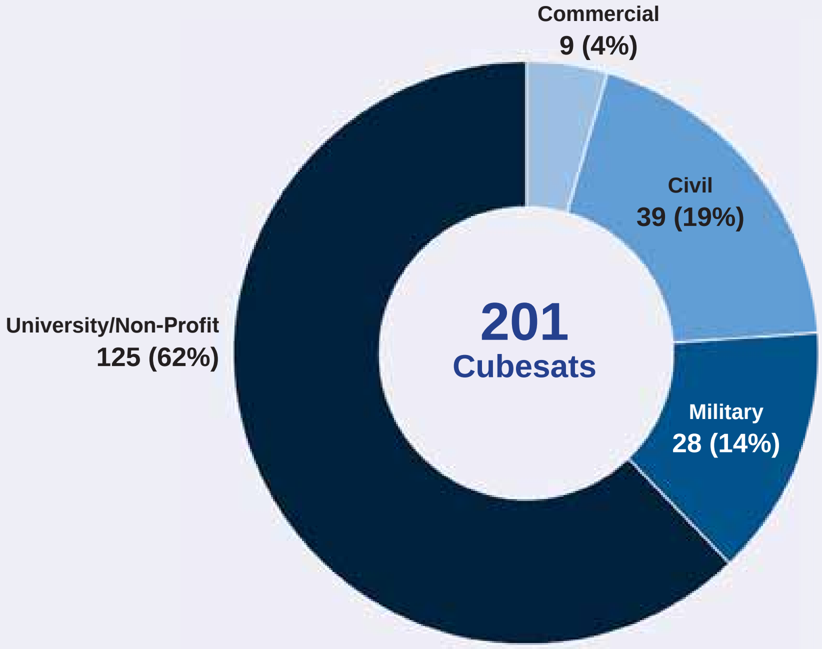
U.S. company NanoRacks also provides capability for orbiting cubesats from the International Space Station (ISS). Prior to such insertion, the cubesats are delivered to ISS onboard orbital cargo vehicles, such as the HTV and Cygnus.

In the United States, the NASA Educational Launch of Nanosatellites (ELaNa) program promotes satellite building for space engineering and science education purposes by providing universities and other organizations developing

Table 21. Cubesats Launched from 2003 to 2013

Type of Launch	Cubesats
Commercial	86
Non-Commercial	115
Total Cubesats Launched	**201**

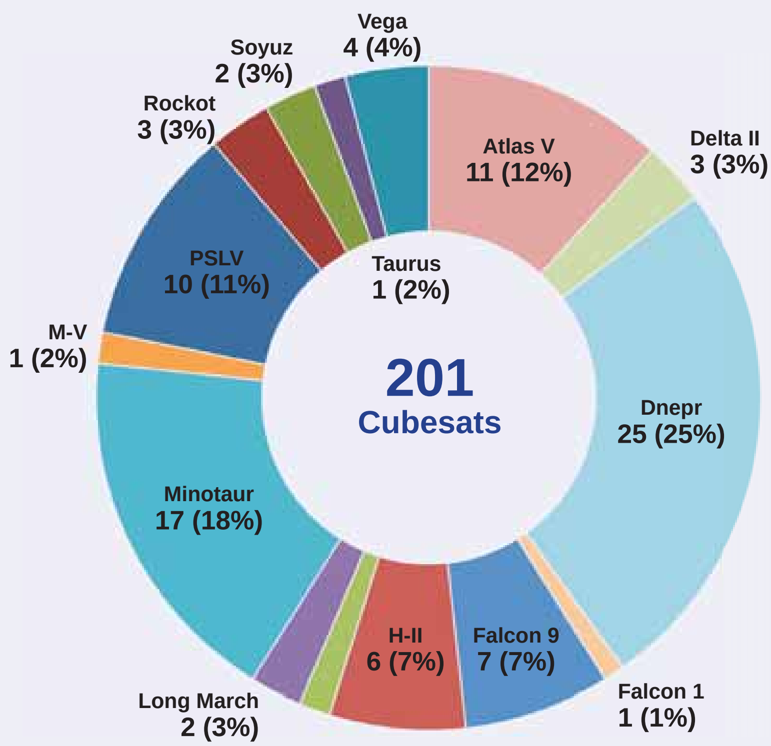
Figure 22. Microsatellites and Nanosatellites Launched in 2003-2013



small satellites with free launches aboard vehicles carrying larger primary missions for NASA or other U.S. Government agencies. These include non-commercial launches by vehicles like the Atlas V or commercial launches to the ISS by a Falcon 9 or Antares.

In the commercial launch sector, Virgin Galactic announced LauncherOne in 2012 to launch satellites weighing up to 100 kilograms to LEO, commercial flights projected to begin in 2016. Super Strypi (also known as SPARK) is another launch vehicle scheduled to make its first flight in 2014. It is designed to launch payloads in the range of 300 kg to LEO.

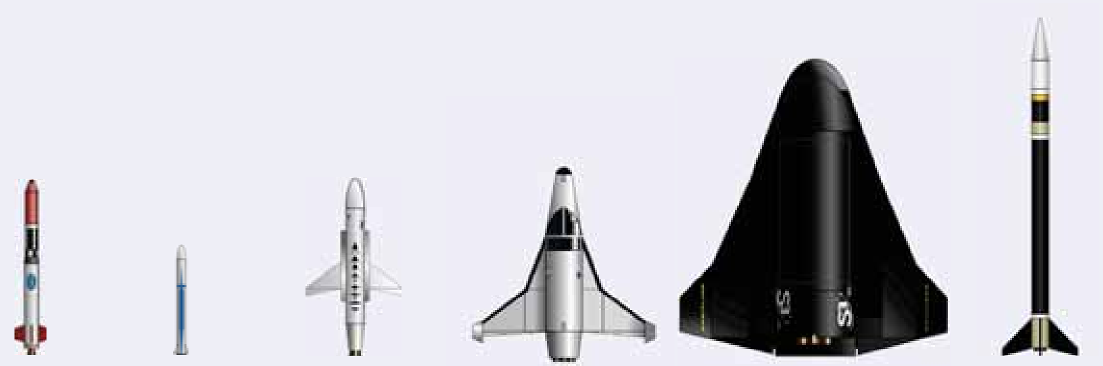
Figure 23. Microsatellites and Nanosatellites Launched by Vehicle, 2003-2013



At present, cubesats are predominantly used for technology demonstration, both in spacecraft technology and satellite applications, such as communications and remote sensing. As the technology matures, more cubesats are built for scientific, communications, and remote sensing purposes, including emerging commercial applications. Thus, U.S. commercial remote sensing company Planet Labs launched a "Flock" of 75 3U cubesats from the ISS, delivered by the Cygnus CRS-1 mission in early 2014 and is planning to launch 25 more cubesats each year during the forecast period. Another Earth remote sensing commercial venture will use 6U cubesats in an 8-satellite Perseus-O constellation, planned by Dauria Aerospace and Elecnor Deimos. Planetary Resources, Inc. also plans to launch cubesat-sized satellites carrying telescopes designed to identify resource-rich targets among near-Earth asteroids.

Table 22 provides summary information on launch vehicles expected to be introduced during the next five years that are specifically designed to launch microsatellites. The majority of these, DARPA's Airborne Launch Assist Space Access (ALASA), Generation Orbit's GOLauncher-2, Virgin Galactic's LauncherOne, and S3's Sub Orbital Aircraft Reusable (SOAR), will be air-launched by a carrier aircraft. Lynx III uses rocket power to take off from a conventional runway, reach suborbital space, release a small launch vehicle with a nanosatellite, then return to land like a conventional airplane. Super Strypi is a rail-launched vehicle.

