Federal Aviation Administration

The Annual Compendium of Commercial Space Transportation: 2012

February 2013

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 art: Phil Smith (2013)

NOTICE

Dear Colleague,

2012 was a very active year for the entire commercial space industry.

In addition to all of the dramatic space transportation events, including the first-ever commercial mission flown to and from the International Space Station, the year was also a very busy one from the government's perspective. It is clear that the level and pace of activity is beginning to increase significantly.

Although they are certainly never pleasant, severe budget constraints can sometimes be a stimulus for innovation. Without sacrificing our commitment to AST's safety mission goals, our challenge was to do something we've always done, but in a different way; to increase AST's value-added to the industry we regulate and encourage. One of the results is this report, entitled "The Annual Compendium of Commercial Space Transportation: 2012".

In previous years, AST has produced many informational reports on the state of the established and emerging industry segments directly related to commercial space transportation. These reports contained valuable information and were widely cited in the trade press.

Going forward, AST plans to continue to provide industry with helpful information. But to have a bigger impact and to minimize overlap and sometimes repetitive reporting, the information will be produced and released under the cover of a single document, serving at once as reference, status report, and forecast. The 2012 Compendium is structured in a way to tell the commercial space industry story: first describing the important participants (including orbital and suborbital launch vehicles, spaceports, and beyond-Earth-orbit commercial ventures), next covering the environment in which they must operate (including regulations, policies, and financing), and finally providing a status of the industry's progress and an outlook for what the future may portend.

Although not all innovations are necessarily beneficial, we are confident that industry participants and observers will find this new approach for industry reporting to be a positive change. We realize that this first edition may not be perfectly constructed. It is our full intention that the content and efficacy of this document will evolve with each annual issuance. The role that you, the reader, plays in this continuous improvement process is vital. If you feel that topics or sections are missing from this report, please let us know. If you think that new terms should be included in the definitions section, please let us know. If you have ideas for ways to improve the report in any way, please let us know.

We value the feedback you provide to us, just as we hope you will value the information we are providing to you. Together, we can all contribute to making 2013 a very successful year in the commercial space industry.

Sincerely,

George C Nield

Dr. George C. Nield
Associate Administrator
FAA Office of Commercial Space Transportation

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INTRODUCTION

The Commercial Space Transportation Compendium by the Federal Aviation Administration's Office of Commercial Space Transportation (FAA AST) provides an overview of the industry's activities from the past year, including:

- orbital launch vehicles, suborbital reusable vehicles (SRVs), and on-orbit vehicles and platforms that launched in 2012 or reached advanced stages of development;
- commercial and Government launch sites;
- other commercial ventures, including companies investing in opportunities beyond low Earth orbit;
- regulations related to commercial space transportation;
- sources of public and private funding for vehicle and launch site development; and
- launch data and analysis, including a review of all orbital launches in 2012, five-year orbital launch trends, a forecast of global launch demand, and a forecast of suborbital market demand.

In addition, throughout each of these sections are brief highlights of significant events from 2012.

See the appendices for other resources, including:

- one-page factsheets for commercial orbital launch vehicles, SRVs, and commercial launch sites;
- the 2012 manifest of worldwide orbital launches;
- definitions of terminology; and
- a list of acronyms and abbreviations.

With commercial cargo flights to the International Space Station underway,

May 2012: *SpaceX Dragon berthed to the ISS - first commercial cargo flight to the station.*

August 2012: *NASA awarded Boeing, Sierra Nevada (Dream Chaser, above), and SpaceX agreements to develop capability to launch people to the ISS.*

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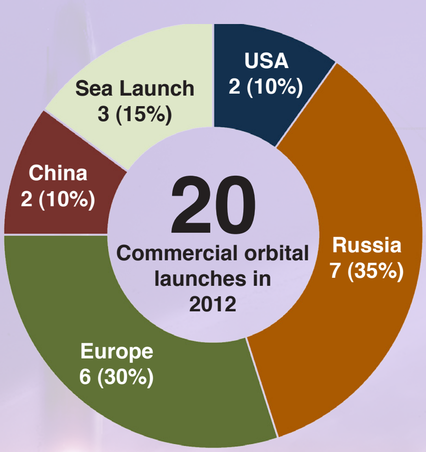
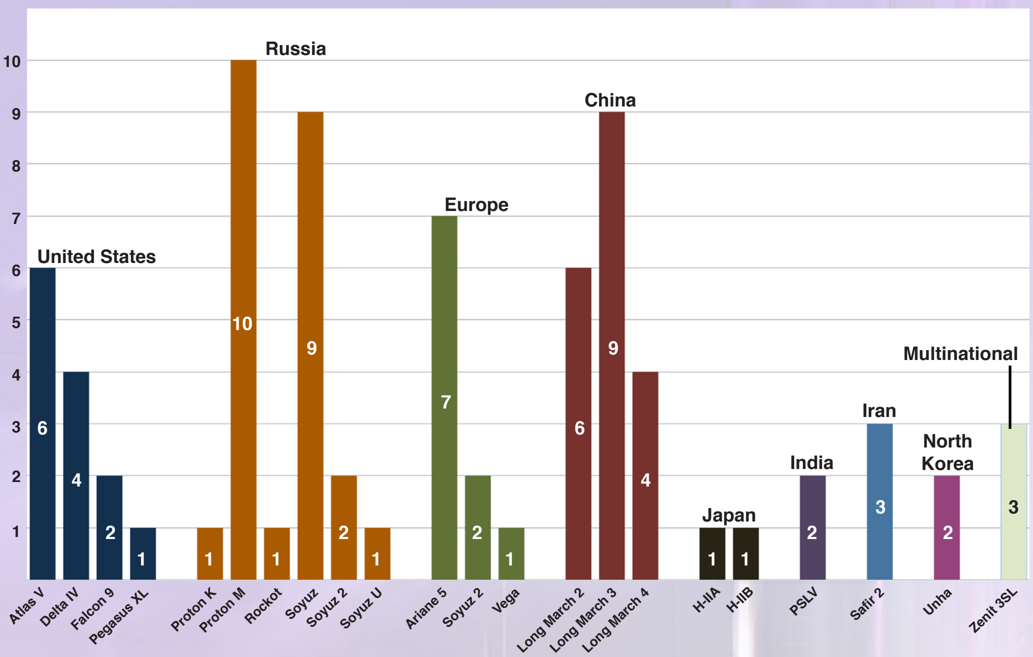
Total worldwide orbital launches in 2012

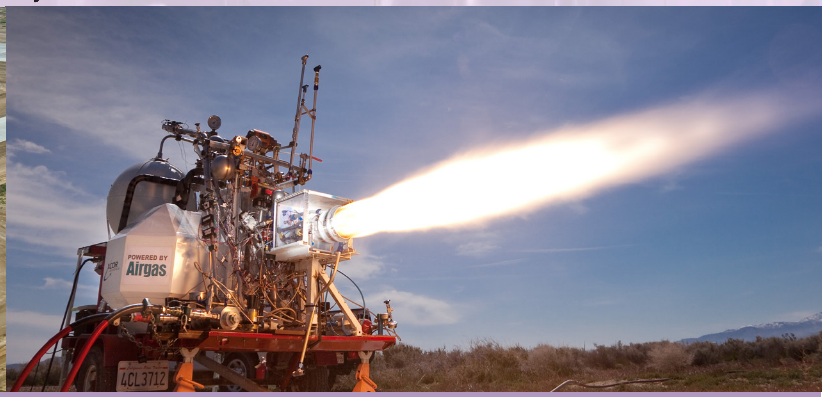




2012 ORBITAL LAUNCHES BY VEHICLE

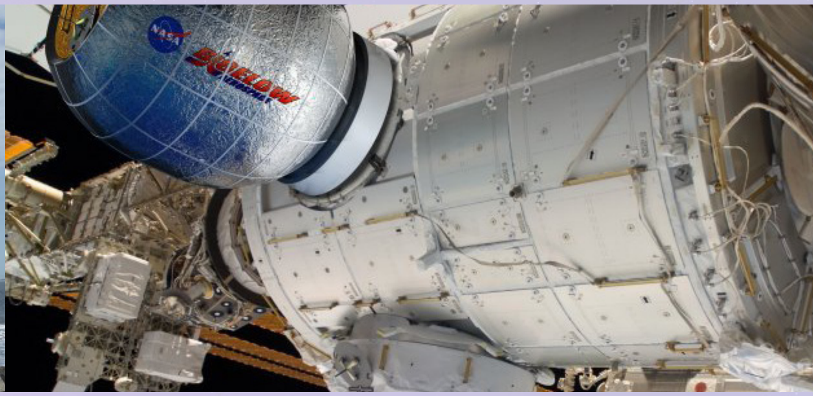
October 2012: *First FAA-licensed suborbital launch from a commercial launch site (Armadillo Aerospace's STIG-B from Spaceport America).*

October 2012: *Test firing of XCOR Aerospace's liquid oxygen/kerosene engine destined to power the company's Lynx suborbital reusable vehicle.*



in 2012 commercial space transportation has entered a new era.

December 2012: Antares launch pad completed at Mid-Atlantic Regional Spaceport.



December 2012: NASA signs $17.8M contract with Bigelow Aerospace to provide a commercial inflatable module to the ISS by 2015.

2 FAA-licensed launches of SpaceX Falcon 9 to the ISS

3 FAA-licensed launches of Sea Launch Zenit 3SL

2 FAA-licensed reentry events for SpaceX Dragon

2 FAA-licensed launches of Armadillo Aerospace STIG-B

2 Flights conducted under FAA Experimental Permits by SpaceX

1 FAA Launch Site License renewal issued to Virginia Commerical Space Flight Authority for operation of the Mid-Atlantic Regional Spaceport

October 2012: Successful test of Blue Origin's crew capsule escape system, which reached an altitude of 703 meters and returned by parachute.

December 2012: Seven successful glide tests of SpaceShipTwo and 13 successful RocketEngineTwo fire tests set the stage for powered test flights in 2013.

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ORBITAL LAUNCH VEHICLES

Orbital launch vehicles send payloads into orbit around the Earth or Sun, including LEO, GTO, SSO, and to other destinations. All of the currently offered orbital vehicles in the world are expendable rockets.

In April, Orbital fully erected the first stage of the Antares rocket into a vertical position at the Mid-Atlantic Regional Spaceport (MARS).

Image credit: NASA

This section describes expendable launch vehicles in detail, beginning with U.S. vehicles and concluding with non-U.S. vehicles. Factsheets providing additional technical detail for each vehicle system are in the Appendix to this report.

U.S. COMMERCIAL ORBITAL LAUNCH VEHICLES

There are five expendable launch vehicle types available for commercial use in the United States: Pegasus XL, Taurus, Falcon 9, Atlas V, and Delta IV. The Antares from Orbital Sciences Corporation (Orbital) and the Super Strypi are new U.S. vehicles expected to make inaugural launches in 2013. The Antares will be commercially available, but the availability of Super Strypi for commercial use is uncertain.

Operator	Vehicle	Year of First Launch	Total Launches	Active Launch Sites	Mass to GTO kg (lb)	Mass to LEO kg (lb)	Mass to SSO kg (lb)
Orbital Sciences Corp.	Antares	2013	0	MARS	--	6,120 (13,492)	4,500 (9,920)
Orbital Sciences Corp.	Pegasus XL	1994	31	CCAFS, Kwajalein, VAFB, WFF	--	475 (1,045)	325 (715)
Orbital Sciences Corp.	Taurus	1994	9	VAFB	--	1,160 (2,552)	1,600 (3,520)
SpaceX	Falcon 9	2010	4	CCAFS	4,850 (10,692)	13,150 (28,991)	--
United Launch Alliance	Atlas V	2002	34	CCAFS, VAFB	2,690-6,860 (5,930-15,120)	8,123-18,814 (17,908-41,478)	6,424-15,179 (14,163-33,464)
United Launch Alliance	Delta IV	2002	21	CCAFS, VAFB	4,541-13,399 (10,012-29,540)	9,390-22,977 (20,702-50,656)	7,746-21,556 (17,078-47,522)
UH, Sandia, Aerojet	Super Strypi	2013	0	Barking Sands	--	200 (441)	--

Table 1. U.S. Commercial Launch Vehicles

Orbital: Antares

Orbital plans to launch the Antares vehicle, a medium-class option for commercial clients, in early 2013. In 2008, the National Aeronautics and Space Administration (NASA) selected the Antares (originally named Taurus II) to receive funding under the Commercial Orbital Transportation Services (COTS) program. NASA ultimately selected Orbital and its competitor SpaceX to provide cargo transportation to the International Space Station (ISS) under a Commercial Resupply Services (CRS) contract.