Table 22. Selected Small Launch Vehicles Expected to be Introduced During the Next 5 Years



	ALASA	GOLauncher-2	LauncherOne	Lynx III	SOAR	Super Strypi
Operator	DARPA	Generation Orbit	Virgin Galactic	XCOR Aerospace	Swiss Space Systems	DoD
Manufacturer	DARPA, Boeing	Generation Orbit	Virgin Galactic, SSTL	XCOR Aerospace	Dassault, Deimos, Sonaca, Meggitt	Aerojet Rocketdyne, Sandia Labs
LEO Capacity (kg)	45	45	100	15	250	275
Planned First Flight	2015	2016	2016	TBD	2017	2014
Method of Launch	Air	Air	Air	Suborbital	Air/Suborbital	Ground (Rail)

Vehicles are to scale. ALASA: Airborne Launch Assist Space Access, CALT: China Academy of Launch Vehicle Technology, CASC: China Aerospace Science and Technology Corporation, CGWIC: China Great Wall Industry Corporation, DARPA: Defense Advanced Research Projects Agency, DoD: Department of Defense, SOAR: Sub Orbital Aircraft Reusable, SSTL: Surrey Satellite Technology Ltd.

Satellite and Launch Forecast Trends

The demand for commercial GEO launches for the next 10 years is expected to stay relatively steady at 15 to 17 launches per year. The demand for commercial NGSO launches is expected to increase relatively significantly as major NGSO telecommunication constellations are replenished and NASA ISS commercial crew and cargo resupply missions become more regular. The annual average of NGSO commercial launches is expected to grow from an annual average of 6 launches a year to almost 14 launches annually

From 2014 to 2023, 558 payloads are projected to launch commercially, driving 138 launches with multi-manifesting. Ten more launches over the next decade are projected compared to last year's forecast of 128 launches. This increase is driven primarily by additional flights for commercial crew and cargo and commercial remote sensing. Figures 24 and 25 show the payloads and launches projected from 2013 to 2022. Table 23 provides the specific numbers of payloads and launches for each segment.

Fifty-eight percent of the predicted launches over the next 10 years are for commercial transportation services. As noted earlier, many of these launches take place on newly developed vehicles. These missions also partly rely on government funding subject to annual appropriations.

Other Commercially Launched Satellites account for 18 percent of launches over the next 10 years. These include a steady stream of basic and applied research and non-commercial remote sensing payloads primarily from countries without indigenous launch capabilities.

The commercial remote sensing accounts for 14 percent of the launches and all the demand for small vehicles. Projected demand is considerably higher in this year's report due the inclusion of new commercial remote sensing companies like Skybox Imaging.

Nine percent of the launches are for commercial telecommunications. Five launches are planned in 2014 and 2015 for ORBCOMM, Globalstar, and O3b satellites. There is another