Antares launch vehicle

Image credit: Orbital

The Antares is the first cryogenically fueled vehicle produced by Orbital, which until now has focused on solid-fueled systems like Pegasus, Taurus, and Minotaur. The Antares consists of a first stage produced by Ukrainian Yuzhnoye Design Office (Yuzhnoye), which is powered by twin Aerojet AJ26-62 engines derived from the Russian NK-33. A customer can select from two different second stages, the Castor-30XL or the Castor-30B, both from Alliant TechSystems (ATK). Orbital also offers an optional Bi-Propellant Third Stage (BTS) for high-energy performance needs. The vehicle is topped off with a payload adapter and a 4-meter (13-foot) diameter fairing. Six variants of the Antares will be available to customers.

Beginning in 2013, Antares flights will take place from Pad 0-A, managed by Virginia's Mid-Atlantic Regional Spaceport (MARS) co-located at NASA's Wallops Flight Facility (WFF).

Antares: 2012 Highlights

Renovation of Pad 0-A to accommodate the Antares concluded during 2012. Among the new facilities is a liquid propellant and fueling system, which required substantial testing to be approved by NASA for use. Orbital conducted a cold flow test in December to validate loading and unloading of liquid oxygen (LOX) to and from the vehicle. A hot-fire test of the Antares vehicle is planned in early 2013 before the first test flight.

NASA completed negotiations with Orbital to "on-ramp" the Antares as part of the agency's Launch Services-II (NLS-II) program, a contracting mechanism that allows NASA to procure qualified launch vehicles for science missions.

Pegasus XL launch vehicle

Image credit: Orbital

Orbital: Pegasus XL

Orbital's Pegasus XL is a small-class, air-launched vehicle. It is normally composed of three solid propellant stages manufactured by ATK, but it may also include an Orbital-built, liquid propellant Hydrazine Auxiliary Propulsion System (HAPS) as a fourth stage depending on customer needs. The vehicle uses a 1.2-meter (3.9-foot) payload fairing. The first, second, and third stages are manufactured by ATK and include Orion-50SXL, Orion-50XL, and Orion-38 motors, respectively. The Orion-50SXL is also integrated with a wing, enabling aerodynamic flight during the launch phase. The vehicle is air-dropped from a Lockheed-built L-1011 aircraft.

Since 1994, the Pegasus XL version has flown 31 times, with 2 failures. Pegasus has flown 27 consecutive successful missions since 1996. It can be launched from a variety of sites due to the air-launched capability, including the Canary Islands, Cape Canaveral Air Force Station (CCAFS), Kwajalein Atoll, Vandenberg Air Force Base (VAFB), and WFF.

Pegasus XL: 2012 Highlights
A Pegasus XL successfully launched NASA's Nuclear Spectroscopic Telescope Array (NuSTAR) to LEO on June 13.

Taurus launch vehicle

Image credit: Orbital

Orbital: Taurus

Orbital also offers the small-class vehicle Taurus. It consists of four stages: the first stage, Castor-120; second stage, Orion-50SGXL; third stage, Orion-50XL; and the fourth stage, Orion-38 or STAR-37. All of the Taurus rocket motors are built by ATK. Orbital offers two payload fairings, including diameters of either 1.6 or 2.3 meters (5.2 or 7.5 feet). Several variations of the Taurus are available, allowing Orbital to mix and match different stages and fairings to address customer needs.

The Taurus launches from SLC-376E at VAFB for orbital missions, though it may also launch from SLC-46 at CCAFS in the future. It can also launch from the commercial launch site on South VAFB, as well as Pad 0-B at WFF.

SpaceX: Falcon 9

Space Exploration Technologies (SpaceX), founded in 2002, first launched its Falcon 9 rocket in 2010 from CCAFS. The vehicle consists of a first stage powered by nine SpaceX Merlin engines, a second stage powered by a single Merlin Vacuum engine, a payload adapter, and a large payload fairing. The Falcon 9 is also designed to launch the company's Dragon capsule, which does not require a fairing. SpaceX is currently upgrading the Falcon 9; the new version will feature a longer first stage, new higher thrust engines (the Merlin 1D instead of the Merlin 1C), and an octagonal arrangement of engines on the first stage (instead of a "tic-tac-toe" pattern) to relieve loads on the vehicle during launch.

The Falcon 9 has launched successfully four times since 2010. It can launch from SLC-40 at CCAFS, and soon from SLC-4E at VAFB.

Falcon 9 launch vehicle

Image credit: SpaceX

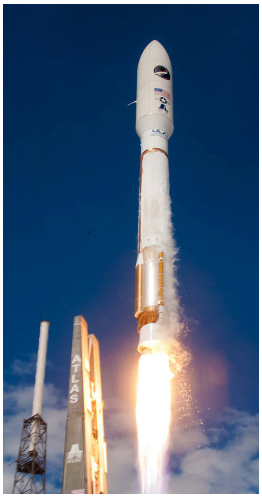
Falcon 9: 2012 Highlights

SpaceX conducted two successful flights of the Falcon 9 in 2012. The first, which launched from CCAFS on May 22, was conducted under a 2006 COTS agreement with NASA to develop the ability to carry cargo to and from the ISS. The mission objectives included successful demonstration of the Dragon cargo module and berthing of the spacecraft to the ISS. The mission also demonstrated the controlled reentry and recovery of the capsule. All mission objectives were fulfilled, preparing Falcon 9 and Dragon to undertake the first mission under NASA's CRS contract later that year.

The first CRS mission launched on October 7. The Dragon capsule was successfully delivered to orbit, but because of an engine anomaly during ascent, a secondary payload was deployed in a lower than intended orbit. The Dragon capsule was successfully recovered later that month after a controlled reentry. The FAA licensed the launch and reentry of both the COTS and CRS missions.

SpaceX was awarded several contracts for its Falcon 9 vehicle this year, including missions for AsiaSat, Asia Broadcast Satellite, SES, and the Air Force. SpaceX and Bigelow Aerospace entered into a partnership to support commercial human spaceflight missions.