Figure 24. Payload Projections

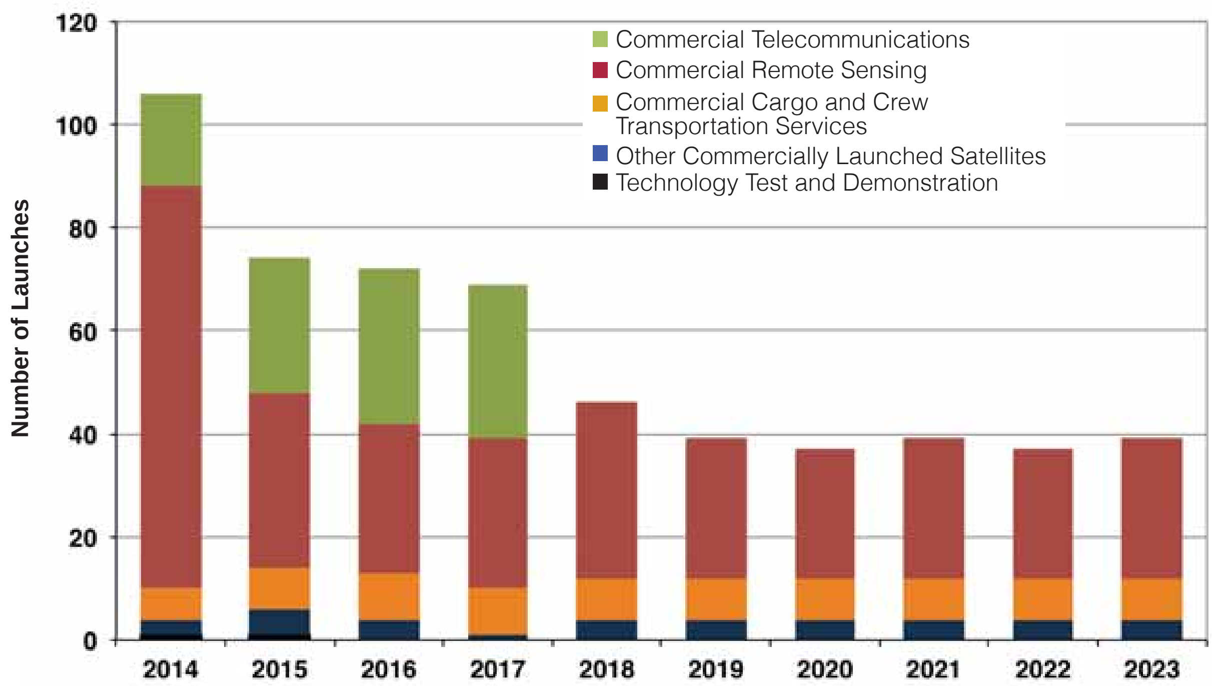


Figure 25. Launch Projections

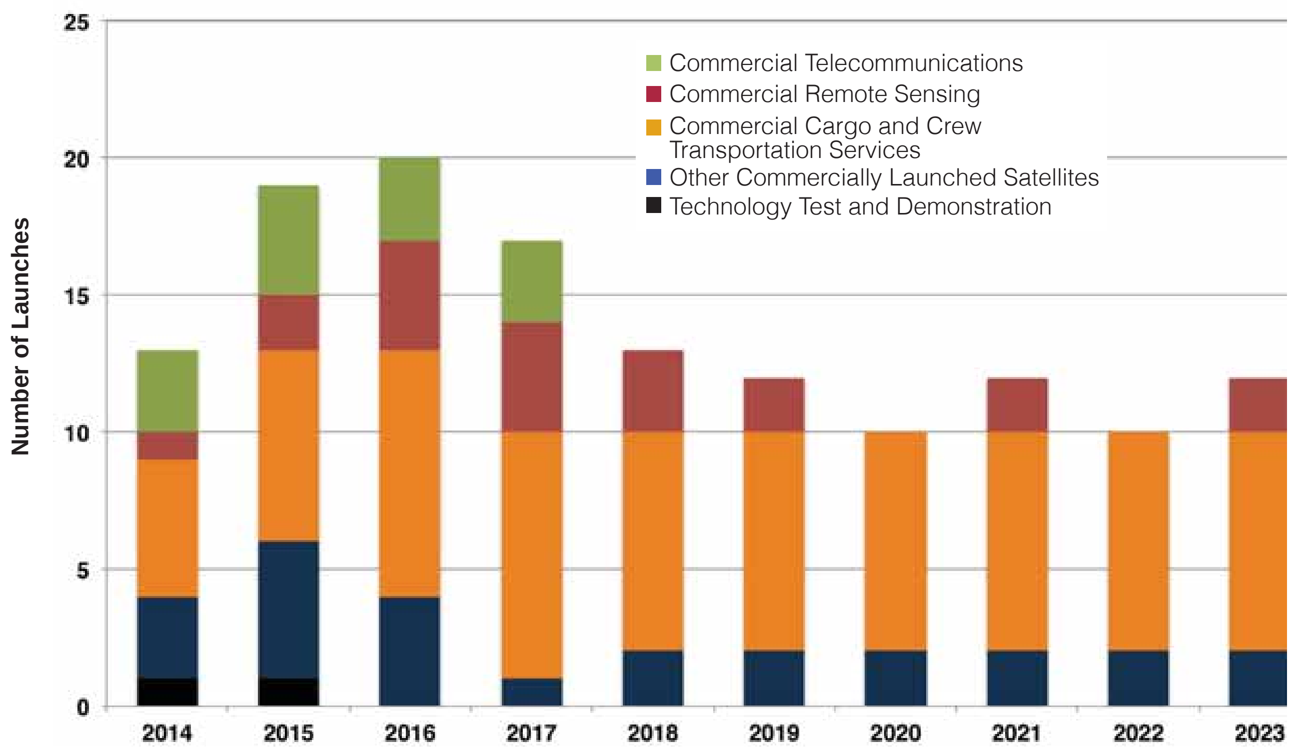


Table 23. Payload and Launch Projections

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total	Avg.
Payloads												
Commercial Telecommunications	18	26	30	30	0	0	0	0	0	0	**104**	**10.4**
Commercial Remote Sensing	78	34	29	29	34	27	25	27	25	27	**335**	**33.5**
Commercial Cargo and Crew Transportation Services	6	8	9	9	8	8	8	8	8	8	**80**	**8**
Other Commercially Launched Satellites	3	5	4	1	4	4	4	4	4	4	**37**	**3.7**
Technology Test and Demonstration	1	1	0	0	0	0	0	0	0	0	**2**	**.2**
Total Satellites	**106**	**74**	**72**	**69**	**46**	**39**	**37**	**39**	**37**	**39**	**558**	**55.8**
Launches												
Medium-to-Heavy Vehicles	13	18	16	14	13	10	10	10	10	10	**124**	**12.4**
Small Vehicles	0	1	4	3	0	2	0	2	0	2	**14**	**1.4**
Total Launches	**13**	**19**	**20**	**17**	**13**	**12**	**10**	**12**	**10**	**12**	**138**	**13.8**

peak of telecommunications launches from 2015 to 2017 as Iridium replaces its satellites. No telecommunications launches are forecasted from 2018 to 2022, after the replacement constellations are completed.

The technology test and demonstration segment accounts for less than 2 percent of launches over the next 10 years, including 2 launches of new technology test and demonstration missions: SpaceX's Falcon Heavy, and NASA's uncrewed test of the Orion MPCV on a Delta IV Heavy.

Payload mass varies significantly in the commercial NGSO market. Increasing numbers of micro- and nanosatellites are launched as secondary or piggyback payloads, and many countries commercially launch mini, small, and medium sized satellites to LEO for scientific research or remote sensing. The number of cubesats launched in 2013 almost double from the previous year. NGSO commercial telecommunications satellites are large constellations of satellites with sizes ranging from nano (AprizeStar) to micro (ORBCOMM) to small (Globalstar, Iridium, O3b), none over 800 kilograms. In contrast, the average mass of a GSO telecommunications satellite is approximately 5,000 kilograms, with many GSO satellites significantly heavier than that. Crew and cargo spacecraft to the ISS and Bigelow space stations will likely include large, heavy, or extra heavy payloads. Table 24 shows the mass distributions of known manifested payloads over the next two years.

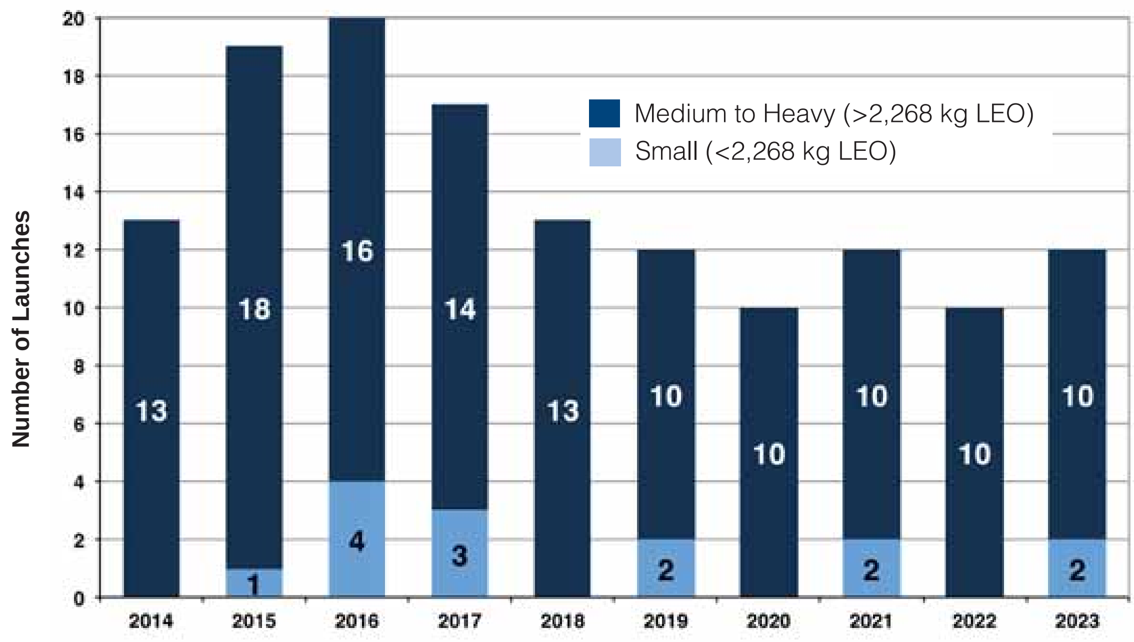
Table 24. Distribution of Payload Masses in Near-Term Manifest

Mass Class	Mass Class Weight	2014	2015	Total	Percent of Total
Femto, Pico, Nano, Micro	0.01-200 kg (0.02-441 lbs)	41	6	**14**	**17%**
Mini	200-600 kg (441-1,323 lbs)	9	13	**22**	**27%**
Small	600-1,200 kg (1,323-2,646 lbs)	10	18	**28**	**35%**
Medium, Intermediate	1,200-4,200 kg (2,646-9,259 lbs)	3	3	**6**	**7%**
Large	4,200-5,400 kg (9,259-11,905 lbs)	0	0	**0**	**0%**
Heavy, Extra Heavy	> 5,400 kg (> 11,905 lbs)	4	7	**11**	**16%**
	Total	**34**	**47**	**81**	**100%**

There are 138 launches projected, comprising 14 small vehicles and 124 medium-to-heavy vehicles. On average, 1.4 launches take place on small vehicles and 12.4 launches on medium-to-heavy vehicles every year. The 2012 report included 130 total launches composed of 3 small and 127 medium-to-heavy launches.

Launch demand divided among launch vehicle mass classes is depicted in Figure 26. The number of medium-to-heavy launches increased slightly compared to last year's forecast, due to the addition of commercial crew test flights in the mid-term. The relatively high cost of a dedicated launch on a small launch vehicle compared to a secondary or piggyback payload on a larger vehicle has kept the demand for small launch vehicles low. This dynamic is beginning to change as new small vehicle systems like Virgin Galactic's LauncherOne become available. This year's report includes 11 more launches of small vehicles, all that demand coming from commercial remote sensing. Factors smaller payloads continuing to use larger launch vehicles are more multiple-manifest launch services, carrying primary missions on both commercial and non-commercial basis, have become readily available

Figure 26. Launch Vehicle Projections



in the recent years; many small payload operators are tied to government funding or national launch capabilities (e.g., small European missions launched by Vega or U.S. university missions getting free rides through programs like NASA's ELaNa). Intermediary companies (such as SpaceFlight Services, Commercial Space Technologies Ltd., and some others) offering brokerage services and pooling together clusters of secondary payloads to be launched together on a single launch vehicle have made the business of booking flights for secondary payloads more organized and predictable.

Table 25 on the next page provides the distribution of launches among the market segments.

Table 25. Distribution of Launches among Market Segments

Market Segment	Payloads	Launch Demand		
		Small	Medium-to-Heavy	Total
Commercial Telecommunications	104	0	13	13
Commercial Remote Sensing	335	14	6	20
Commercial Cargo and Crew Transportation Services	80	0	78	78
Other Commercially Launched Satellites	37	0	25	25
Technology Test and Demonstration	2	0	2	2
Total	**558**	**14**	**124**	**138**

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. In the U.S., SpaceX began to launch revenue-generating flights of the Falcon 9 in 2012, and Orbital’s Antares vehicle begin revenue-generating flights in 2014. In 2015 Orbital will launch the Minotaur C, essentially a modified Taurus, with Skybox Imaging satellites. The Super Strypi, a rail launched vehicle, may launch for the first time in 2014. Virgin Galactic intends to begin commercial launches of its new LauncherOne vehicle in 2016, and has booked three Skybox Imaging flights that year. Generation Orbit and XCOR are also expected to provide small launch services in the near-term. Stratolaunch Systems, which is developing a vehicle that will be launched from a huge carrier aircraft called Stratolauncher, will introduce its vehicle system in 2018. This vehicle will have a capacity of about 6,000 kg to LEO.

In Europe, Arianespace’s small vehicle Vega is now available for commercial launches, and the company will be introducing a replacement to Ariane 5 later in the forecast period. Swiss Space Systems is also expected to introduce its SOAR shuttle in 2017, which will carry small payloads to LEO. China may introduce a small vehicle called the Long March 6, which may be offered commercially, by 2017. The larger Long March-5, -7, and -11 are also expected to be introduced during the forecast period. In 2013, Japan launched its Epsilon small launch vehicle in 2013 and South Korea launched the small Naro-1 vehicle. Russia plans the first launch of its long-awaited Angara series in 2014.

RISK FACTORS THAT AFFECT SATELLITE AND LAUNCH DEMAND

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. Factors that contribute to the difference between forecasted and realized launches include financial, political, and technical uncertainty.

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, 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 missing 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 on 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: HISTORICAL GSO SATELLITES AND LAUNCHES

Historical data for addressable commercial satellites launched from 1994 through 2013 is shown in Table 26. Historical data for unaddressable satellites launched from 1993 to 2012 is shown in Table 27.

Table 26. Historical Addressable Commercial GSO Satellites Launched (1994-2013)

	1994			1995			1996		
Total Launches	14			17			21		
Total Satellites	18			18			25		
Over 5,400 kg (>11,905 lbm)	0			0			0		
4,200 - 5,400 kg (9,260 - 11,905 lbm)	0			0			0		
2,500 - 4,200 kg (5,510 - 9,260 lbm)	9			14			14		
		Astra 1D	Ariane 4		Astra 1E	Ariane 4	DM3	Arabsat 2A	Ariane 4
		Intelsat 702	Ariane 4		DBS 3	Ariane 4	DM4	Arabsat 2B	Ariane 4
	DM2	PAS 2	Ariane 4		Intelsat 706	Ariane 4		EchoStar 2	Ariane 4
		PAS 3	Ariane 4		NSTAR a	Ariane 4		Intelsat 707	Ariane 4
	DM4	Solidaridad 2	Ariane 4		PAS 4	Ariane 4		Intelsat 709	Ariane 4
		Telstar 402	Ariane 4		Telstar 402R	Ariane 4		MSAT 1	Ariane 4
		DBS 2	Atlas II		AMSC 1	Atlas II		NSTAR b	Ariane 4
		Intelsat 703	Atlas II		Galaxy 3R	Atlas II	DM2	Palapa C2	Ariane 4
		Optus B3	LM-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	LM-2E		Palapa C1	Atlas II
					Asiasat 2	LM-2E		Intelsat 708	LM-3B
					EchoStar 1	LM-2E		Astra 1F	Proton K/DM
Below 2,500 kg (<5,510 lbm)	9			4			11		
	DM3	Brazilsat B1	Ariane 4	DM1	Brazilsat B2	Ariane 44	DM2	Amos 1	Ariane 4
	DM2	BS-3N	Ariane 4	DM1	Hot Bird 1	Ariane 44	DMU	Italsat 2	Ariane 4
	DM1	Eutelsat II F5	Ariane 4	DMU	Insat 2C	Ariane 44	DM1	Measat 1	Ariane 4
	DM4	Thaicom 2	Ariane 4		Koreasat	Delta I	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 1R	Delta II					Galaxy 9	Delta II
		APStar 1	LM-3					Koreasat 2	Delta II
								APStar 1A	LM-3
								Inmarsat 3F2	Proton K/DM

= Launch Failure

DM# = Dual-manifested Launch with another Addressable 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 26. Historical Addressable Commercial GSO Satellites Launched (1994-2014) (Continued)

	1997			1998			1999		
Total Launches	24			19			19		
Total Satellites	28			23			23		
Over 5,400 kg (>11,905 lbm)	0			0			0		
4,200 - 5,400 kg (9,260 - 11,905 lbm)	0			0			2		
								Galaxy 11	Ariane 4
								Orion 3	Delta III
2,500 - 4,200 kg (5,510 - 9,260 lbm)	21			14			14		
	DMU	Hot Bird 3	Ariane 4	DM4	Afristar	Ariane 4		AMC 4	Ariane 4
		Intelsat 801	Ariane 4	DM3	Eutelsat W2	Ariane 4	DM1	Arabsat 3A	Ariane 4
		Intelsat 802	Ariane 4		Hot Bird 4	Ariane 4		Insat 2E	Ariane 4
		Intelsat 803	Ariane 4		PAS 6B	Ariane 4		Koreasat 3	Ariane 4
		Intelsat 804	Ariane 4		PAS 7	Ariane 4		Orion 2	Ariane 4
		JCSat 5	Ariane 4		Satmex 5	Ariane 4		Telkom	Ariane 4
		PAS 6	Ariane 4		ST 1	Ariane 4		Telstar 7	Ariane 4
	DM4	Sirius 2	Ariane 4		Hot Bird 5	Atlas II		Echostar 5	Atlas II
	DM2	Thaicom 3	Ariane 4		Intelsat 805	Atlas II		Eutelsat W3	Atlas II
		AMC 3	Atlas II		Intelsat 806	Atlas II		JCSat 6	Atlas II
		DirecTV 6	Atlas II		Galaxy 10	Delta III		Asiasat 3S	Proton K/DM
		EchoStar 3	Atlas II		Astra 2A	Proton K/DM		Astra 1H	Proton K/DM
		Galaxy 8i	Atlas II		EchoStar 4	Proton K/DM		LMI 1	Proton K/DM
		JCSat 4	Atlas II		PAS 8	Proton K/DM		Nimiq	Proton K/DM
		Superbird C	Atlas II					Telstar 6	Proton K/DM
		Agila II	LM-3B					DirecTV 1R	Sea Launch
		APStar 2R	LM-3B						
		Astra 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)	9			1			1		
	DM1	AMC 2	Ariane 4	DM4	AMC 5	Ariane 4	DM1	Skynet 4E	Ariane 4
	DM2	BSat 1A	Ariane 4	DM1	Brazilsat B3	Ariane 4			
	DM4	Cakrawarta 1	Ariane 4	DM2	BSat 1B	Ariane 4			
	DM3	Inmarsat 3F4	Ariane 4	DM1	Inmarsat 3F5	Ariane 4			
	DM3	Insat 2D	Ariane 4	DM2	NileSat 101	Ariane 4			
	DM1	Nahuel 1A	Ariane 4	DM3	Sirius 3	Ariane 4			
		Thor II	Delta II		Bonum 1	Delta II			
					Skynet 4D	Delta II			
					Thor III	Delta II			

= Launch Failure

DM# = Dual-manifested Launch with another Addressable 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 26. Historical Addressable Commercial GSO Satellites Launched (1994-2013) (Continued)