SpaceX successfully hot fired its new Merlin 1D engine, simulating a burn time that will occur on typical launches. Also in 2012, SpaceX successfully conducted three test flights of the Grasshopper from the company's McGregor, Texas test site. Grasshopper is a flight test vehicle that supports the company's goal of developing a reusable Falcon 9 rocket. Grasshopper stands 10 stories tall and consists of a Falcon 9 rocket first stage, Merlin 1D engine, four steel landing legs with hydraulic dampers, and a steel support structure.



Atlas V launch vehicle

Image credit: Boeing

ULA: Atlas V

The Atlas V is a product of the U.S. Air Force's Evolved Expendable Launch Vehicle Program (EELV), which began in 1995. ULA markets the Atlas V to U.S. Government customers, and Lockheed Martin Commercial Launch Services (LMCLS) markets the vehicle to commercial clients worldwide. In 2010, ULA began the process of certifying Atlas V for human missions, to launch NASA astronauts to low Earth orbit (LEO). ULA has agreements with Boeing and Sierra Nevada Corporation (SNC) to launch their crewed orbital vehicles on an Atlas V.

Lockheed Martin develops the Atlas V, which consists of the Common Core Booster (CCB) powered by a Russian RD-180 engine, a Centaur upper stage powered by either one or two Pratt & Whitney Rocketdyne (PWR) RL10A-4-2 engines, a payload adapter, and a payload fairing. The vehicle variants are described in two groups: Atlas V 400 series and Atlas V 500 series. The first number of the three-digit designator indicates the diameter of the fairing in meters, the second number indicates the number of Aerojet solid rocket boosters used (zero to five), and the third number indicates the number of RL10A-4-2 engines employed by the Centaur upper stage (one or two).

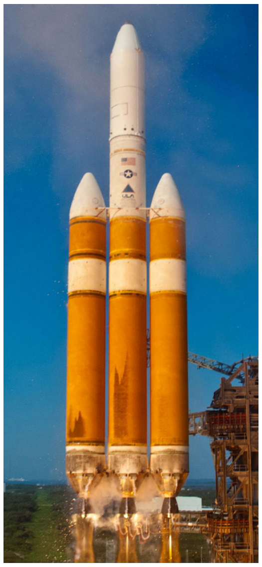
Since its first launch in 2002, the Atlas V has flown 34 times, each successfully. The vehicle is launched from SLC-41 at CCAFS and SLC-3E at VAFB.

Atlas V: 2012 Highlights

The Atlas V successfully deployed six payloads in 2012. These include the U.S. Navy's first satellite in the Mobile User Objective System (MUOS) constellation, the Air Force's second Advanced Extremely High Frequency (AEHF) satellite, two satellites for the National Reconnaissance Office (NRO), the Air Force's X-37B robotic reusable spaceplane, and NASA's Radiation Belt Storm Probes (RBSP).

ULA completed its fifth and final milestone under its unfunded SAA with NASA. Under the second phase Commercial Crew Development (CCDev2) program, ULA was required to complete a Hazard, System, and Safety Probablistic Risk Assessment to ensure crew safety during launch and ascent. ULA also established a Human Launch Services division and selected Hensel Phelps Construction to begin upgrading SLC-41 to accommodate crewed launches.

ULA: Delta IV



Delta IV launch vehicle

Image credit: Boeing

Commercial clients can procure ULA's Delta IV through Boeing Launch Services (BLS). Like the Atlas V, the Delta IV emerged from the EELV program. It was developed by Boeing.

The Delta IV is composed of a Common Booster Core (CBC) powered by a PWR RS-68A main engine, one of two cryogenic upper stages (varying in propellant tank volume and diameter) powered by a PWR RL10B-2 engine, a payload adapter, and a payload fairing. The vehicle may also feature between two and four ATK GEM-60 motors.

The Delta IV is available in five variants:

- The Delta IV Medium consists of a CBC, no GEMs, a 4-meter diameter upper stage, and a 4-meter diameter fairing.
- The Delta IV Medium+(4,2) uses one CBC, two GEMs, a 4-meter diameter upper stage, and a 4-meter diameter fairing.
- The Delta IV Medium+(5,2) uses one CBC, 2 GEMs, a 5-meter diameter upper stage, and a 5-meter diameter payload fairing.
- The Delta IV Medium+(5,4) uses one CBC, four GEMs, a 5-meter diameter upper stage, and a 5-meter diameter fairing.
- The Delta IV Heavy uses three CBCs (in this configuration, the additional CBCs are called Liquid Rocket Boosters), a 5-meter diameter upper stage, and a 5-meter diameter fairing.

Since its first launch in 2002, the Delta IV has had 21 launches, all successful. It launches from SLC-37 at CCAFS and SLC-6 at VAFB.

Delta IV: 2012 Highlights

The Delta IV launched four satellites in 2012: two for the Air Force (the second satellite in the Wideband Global Satellite system and a GPS satellite) and two for the NRO. Although all flights were conducted successfully, the flight on October 4 experienced a low thrust anomaly with the RL10B-2 engine powering the upper stage. A joint investigation between ULA and PWR will assess the event. ULA successfully tested the GEM-60 motors of the Delta IV.

Commercial Space Highlights: Delta IV to Launch Orion

A Delta IV Heavy is scheduled to launch the first flight of NASA's orbital vehicle, Orion. The mission, Exploration Flight Test (EFT-1), may qualify as a commercial launch and require an FAA license.

The Multi-Purpose Crew Vehicle being assembled and tested at Lockheed Martin's Vertical Testing Facility in Colorado.

Image credit: Lockheed Martin

Artist's conception of the Super Strypi launch vehicle

Image credit: Aerojet

UH, Sandia, and Aerojet: Super Strypi

The rail-launched Super Strypi is scheduled to make its inaugural flight in 2013 from the Pacific Missile Range Facility (PMRF) at Barking Sands in Hawaii. The three-stage all-solid motor vehicle, based on Sandia National Laboratories (SNL) 1960s-era Strypi test missile, is being developed by a partnership among the Operationally Responsive Space (ORS) Office, SNL, Aerojet and the University of Hawaii. The ORS Office is providing the funding and program management of SNL's design along with the development of three solid rocket motors from Aerojet. A launch site is being developed at PMRF with help being provided to the ORS Office through the University of Hawaii. It is desired that after the completion of the demonstration launch, the Super Strypi vehicle will be transitioned from SNL to a commercial entity that will provide launch services to the Government, both Civil and Department of Defense (DoD), as well as commercial programs.