	2000			2001			2002		
Total Launches	20			12			20		
Total Satellites	24			14			22		
Over 5,400 kg (>11,905 lbm)	0			0			0		
4,200 - 5,400 kg (9,260 - 11,905 lbm)	4			5			9		
		Anik F1	Ariane 4		DirecTV 4S	Ariane 4		Intelsat 904	Ariane 4
		PAS 1R	Ariane 5		Intelsat 901	Ariane 4		Intelsat 905	Ariane 4
		Garuda 1	Proton K/DM		Intelsat 902	Ariane 4		Intelsat 906	Ariane 4
		Thuraya 1	Sea Launch		XM Rock	Sea Launch		NSS 6	Ariane 4
					XM Roll	Sea Launch		NSS 7	Ariane 4
								Astra 1K	Proton K/DM
								Echostar 8	Proton K/DM
								Intelsat 903	Proton K/DM
								Galaxy 3C	Sea Launch
2,500 - 4,200 kg (5,510 - 9,260 lbm)	14			6			11		
	DM1	Asiastar 1	Ariane 5		Atlantic Bird 2	Ariane 4		Insat 3C	Ariane 4
	DM3	Astra 2B	Ariane 5		Turksat 2A	Ariane 4	DM1	JCSat 8	Ariane 4
		Europe*Star 1	Ariane 4	DM2	Artemis	Ariane 5	DMU	Atlantic Bird 1	Ariane 5
		Eutelsat W1R	Ariane 4	DM1	Eurobird	Ariane 5	DMU	Hotbird 7	Ariane 5
		Galaxy 10R	Ariane 4		Astra 2C	Proton K/DM	DM2	Stellat 5	Ariane 5
		Galaxy IVR	Ariane 4		PAS 10	Proton K/DM		Hispasat 1D	Atlas II
		NSat 110	Ariane 4					Echostar 7	Atlas III
		Superbird 4	Ariane 4					Hotbird 6	Atlas V
		Echostar 6	Atlas II					Eutelsat W5	Delta IV
		Hispasat 1C	Atlas II					DirecTV 5	Proton K/DM
		Eutelsat W4	Atlas III					Nimiq 2	Proton M
		AAP 1	Proton K/DM						
		AMC 6	Proton K/DM						
		PAS 9	Sea Launch						
Below 2,500 kg (<5,510 lbm)	6			3			2		
	DM2	Brazilsat B4	Ariane 4	DMU	Skynet 4F	Ariane 4	DM1	Astra 3A	Ariane 4
	DM2	Nilesat 102	Ariane 4	DM1	BSat 2A	Ariane 5	DM2	NSTAR c	Ariane 5
	DM3	AMC 7	Ariane 5	DM2	BSat 2B	Ariane 5			
	DM4	AMC 8	Ariane 5						
	DM4	Astra 2D	Ariane 5						
	DM1	Insat 3B	Ariane 5						

= Launch Failure

DM# = Dual-manifested Launch with another Addressable 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 26. Historical Addressable Commercial GSO Satellites Launched (1994-2013) (Continued)

	2003			2004			2005		
Total Launches	12			13			15		
Total Satellites	15			13			16		
Over 5,400 kg (>11,905 lbm)	0			3			6		
					Anik F2	Ariane 5	DM1	Spaceway 2	Ariane 5
					Intelsat X	Proton M		Thaicom 4	Ariane 5
					DirecTV 7S	Sea Launch		Inmarsat 4F1	Atlas V
								IA 8	Sea Launch
								Inmarsat 4F2	Sea Launch
								Spaceway 1	Sea Launch
4,200 - 5,400 kg (9,260 - 11,905 lbm)	5			4			4		
		Intelsat 907	Ariane 4		Amazonas	Proton M		AMC 12	Proton M
	DM2	Optus C1	Ariane 5		Eutelsat W3A	Proton M		AMC 23	Proton M
		Rainbow 1	Atlas V		APStar V	Sea Launch		Anik F1R	Proton M
		EchoStar 9	Sea Launch		Estrela do Sul	Sea Launch		XM 3	Sea Launch
		Thuraya 2	Sea Launch						
2,500 - 4,200 kg (5,510 - 9,260 lbm)	6			4			3		
	DM1	Insat 3A	Ariane 5		Superbird 6	Atlas II		Insat 4A	Ariane 5
	DM3	Insat 3E	Ariane 5		MBSat	Atlas III	DMU	XTAR-EUR	Ariane 5
		Asiasat 4	Atlas III		AMC 16	Atlas V		DirecTV 8	Proton M
		HellasSat	Atlas V		AMC 15	Proton M			
		AMC 9	Proton K/M						
		Galaxy 13	Sea Launch						
Below 2,500 kg (<5,510 lbm)	4			2			3		
	DM2	Bsat 2C	Ariane 5		AMC 10	Atlas II	DM1	Telkom 2	Ariane 5
	DM3	e-Bird 1	Ariane 5		AMC 11	Atlas II	DMU	Galaxy 15	Ariane 5
	DM1	Galaxy 12	Ariane 5					Galaxy 14	Soyuz
		Amos 2	Soyuz						

= Launch Failure

DM# = Dual-manifested Launch with another Addressable 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 26. Historical Addressable Commercial GSO Satellites Launched (1994-2013) (Continued)

	2006			2007			2008		
Total Launches	15			12			18		
Total Satellites	19			18			23		
Over 5,400 kg (>11,905 lbm)	2			3			5		
	DM2	Satmex 6	Ariane 5	DM3	Spaceway 3	Ariane 5		ICO G-1	Atlas V
	DM3	DirecTV 9S	Ariane 5		DirecTV 10	Proton M		Ciel 2	Proton M
					NSS 8	Sea Launch		Inmarsat 4F3	Proton M
								DirecTV 11	Sea Launch
								Echostar 11	Sea Launch
4,200 - 5,400 kg (9,260 - 11,905 lbm)	9			6			8		
	DM4	Wildblue 1	Ariane 5	DM2	Astra 1L	Ariane 5	DM3	HotBird 9	Ariane 5
		Astra 1KR	Atlas V	DM1	Skynet 5A	Ariane 5	DM1	Skynet 5C	Ariane 5
		Hotbird 8	Proton M	DM5	Skynet 5B	Ariane 5	DM5	Superbird 7	Ariane 5
		Measat 3	Proton M		Nigcomsat	LM-3B		Astra 1M	Proton M
		Echostar 10	Sea Launch		Anik F3	Proton M		Nimiq 4	Proton M
		Galaxy 16	Sea Launch		SES Sirius 4	Proton M		Galaxy 18	Sea Launch
		JCSat 9	Sea Launch					Galaxy 19	Sea Launch
		Koreasat 5	Sea Launch					Thuraya 3	Sea Launch
		XM 4	Sea Launch						
2,500 - 4,200 kg (5,510 - 9,260 lbm)	6			5			8		
	DM1	Hotbird 7A	Ariane 5	DM2	Galaxy 17	Ariane 5	DM1	Turksat 3A	Ariane 5
	DMU	JCSat 10	Ariane 5	DM1	Insat 4B	Ariane 5	DM2	Badr 6	Ariane 5
	DM1	Spainsat	Ariane 5	DM6	RASCOM 1	Ariane 5	DM2	Protostar 1	Ariane 5
	DM2	Thaicom 5	Ariane 5	DM5	Star One C1	Ariane 5	DM3	Eutelsat W2M	Ariane 5
		Arabsat 4A	Proton M		JCSat 11	Proton M	DM4	Vinasat	Ariane 5
		Arabsat 4B	Proton M				DM4	StarOne C2	Ariane 5
							DM5	AMC 21	Ariane 5
								AMC 14	Proton M
Below 2,500 kg (<5,510 lbm)	2			4			2		
	DM4	AMC 18	Ariane 5	DM3	Bsat 3A	Ariane 5		AMOS 3	Land Launch
	DM3	Optus D1	Ariane 5	DM4	Intelsat 11	Ariane 5		Thor 5	Proton M
				DM4	Optus D2	Ariane 5			
				DM6	Horizons	Ariane 5			

[grey box] = Launch Failure

DM# = Dual-manifested Launch with another Addressable 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 26. Historical Addressable Commercial GSO Satellites Launched (1994-2013) (Continued)

	2009	2010	2011
Total Launches	18	14	12
Total Satellites	22	20	15
Over 5,400 kg (>11,905 lbm)	8 DM1 Amazonas 2 Ariane 5 DM2 NSS 12 Ariane 5 Terrestar 1 Ariane 5 Intelsat 14 Atlas V DirecTV 12 Proton M Eutelsat W2A Proton M Eutelsat W7 Proton M Sirius FM5 Proton M	7 DM4 Eutelsat W3B Ariane 5 Arabsat 5B Proton M Echostar 14 Proton M Echostar 15 Proton M KA-Sat Proton M SkyTerra 1 Proton M XM 5 Proton M	3 DM1 Yahsat 1A Ariane 5 Quetzsat Proton M Viasat 1 Proton M
4,200 - 5,400 kg (9,260 - 11,905 lbm)	2 DM3 Hotbird 10 Ariane 5 Nimiq 5 Proton M	4 DM1 Astra 3B Ariane 5 DM2 Arabsat 5A Ariane 5 DM6 Hispasat 1E Ariane 5 DM5 Intelsat 17 Ariane 5	6 DM3 Arabsat 5C Ariane 5 DM2 Astra 1N Ariane 5 DMU ST 2 Ariane 5 Eutelsat W3C Long March Telstar 14R Proton M Atlantic Bird 7 Sea Launch
2,500 - 4,200 kg (5,510 - 9,260 lbm)	9 DM4 JCSat 12 Ariane 5 DM1 Satcom BW1 Ariane 5 DM2 Thor 6 Ariane 5 Telstar 1N Land Launch Intelsat 15 Long March Palapa D Long March Asiasat 5 Proton M Protostar II Proton M Sicral 1B Sea Launch	6 DM5 Hylas Ariane 5 DM6 Koreasat 6 Ariane 5 DM3 Nilesat 201 Ariane 5 DM3 RASCOM 1R Ariane 5 DM1 Satcom BW2 Ariane 5 SES 1 Proton M	6 DM2 BSAT 3C Ariane 5 DM1 New Dawn Ariane 5 DM3 SES 2 Ariane 5 Intelsat 18 Land Launch Asiasat 7 Proton M DMU SES 3 Proton M/ DM
Below 2,500 kg (<5,510 lbm)	3 DM3 NSS 9 Ariane 5 DM4 Optus D3 Ariane 5 Measat 3A Land Launch	3 DM1 Telkom 2 Ariane 5 DMU Galaxy 15 Ariane 5 Galaxy 14 Soyuz	0

= Launch Failure

DM# = Dual-manifested Launch with another Addressable 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 26. Historical Addressable Commercial GSO Satellites Launched (1994-2013) (Continued)

	2012			2013		
Total Launches	12			13		
Total Satellites	21			16		
Over 5,400 kg (>11,905 lbm)	10			10		
	DM3	Astra 2F	Ariane 5	DM1	Amazonas 3	Ariane 5
	DMU	Echostar 17	Ariane 5	DM2	Alphasat	Ariane 5
	DM2	Intelsat 20	Ariane 5	DM3	Eutelsat 25B	Ariane 5
		Echostar 16	Proton M		Satmex 8	Proton M
		Intelsat 22	Proton M		Eutelsat 7B	Proton M
		SES 4	Proton M		SES 6	Proton M
		SES 5	Proton M		Astra 2E	Proton M
		Yahsat 1B	Proton M		Sirius FM6	Proton M
		Intelsat 19	Sea Launch		Inmarsat 5F1	Proton M
		Intelsat 21	Sea Launch		Intelsat 27	Sea Launch
4,200 - 5,400 kg (9,260 - 11,905 lbm)	5			1		
	DM4	Eutelsat 21B	Ariane 5		Anik G1	Proton M
	DM1	JCSAT 13	Ariane 5			
	DM5	Skynet 5D	Ariane 5			
		Nimiq 6	Proton M			
		Eutelsat 70B	Sea Launch			
2,500 - 4,200 kg (5,510 - 9,260 lbm)	6			5		
	DM3	GSAT 10	Ariane 5	DM1	Africasat 1A	Ariane 5
	DM2	Hylas 2	Ariane 5	DM2	GSAT 7	Ariane 5
	DM5	Mexsat 3	Ariane 5	DM 3	Insat 3D	Ariane 5
	DM4	Star One C3	Ariane 5		SES 8	Falcon 9
	DM1	Vinasat 2	Ariane 5		Amos 4	Land Launch
		Intelsat 23	Proton M			
Below 2,500 kg (<5,510 lbm)	0			0		

= Launch Failure

DM# = Dual-manifested Launch with another Addressable 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 27. Historical Unaddressable Commercial GSO Satellites Launched (1994-2013)

	1994			**1995**			**1996**			**1997**		
Launches	4			1			4			1		
Spacecraft	4			2			5			1		
		DFH 3-1	LM-3A	DMC	Telecom 2C	Ariane 4	DMC	Telecom 2D	Ariane 4		Chinasat 6	LM-3A
		Express	Proton K/DM		Gals 2	Proton K/DM		Chinasat 7	LM-3A			
		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			
	1998			**1999**			2000			**2001**		
Launches	2			2			5			1		
Spacecraft	2			3			5			1		
		ChinaStar 1	LM-3B		Express A1	Proton K/DM		Express A2	Proton K/DM		Ekran M	Proton M
		Sinosat 1	LM-3C	DM1	Yamal 101	Proton K/DM		Express A3	Proton K/DM			
				DM1	Yamal 102	Proton K/DM		Gorizont 45	Proton K/M			
								SESAT 1	Proton K/DM			
								Chinasat 22	LM-3A			
	2002			2003			2004			2005		
Launches	1			3			2			3		
Spacecraft	1			4			2			3		
		Express A4	Proton K/DM		Express AM22	Proton K/DM		Express AM11	Proton K/DM		Express AM 2	Proton K/DM
				DM1	Yamal 201	Proton K/DM		Express AM1	Proton K/DM		Express AM 3	Proton K/DM
				DM1	Yamal 202	Proton K/DM					Apstar 6	LM-3B
					Chinasat 20	LM-3A						
	2006			2007			2008			2009		
Launches	4			4			3			1		
Spacecraft	4			4			3			2		
		Kazsat	Proton K/DM		Sinosat 3	LM-3B		Venesat 1	LM-3B	DM1	Express MD1	Proton M
		Sinosat 2	LM-4B		Chinasat 6B	LM-3B		Chinasat 9	LM-3B	DM1	Express AM44	Proton M
		Chinasat 22A	LM-3A		Nigcomsat 1	LM-3B		Express AM33	Proton			
		Insat 4C	GSLV		Insat 4CR	GSLV						
	2010			2011			2012			2013		
Launches	3			8			6					
Spacecraft	3			10			8					
		ChinaSat 6A	LM-3B		GSAT 8	Ariane 5		Apstar 7	LM-3B			
		ChinaSat 20A	LM-3A		Chinasat 10	LM-3B		Chinasat 2A	LM-3B			
		Insat 4D	GSLV		Chinasat 1A	LM-3B		Chinasat 12	LM-3B			
					Nigcomsat 1R	LM-3B	DM1	Express MD2	Proton M			
					Paksat 1R	LM-3B	DM2	Luch 5B	Proton M			
				DM1	Amos 5	Proton M	DM1	Telkom 3	Proton M			
				DM1	Luch 5A	Proton M	DM2	Yamal 300K	Proton M			
					Express AM4	Proton M		Yamal 402	Proton M			
				DMA	Kazsat 2	Proton M						
					GSAT 12	PSLV						

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 2013 NGSO report projects demand consistently higher than the average of 5.5 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 2013 NGSO report shows the launches scheduled to deploy the replacement satellites for each of the systems. Globalstar plans to complete their constellation in 2015, and a new O3b constellation will launch at the same time as ORBCOMM plans its major launch campaign. The Iridium NEXT deployment schedule does not fully overlap with the other constellations as it did in the late 1990s.