Aerojet is developing the three new solid rocket motors that support the Super Strypi launch system. The first stage is the LEO-46, second stage is the LEO-7 and the third stage is the LEO-1. Super Strypi will initially launch from PMRF using Pad 41 at the Kauai Test Facility Kokole Point, but the vehicle is also compatible with other launch sites, such as, but not limited to, Space Florida's Cape Canaveral Spaceport, Kodiak Launch Complex in Alaska, and NASA's WFF.

Super Strypi: 2012 Highlights

In August, Aerojet successfully test fired a LEO-7 solid motor, which will be used as the second stage for Super Strypi. SNL completed a delta CDR and has finalized the design of the Super Strypi launch vehicle. The rail launcher design was completed and modifications to the Scout launcher system as well as fabrication of new components was started. Finally, the program completed the necessary environmental paperwork to establish the launch site at PMRF and received a Finding of No Significant Impact and can begin work on the launch site.

OTHER U.S. VEHICLES IN DEVELOPMENT WITH ORBITAL DEPLOYMENT CAPABILITY

Vehicle	Manufacturer	Anticipated Introduction Year	Description
Athena	Lockheed Martin	2014	Lockheed Martin is reintroducing the Athena to address small- to medium-class payloads. The vehicle uses solid propellant stages, offered in three versions depending on customer needs. Initial flights of the vehicle are expected to launch from a new facility currently under construction at Kodiak Launch Complex and possibly from other sites like Cape Canaveral Spaceport's SLC-46.
Lynx Mark III	XCOR Aerospace	2015-2016	XCOR will launch microsatellites using an upper stage rocket carried in a dorsal pod on the Lynx Mark III SRV. Maximum payload capacity will be 15 kilograms (33 pounds). The Lynx Mark III will roll out after successful test flights of the prototype Lynx Mark I and operational experience with Lynx Mark II.
LauncherOne	The Spaceship Company	2016	Virgin Galactic will offer LauncherOne, a small-class orbital launch vehicle. It will use the WhiteKnightTwo carrier aircraft and an air-launched expendable rocket stage (called LauncherOne) to carry the payload. The payload capacity will be 225 kilograms (500 pounds). SkyBox Imaging and GeoOptics have already signed contracts with Virgin Galactic for the launch of their satellites.
Stratolaunch Carrier Aircraft	Stratolaunch Systems	2017	Stratolaunch is an orbital launch services venture involving Scaled Composites (design and manufacture of carrier aircraft), Orbital (design and manufacture of the rocket stage), and Dynetics (design and manufacture of the mating and integration system). The carrier aircraft is composed of a twin-fuselage design incorporating two 747-400 airframes. Development cost for the launch system is estimated to be about $300 million, with manufacturing conducted at Mojave Air and Space Port in California. A test flight is expected to launch from NASA's Kennedy Space Center Shuttle Launch Facility.
GOLauncher	Generation Orbit and Space Propulsion Group	TBD	Generation Orbit is introducing an air-launch capability using a conventional high-performance jet aircraft that carries either a GO1 rocket stage for suborbital missions or a GO2 rocket stage capable of sending 20-30 kilograms (44-66 pounds) into LEO.
NEPTUNE	Interorbital Systems (IOS)	TBD	Mojave-based IOS is developing a line of NEPTUNE vehicles to send micro- and small-class satellites into orbit. NEPTUNE variants are composed of clusters of Common Propulsion Modules (CPMs); for example, the NEPTUNE 5 consists of five CPMs and can send a 30-kilogram (66-pound) payload into LEO. IOS has performed engine tests during the past few years and is planning operational launches from Tonga.

Table 2. Other U.S. Vehicles in Development with Orbital Deployment Capability

NON-U.S COMMERCIAL ORBITAL LAUNCH VEHICLES

There are 11 expendable launch vehicle types available for commercial use outside the United States: Ariane 5, Soyuz 2, Vega, Long March 2D, Long March 3A, Rockot, Proton M, Dnepr, Epsilon, H-IIA/B, and Zenit 3SL/SLB.

Operator	Vehicle	Year of First Launch	Total Launches	Active Launch Sites	Mass to GTO kg (lb)	Mass to LEO kg (lb)	Mass to SSO kg (lb)
Arianespace	Ariane 5	1996	67	Guiana Space Center	9,500 (20,944)	21,000 (46,297)	10,000 (22,046)
Arianespace	Soyuz 2	2004	20	Baikonur, Guiana Space Center, Plesetsk	3,250 (7,165)	4,850 (10,692)	4,400 (9,700)
Arianespace	Vega	2012	1	Guiana Space Center	--	1,500 (3,307)	--
CGWIC	Long March 2	2C: 1975 2D: 1992	2C: 32 2D:11	Jiuquan, Taiyuan, Xichang	2C: 1,250 (2,756)	2C: 3,850 (8,488)	2C: 1,900 (4,189) 2D: 1,300 (2,866)
CGWIC	Long March 3A	A: 1994 B: 1996 BE: 2007 C: 2008	A: 23 B: 10 BE:13 C: 10	Xichang	A: 2,600 (5,732) B: 5,100 (11,244) BE: 5,500 (12,125) C: 3,800 (8,378)	--	--
Eurockot	Rockot	1990	20	Baikonur, Plesetsk	--	2,140 (4,718)	--
ILS	Proton M	2001	68	Baikonur	6,920 (15,256)	23,000 (50,706)	--
ISC Kosmotras	Dnepr	1999	17	Baikonur, Dombarovsky	--	3,700 (8,157)	2,300 (5,071)
JAXA	Epsilon	2013	0	Uchinoura	--	1,200 (2,646)	700 (1,543)
Mitsubishi	H-IIA/B	A: 2001 B: 2009	A: 21 B: 3	Tanegashima	A: 4,100-6,000 (9,039-13,228) B: 8,000 (17,637)	A: 10,000-15,000 (22,046-33,069) B: 19,000 (41,888)	--
Sea Launch/ Land Launch	Zenit 3	3SL: 1999 3SLB: 2008	3SL: 34 3SLB: 5	Baikonur, Sea Launch	3SL: 6,000 (13,228) 3SLB: 3,500 (7,716)	--	--