The Other Commercially Launched Satellites and Commercial Remote Sensing Satellite markets create consistent launch demand according to historical figures. Since 1996, there had always been at least one launch of a government satellite launched commercially. The Commercial Remote Sensing Market has low launch demand and it is more sporadic than Other Commercially Launched Satellites.

The number of payloads launched by market sector and the total commercial launches that were internationally competed or commercially sponsored from 2003 through 2012 are provided in Table 28. Small vehicles performed 22 launches during this period, while medium-to-heavy vehicles conducted 33 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, with a trend emerging since 2007 of payloads increasingly launching on medium-to-heavy vehicles. The 2013 NGSO report estimates the larger vehicle class will continue to conduct the most launches.

Historical satellite and launch data from 2003 through 2013 are shown in Table 29.

Table 28. Historical Payloads and Launches[6]

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Payloads											
Commercial Telecommunication	2	0	0	8	6	2	6	14	1	12	**51**
Commercial Remote Sensing	0	1	1	3	8	1	1	2	0	8	**25**
Commercial Cargo and Crew Transportation Services	0	0	0	0	0	0	1	0	2	2	**5**
Other Commercially Launched Satellites	7	7	3	13	6	7	6	4	1	5	**59**
Technology Test & Demonstration	0	0	1	1	1	0	1	0	0	1	**5**
Total Satellites	**9**	**8**	**5**	**25**	**19**	**10**	**15**	**20**	**4**	**28**	**145**
Launches											
Medium-to-Heavy Vehicles	1	0	2	10	4	2	7	3	3	8	**41**
Small Vehicles	1	3	3	2	6	3	1	0	0	2	**21**
Total Launches	**2**	**3**	**5**	**12**	**10**	**5**	**8**	**3**	**3**	**10**	**62**

[6] 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.

Table 29. Historical NGSO Payload and Launch Activities (2004-2013)

Summary	Market Segment	Date	Satellite	Launch Vehicle	
2013					
28 Satellites 12 Telecommunication 8 Remote Sensing 2 Transportation 6 Other 10 Launches 8 Medium-to-Heavy 2 Small	Telecommunication	2/6/13 6/25/13	Globalstar II 19-24 O3b 01-04 AprizeSat 7-8	Soyuz 2.1a Soyuz 2.1b	Medium-to-Heavy Medium-to-Heavy
	Remote Sensing	8/22/13 11/21/13	Kompsat-5 DubaiSat-2 SkySat-1 WINISAT-1 Dove 1-4	Dnepr Dnept	Medium-to-Heavy Medium-to-Heavy
	Transportation	3/1/13 9/18/13	Dragon CRS D2 Orb-D1	Falcon 9 Antares	Medium-to-Heavy Medium-to-Heavy
	Other	4/21/13 11/19/13	A-ONE STPSAT-3 CASSIOPE SWARM 1-3	Antares Minotaur I Falcon 9 Rockot	Medium-to-Heavy Small Medium-to-Heavy Small
2012					
4 Satellites 1 Telecommunication 2 Transportation 1 Other 3 Launches 3 Medium-to-Heavy	Telecommunication		ORBCOMM OG2-01[1]		
	Transportation	5/22/12 10/7/12	Dragon COTS Demo 2/3 Dragon CRS D1	Falcon 9 Falcon 9	Medium-to-Heavy Medium-to-Heavy
	Other	12/19/12	Gökturk 2	LM 2D	Medium-to-Heavy
2011					
20 Satellites 14 Telecommunication 2 Remote Sensing 4 Other 3 Launches 3 Medium-to-Heavy	Telecommunication	7/13/11 12/28/11	Globalstar 2nd Gen. 7-12 AprizeStar 5-6[2] Globalstar 2nd Gen.13-18	Soyuz 2 Soyuz 2	Medium-to-Heavy Medium-to-Heavy
	Remote Sensing		Nigeriasat-2[3A] NX[3B]		
	Other	8/17/11	Sich 2 RASAT Edusat BPA-2	Dnepr	Medium-to-Heavy
2010					
15 Satellites 6 Telecommunication 1 Remote Sensing 6 Other 1 Test and Demo 1 Transportation **8 Launches** 7 Medium-to-Heavy 1 Small	Telecommunication	10/19/10	Globalstar 2nd Gen. 1-6	Soyuz 2	Medium-to-Heavy
	Remote Sensing	6/20/10	TanDEM X	Dnepr M	Medium-to-Heavy
	Other	4/7/10 6/1/10 6/14/10 11/5/10	Cryosat 2 SERVIS 2 Prisma (2 sats) Picard[4] Cosmos-SkyMed 4	Dnepr M Rockot Dnepr M Delta II	Medium-to-Heavy Small Medium-to-Heavy Medium-to-Heavy
	Test and Demo	6/9/10	Falcon 9 Demo Flight	Falcon 9	Medium-to-Heavy
	Transportation	12/8/10	Dragon COTS Demo 1	Falcon 9	Medium-to-Heavy

= Launch Failure

DM# = Dual-manifested Launch with another Unaddressable 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.

1 ORBCOMM OG2-01 deployed on launch with Dragon CRS 1D
2 AprizeStar 5 & 6 deployed on launch with Sich 2 et al.
3 Nigeriasat-2 and NX deployed on launch with Sich 2 et al.
4 Picard deployed on launch with Prisma Main & Target

Table 29. Historical NGSO Satellite and Payload Activities (2004-2013) (Continued)

Summary	Market Segment	Date	Satellite	Launch Vehicle	
			2009		
12 Satellites 2 Telecommunication 3 Remote Sensing 7 Other **5 Launches** 2 Medium-to-Heavy 3 Small	Telecommunication		AprizeStar 3-4[5]		
	Remote Sensing	10/8/09	Worldview 2 DEIMOS[6A] UK DMC 2[6B]	Delta II	Medium-to-Heavy
	Other	7/13/09 7/29/09 3/17/09 11/2/09	RazakSat DubaiSat 1 Nanosat 1B GOCE SMOS Proba 2 UGATUSAT[7]	Falcon I Dnepr Rockot Rockot	Small Medium-to-Heavy Small Small
			2008		
19 Satellites 6 Telecommunication 6 Remote Sensing 6 Other 1 Test and Demo **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
	Other	3/27/08 4/16/08 7/22/08 8/3/08 10/1/08 10/24/08	SAR Lupe 4 C/NOFS SAR Lupe 5 Trailblazer[F] THEOS Cosmo-SkyMed 3	Cosmos 3M Pegasus XL Cosmos 3M Falcon 1 Dnepr 1 Delta II	Small Small Small Small Medium-to-Heavy Medium-to-Heavy
	Test and Demo	9/28/08	Falcon 1 Mass Simulator	Falcon 1	Small
			2007		
25 Satellites 8 Telecommunication 3 Remote Sensing 13 Other 1 Test and Demo **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 SoyuzD	Medium-to-Heavy Medium-to-Heavy Medium-to-Heavy
	Other	4/17/07 4/23/07 6/7/07 7/2/07 11/1/07 12/8/07	Egyptsat SaudiComsat 3-7 Saudisat 3 AGILE AAM Cosmos-SkyMed 1 SAR Lupe 2 SAR Lupe 3 Cosmo-SkyMed 2	Dnepr PSLV Delta II Cosmos 3M Cosmos 3M Delta II	Medium-to-Heavy Medium-to-Heavy Medium-to-Heavy Small Small Medium-to-Heavy
	Test and Demo	6/28/07	Genesis II	Dneor	Medium-to-Heavy
			2006		
5 Satellites 1 Remote Sensing 3 Other 1 Test and Demo **5 Launches** 2 Medium-to-Heavy 3 Small	Remote Sensing	4/25/06	EROS B	START 1	Small
	Other	7/28/06 12/27/06 12/19/06	Kompsat 2 Corot SAR Lupe 1	Rockot Soyuz 2 1B Cosmos	Small Medium-to-Heavy Small
	Test and Demo	7/12/06	Genesis 1	Soyuz 2 1B	Medium-to-Heavy
			2006		