Table 3. Non-U.S. Commercial Launch Vehicles

Arianespace: Ariane 5

The Ariane 5, technically the Ariane 5 ECA, is the workhorse of France-based Arianespace, a European launch consortium. With a direct technical heritage to the Ariane 4 series, the Ariane 5 consists of an Astrium liquid-fueled core stage powered by the Snecma Vulcain 2 engine, two Europropulsion strap-on solid boosters, a Snecma cryogenic upper stage powered by an HM7B engine direct heritage from Ariane 4, an Astrium payload adapter that can accommodate two satellites (called SYLDA), and a Ruag-built payload fairing. Arianespace also operates the Ariane 5 ES version with a storable propellant upper stage engine used to launch the Automated Transfer Vehicles (ATV) to the ISS and very large satellites like Envisat.

Arianespace oversees the procurement, quality control, and launch operations of the Ariane 5. The Ariane 5 has had 67 launches, including 4 failures and 2 partial failures, all from the ELA-3 launch complex at the Guiana Space Center in French Guiana.

Ariane 5 launch vehicle

Image credit: Arianespace

Ariane 5: 2012 Highlights

During 2012, Arianespace successfully launched seven Ariane 5 vehicles. The first mission was the ATV Edoardo Amaldi to the ISS in March. The six other flights were dual launches to geostationary transfer orbit (GTO), deploying the following satellites: JCSAT-13 and VINASAT 2; EchoStar XVII and MSG-3; HYLAS 2 and Intelsat 20; ASTRA 2F and GSAT-10; Eutelsat-21B and Star One C3; and Mexsat Bicentenario and Skynet 5D.

In November, the European Space Agency (ESA) secured member state funding for the continued development of the Ariane 5 ME (Mid-life Evolution) featuring a re-ignitable cryogenic upper stage engine, and for a definition study of an all new Ariane 6 launch system. The Ariane 5ME is expected to be 20 percent more capable than the Ariane 5 ECA to GTO with a target flight date of 2017. The new Ariane 6 is projected to fly by 2021. ESA is funding both activities for two years and will reevaluate the future of Europe's launch capability in 2014.

Arianespace: Soyuz 2

The Soyuz vehicle has a long history, tracing back to the Soviet R-7 intercontinental ballistic missile (ICBM), which launched the world's first satellite, the first human in space, and the first multiple crews into orbit. There have been seven versions of the Soyuz, culminating with the Soyuz 2, also called the Soyuz ST. The Soyuz 2 is operated by Arianespace at the Guiana Space Center. Arianespace's sister company, Starsem, operates the Soyuz from Baikonur.

The Soyuz 2 is manufactured by TsSKB-Progress at the Samara Space Center and NPO Lavotchkin. The vehicle consists of a core stage powered by an RD-108A, four liquid strap-on boosters powered by RD-107A engines, a second stage powered by an RD-0124 engine, and a Lavotchkin Fregat upper stage powered by an S5.92 engine. A payload adapter and standard 4-meter (13-foot) diameter fairing complete the vehicle system. TsSKB-Progress can produce about 20 Soyuz vehicles per year.

Soyuz 2 launch vehicle

Image credit: ILS

Commercial launches of the Soyuz 2 occur at the ELS complex at Guiana Space Center, LC-31 and LC-6 at Baikonur Kosmodrome, with Russian Government launches from LC-43 at Plesetsk Kosmodrome. From all three sites, the Soyuz 2 has flown successfully a total of 20 times since its inaugural flight in 2004. However, the Soyuz 2 builds on the legacy of the Soyuz vehicle family, which has flown 1,791 times since 1966, with 44 failures.

Soyuz 2: 2012 Highlights
Arianespace conducted one Soyuz mission from Baikonur with Starsem and flew two Soyuz missions from Guiana Space Center during 2012. All three missions were successful. The first Soyuz 2 mission in September carried METOP B. The second Soyuz 2 mission to medium Earth orbit (MEO) was Galileo IOV-M2. The third flight sent the French Pleiades HR-2 to LEO.

Vega launch vehicle

Image credit: Arianespace

Arianespace: Vega

The Vega launch vehicle is operated by Arianespace and targets scientific and Earth observing satellites to polar and LEO. Development of the Vega began in 2003 with joint contributions from ESA, the Italian Space Agency, the French Space Agency, and Italy-based Avio. The Vega launched for the first time in February 2012.

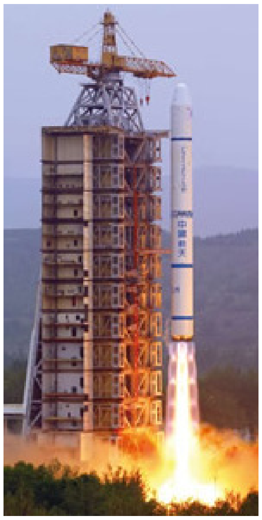
The Vega consists of four stages: a first stage P80 solid motor, a second stage Zefiro-23 solid motor, a third stage Zefiro-9 solid motor, and a liquid-fueled fourth stage called the Attitude and Vernier Upper Module (AVUM). The AVUM, powered by the RD-869, is produced by Yuzhnoye in the Ukraine. The payload adapter is affixed to the fourth stage and covered in a fairing during launch.

The Vega has had one successful launch. It launches from the ZLF launch complex at the Guiana Space Center.

Vega: 2012 Highlights
The Vega made its inaugural launch in 2012. It carried an assortment of payloads, including the ESA primary payload LARES and the secondary payloads Almsasat-1, eSt@r, Goliat, MaSat-1, PW-Sat-1, Robusta, Unicubesat-GG, and XaTcobeo.

CGWIC: Long March 2

The Long March 2 is a small-class vehicle designed to address LEO and sun-synchronous orbit (SSO) missions. The two- to three-stage vehicle is built by the Shanghai Academy of Spaceflight Technology (SAST) and marketed by China Great Wall Industry Corporation (CGWIC). Both organizations are subsidiaries of the China Aerospace Science and Technology Corporation (CASC). The Long March 2C is available to commercial clients, and although the Long March 2D is not marketed commercially, a contract signed in 2012 indicates it is also commercially available.