5 AprizeStar 3 & 4 deployed on launch with DubaiSat 1
6 DEIMOS and UK DMC 2 deployed on launch with DubaiSat 1
7 UGATUSAT deployed on launch with Meteor 3M-N3
F Launch Failure

Table 29. Historical NGSO Satellite and Payload Activities (2004-2013) (Continued)

Summary	Market Segment	Date	Satellite	Launch Vehicle	
5 Satellites 1 Remote Sensing 3 Other 1 Test and Demo 5 Launches 2 Medium-to-Heavy 3 Small	Remote Sensing	4/25/06	EROS B	START 1	Small
	Other	7/28/06 12/27/06 12/19/06	Kompsat 2 Corot SAR Lupe 1	Rockot Soyuz 2 1B Cosmos	Small Medium-to-Heavy Small
2005					
8 Satellites 1 Remote Sensing 7 Other **3 Launches** 3 Small	Remote Sensing	10/27/05	Beijing 1	Cosmos	Small
	Other	10/8/08 6/21/05	Cryosat Cosmos 1 Rubin 5[8A] Sinah 1[8B] SSETI Express[8C] Mozhayets 5[9D] Topsat[9E]	Rockot[F] Volna[F]	Small Small
2004					
9 Satellites 2 Telecommunication 7 Other **2 Launches** 1 Medium-to-Heavy 1 Small	Telecommunication		LatinSat (2 sats)[9]		
	Other	5/20/04 6/29/04	Rocsat 2 Demeter AMSat-Echo[10A] SaudiComSat 1-2[10B] SaudiSat 2[10C] Unisat 3[10D]	Taurus Dnepr	Small Medium-to-Heavy

8 Rubin 5, Sinah 1, SSETI Express, Mozhayets 5, and Topsat deployed on launch with Beijing 1
9 LatinSat deployed on launch with Demeter
10 AMSat-Echo, SaudiComSAT 1-2, SaudiSat 2, and Unisat 3 deployed on launch with Demeter
11 Rubin 4-DSI deployed on launch with BilSat 1
F Launch Failure

APPENDIX 3: 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 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, such as the Moon.

APPENDIX 4: MASS CLASSES FOR GSO AND NGSO PAYLOADS

Table 30. Mass Classes for GSO and NGSO Payloads

Class Name	Kilograms (kg)	Pounds (lb)
Femto	0.01 - 0.1	0.02 - 0.2
Pico	0.1 - 1	0.2 - 2
Nano	1 - 10	2 - 22
Micro	10 - 200	22 - 441
Mini	200 - 600	441 - 1,323
Small	600 - 1,200	1,323 - 2,646
Medium	1,200 - 2,500	2,646 - 5,512
Intermediate	2,500 - 4,200	5,512 - 9,259
Large	4,200 - 5,400	9,259 - 11,905
Heavy	5,400 - 7,000	11,905 - 15,432
Extra Heavy	> 7,000	> 15,432

APPENDIX 5: ACRONYMS

21AT	Twenty First Century Aerospace Technology Company Ltd.
ABS	Asia Broadcast Satellite
AIS	Automatic Identification System
ADF	Australian Defense Force
ATK	Alliant Technologies
ATV	Automated Transfer Vehicle
BEAM	Bigelow Expandable Activity Module
BMBF	Federal Ministry of Education and Research
BPA	Blok Perspektivnoy Avioniki
CASSIOPE	Cascade, Smallsat, and Ionospheric Polar Explorer
CAST	Chinese Academy of Space Technology
CCAFS	Cape Canaveral Air Force Station
CCDev	Commercial Crew Development
CCiCAP	Commercial Crew Integrated Capacity
CEO	Chief Executive Officer
CHIRP	Commercially Hosted Infrared Payload Flight Demonstration Program
COMSTAC	Commercial Space Transportation Advisory Committee
COTS	Commercial Orbital Transportation Services
CPC	Certification Product Contract
CRS	Commercial Resupply Services
CSA	Canadian Space Agency
CSSWE	Colorado Student Space Weather Experiment
CST-100	Crew Space Transportation-100
CXBN	Cosmic X-Ray Background
DARS	Digital Audio Radio Service
DBS	Direct Broadcasting Services
DEM	Digital Elevation Model
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German space agency)
DMC	Disaster Monitoring Constellation
DMCii	DMC International Imaging, Ltd.
DTH	Direct-to-Home
EADS	European Aeronautic Defence and Space Company
EAL	Excalibur Almaz, Ltd.
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
EXIM	Export-Import Band
EXT	External or Non-Geocentric Orbit
FAA AST	Federal Aviation Administration, Office of Commercial Space Transportation
FCC	Federal Communications Commission
FY	Fiscal Year
FSS	Fixed Satellite Services
GIS	Geographic Information Systems
GMW	GeoMetWatch
GPS	Global Positioning System
GSLV	Geosynchronous Satellite Launch Vehicle
GSO	Geosynchronous Orbit
GTO	Geosynchronous Transfer Orbit
HDTV	High Definition Television Services
HEO	Highly Elliptical Orbit
HPA	Hosted Payload Alliance
ICL	Imperial College London
ILS	International Launch Services
IPO	Initial Public Offering
ISRO	Indian Space Research Organization
ISS	International Space Station
ITAR	International Traffic in Arms Regulations
ITT	International Telephone & Telegraph
ITU	International Telecommunications Union
KARI	Korea Aerospace Research Institute
KSLV	Korean Space Launch Vehicle
LEO	Low Earth Orbit
LCRD	Laser Communications Relay Demonstration
LLC	Limited Liability Company
MEO	Medium Earth Orbit
MHI	Mitsubishi Heavy Industries, Ltd.
MPCV	Multi Purpose Crew Vehicle
MSS	Mobile Satellite Services
NASA	National Aeronautics and Space Administration
NEC	Nippon Electric Company
NGA	National Geospatial-Intelligence Agency
NGSO	Non-Geosynchronous Orbits

NOAA	National Oceanic and Atmospheric Administration
O3b	Other Three Billion Networks, Ltd.
OHB	Orbitale Hochtechnologie Bremen
Orbital	Orbital Sciences Corporation
PSLV	Polar Satellite Launch Vehicle
RCM	RADARSAT Constellation Mission
RRV	Reusable Return Vehicle
SAA	Space Act Agreement
SAR	Synthetic Aperture Radar
SBAS	Satellite-Based Augmentation Systems
SNC	Sierra Nevada Corporation
SpaceX	Space Exploration Technologies Corporation
SPOT	Satellite Pour l'Observation de la Terre
SSL	Space Systems Loral
SSO	Sun-Synchronous Orbit
SSTL	Surrey Satellite Technology Limited
TBD	To Be Determined
TSX	TerraSAR X-band
UAE	United Arab Emirates
UCISAT	University of California, Irvine Satellite
UHF	Ultra-High Frequency
ULA	United Launch Alliance
USLM	United States Munitions List
USAF	United States Air Force
WAAS	Wide Area Augmentation System

Federal Aviation Administration

Office of Commercial Space Transportation
800 Independence Avenue SW
Washington, DC 20591

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