Long March 2C launch vehicle

Image credit: CGWIC

The Long March 2D consists of two stages, while the Long March 2C features an upper stage. The first stage is powered by the YF-21C engine and the second stage by a YF-24 engine. The third stage, if used, is a solid motor designated 2804. A payload adapter and fairing complete the vehicle system.

The Long March 2C has successfully flown 32 times since its introduction in 1975. The vehicle can launch from the Jiuquan, Taiyuan, and Xichang sites. The Long March 2D has flown 11 times since 1992, each time successfully. It typically launches from the Jiuquan Satellite Launch Center, but in 2014, the vehicle will launch from Xichang for the first time.

Long March 2: 2012 Highlights

In December, a Long March 2D successfully launched Gokturk-2, an Earth observation satellite for the Turkish military. In August, CGWIC signed a contract with the Spain-based Barcelona Moon Team for a Long March 2D flight expected in 2014 from Xichang. The payload will be a lunar rover in a bid to win the Google Lunar X PRIZE.

CGWIC: Long March 3A

The Long March 3A is a modified version of the original Long March 3 vehicle, which was introduced in 1984 and is now discontinued. CGWIC markets the Long March 3A vehicle family for commercial use. Development and manufacturing of the Long March 3A vehicles are shared between the China Academy of Launch Vehicles (CALT) and SAST.

Long March 3B launch vehicle

Image credit: CGWIC

There are four versions of the three-stage Long March 3A. The Long March 3A consists of a core stage powered by four YF-21C engines, a second stage powered by a YF-24E engine, and a third stage powered by a YF-75 engine. The vehicle is topped with a payload adapter and fairing. The Long March 3B and Long March 3BE have the same core stage powered by four YF-21C engines, the same second stage powered by a YF-24E engine, and the same third stage powered by a YF-75 engine. The difference between the two is the type of liquid rocket boosters they use. The Long March 3C is the same as the Long March 3B, but with two liquid rocket boosters instead of four. A selection of four payload fairings is offered for all variants.

The Long March 3A vehicles launch from LC-2 or LC-3 at the Xichang Satellite Launch Center. The Long March 3A has successfully launched 23 times since 1994. The Long March 3B has launched 10 times (with 2 failures), and the Long March 3BE has launched 13 times successfully. The Long March 3C has launched 10 times successfully since it was introduced in 2008.

Long March 3A: 2012 Highlights

Nine Long March 3 missions launched in 2012. The one commercial launch carried ApStar 7 to a geosynchronous orbit (GEO) in March.

CGWIC signed several contracts in 2012, including two that will use the Long March 3B to send CongoSat-01 and an APT satellite to GTO.

Rockot launch vehicle

Image credit: Eurockot

Eurockot: Rockot

The Rockot is a small launcher based on missile components, specifically the Russian UR100N (SS-19) ICBM. The Russian Government uses Rockot for its launches. Eurockot Launch Services GmbH, a joint company between EADS Astrium (51%) and Khrunichev Space Center (49%), offers commercial launch services to customers outside the Russian Federation.

The Rockot consists of three stages. The first two stages are composed of SS-19 booster segments. The first stage is powered by an RD-244 engine and the second by an RD-235 engine. The third stage is a newly manufactured Khrunichev Breeze-KM upper stage. A payload adapter and fairing complete the vehicle system.

Since 1990, the vehicle has launched 20 times, with 2 failures. The first three launches were with the initial version, the Rockot-K. In May 2000, the vehicle was upgraded to accommodate a larger payload, it became the Rockot-KM, which has launched 17 times with 2 failures. The Rockot-KM launches from Plesetsk Kosmodrome in Russia.

The Rockot is predominantly used for scientific Earth observation and climate research missions in LEO. Ten flights have been performed by Eurockot Launch Services for international customers. Rockot-KM currently has a backlog of commercial customers until 2015 and Russian government flights to the end of the decade.

Rockot: 2012 Highlights

One Rockot mission flew in 2012. The non-commercial flight, which carried a series of military satellites, was successful.

ILS: Proton M

The Proton vehicle traces its lineage to the UR500 system developed in 1965. Today, the vehicle is built by the Khrunichev State Research and Production Space Center (KhSC) and marketed to commercial customers by International Launch Services (ILS).

The Proton M consists of a first stage powered by six RD-276 engines, a second stage powered by three RD-0210 engines, and a third stage powered by an RD-0123 engine. The fourth stage is a Breeze-M powered by one 14D30 engine. The Breeze-M also features 4 settling thrusters and 12 attitude control thrusters. The payload fairing covers both the payload and the Breeze-M upper stage during launch. Until December 2012, the Russian government used an earlier version of the Proton, often called the Proton K. It will now use the Proton M with either versions of the Block DM or the Breeze-M as the fourth stage or as a three-stage vehicle for LEO missions.

Since 2001, the Proton M has had 69 launches, with 7 failures. It launches from LC-81 and LC-200 at the Baikonur Kosmodrome. Launches are managed by a team consisting of members from ILS, KhSC, and the Center for Ground-Based Space Infrastructure Facilities Operation (TsENKI).

Proton M launch vehicle

Image credit: ILS

Proton M: 2012 Highlights

There were 10 Proton M missions in 2012. ILS successfully launched the Echostar XVI, Express-MD2, Intelsat 22, Intelsat 23, Nimiq-6, SES-4, SES-5, Telkom-3, Yahsat-1B, and Yamal-402. Due to a failure of the Breeze-M stage, the dual launch of Telkom-3 and Express-MD2 in August ended with the loss of the satellites. The Yamal-402 launch was compromised when the Breeze-M failed to deploy the satellite in the correct orbit, but the satellite's onboard fuel enabled it to reach the intended destination later in the month.

ISC Kosmotras: Dnepr

The Dnepr is developed from surplus Soviet R-36 (SS-18) ICBM refurbished by Yuzhnoye. The three-stage, liquid-fueled vehicle is designed for medium-class payloads or clusters of small- and micro-class satellites. The Russian company ISC Kosmotras markets the Dnepr.

The Dnepr has launched 17 times, with 1 failure. It launches from Pad 109/95 at the Baikonur Kosmodrome and the Dombarovsky missile base in Western Russia.

Dnepr launch vehicle

Image credit: ISC Kosmotras

Epsilon launch vehicle

Image credit: JAXA

JAXA: Epsilon

The Epsilon vehicle is under development and expected to enter service in 2013. Developed by the Japan Aerospace Exploration Agency (JAXA), the system is derived from the Nissan-built M-V.

The first stage of the Standard Configuration Epsilon is a solid motor similar to those on the H-IIA. An M-34c solid motor constitutes the second stage, and a KM-2Vb represents the third stage. A payload adapter and fairing complete the system. A second version of the vehicle, called the Optional Configuration, features an additional compact liquid propulsion system atop the third stage.

The vehicle will launch from Uchinoura Space Center, formerly called Kagoshima Space Center.

Epsilon: 2012 Highlights

Development of the Epsilon continued through 2012, with tests for acoustic measurements on a mock-up of the planned launch site and various integration tests for the third stage and second stage motors.

H-IIA launch vehicle

Image credit: Mitsubishi Heavy Industries

JAXA: H-IIA/B

The two-stage H-IIA and H-IIB were jointly developed by the Japanese Exploration Agency (JAXA) and Mitsubishi Heavy Industries, Ltd. (MHI), as Japan's primary launch vehicles. There are two versions of the H-IIA and one version of the H-IIB. The H-IIB is an upgraded version of the H-IIA. Japan built the larger capacity H-IIB to launch the H-II Transfer Vehicle (HTV) to the ISS and to launch multiple satellites at reduced costs.

The H-IIA vehicle features a cryogenic core stage powered by a single LE-7A engine, two large liquid rocket boosters, an upper stage, a payload adapter, and a payload fairing. The vehicle may also employ a combination of solid boosters to supplement thrust. The H-IIA 202 uses two solid rocket boosters, and the H-IIA 204 uses four solid rocket boosters. The H-IIB features a large first stage powered by two LE-7A engines and supplemented by four liquid rocket boosters and a second stage powered by an LE-5B engine.

The H-IIA has launched 21 times since 2001, with 1 failure. The H-IIB, which launches HTV missions, has had three successful launches since 2009. Both vehicles launch from the Yoshinobu Launch Complex at the Tanegashima Space Center. The H-IIA uses Pad LA-Y1, and the H-IIB uses Pad LA-Y2.

H-IIA/B: 2012 Highlights

One H-IIA and one H-IIB successfully launched in 2012. The H-IIA mission carried GCOM-W1, Arirang 3 (KOMPSAT 3), SDS-4, and Horyu-2. The H-IIB flight carried HTV-3 to the ISS, along with an assortment of microsatellites. In September, JAXA and MHI agreed to privatize launch services of the H-IIB. JAXA will continue to be responsible for safety operations.

Sea Launch: Zenit 3

Zenit 3SL launch vehicle on the Odyssey platform.

Image credit: Sea Launch

The Zenit 3 vehicle is manufactured by Yuzhnoye and launched by Sea Launch. Sea Launch AG, headquartered in Switzerland, is a conglomerate entity with four major component providers: Russian (RSC Energia), Ukrainian (Yuzhnoye/Yuzhmash), Norwegian (Aker Solutions), and United States (Boeing).

The Zenit 3SL is a three-stage vehicle. Yuzhnoye provides both the first and second stages, which are powered by the RD-171M and the RD-120 engines, respectively. A specially modified Block-DM third stage is supplied by S.P. Korolev Rocket and Space Corporation Energia (RKK Energia). Boeing provides the payload fairing. The Zenit 3SLB is a modernized version of the two-stage Zenit. Land Launch, a subsidiary of Sea Launch, markets the Zenit 3SLB, which features a Block-DM third stage. Land Launch also markets the Zenit 2SLB, the two-stage version of the Zenit 3SLB.

Sea Launch's Zenit 3SL has launched 34 times since 1999. It launches from the *Odyssey* platform, a significantly modified mobile oil platform provided by Norway's Kvaerner. The platform sails to the Central Pacific with the control ship *Commander*, where the equatorial latitude provides maximum benefit for GTO-bound payloads. The Land Launch 3SLB has had five successful launches from LC-45 at the Baikonur Kosmodrome.

Zenit 3: 2012 Highlights
Sea Launch conducted three successful flights of the Zenit 3SL during 2012, launching Intelsat 19, Intelsat 21, and Eutelsat 70B to GTO.

OTHER NON-U.S. ORBITAL LAUNCH VEHICLES IN DEVELOPMENT

Vehicle	Manufacturer	Anticipated Introduction Year	Description
Long March 5, 6, and 7	China Academy of Launch Vehicle Technology (CALT) and Shanghai Academy of Spaceflight Technology (SAST)	2014	The newest generation of Long March vehicles will feature several variants based on interchangeable liquid-fueled stages. The Long March 5 is a heavy-lift version featuring a core stage and combinations of strap-on boosters based on the cores of Long March 6 or 7. It will launch from the new Wenchang Satellite Launch Center on Hainan Island. The Long March 6 is a three-stage, small-class vehicle. The first stage of this vehicle will be an optional strap-on liquid stage for the Long March 7. The Long March 7 is a three-stage, medium-class vehicle featuring a core first stage and optional strap-on liquid boosters based on the Long March 6. It will likely replace the Long March 2F for human missions.
Tsyklon 4	Yuzhnoye Design Office	2014	The Brazilian Space Agency signed an agreement with the Ukrainian Space Agency to support development of the Tsyklon 4. Based on the Tsyklon 3, the Tsyklon 4 is a three-stage, medium-class launch vehicle. It is being developed by Alcântara Cyclone Space (ACS), a joint effort between Brazil and Ukraine. It will launch from Brazil's Alcântara launch site.
Angara	Khrunichev State Research and Production Space Center	2017	Since 1995, the Angara has been an effort to produce modular launch vehicles with a CCB using LOX and kerosene as propellants and powered by an RD-191 engine. Two small-class Angara 1 versions will use one CCB, a medium-class Angara 3 will use three, the heavy-class Angara A5 will use five, and the heavy-class Angara A7 will use seven CCBs. The vehicles will also use Breeze-KM and Breeze-M upper stages. An Angara 1 is expected to fly from Plesetsk in 2013, with regular flights from there and Vostochny soon after.

Table 4. Other Non-U.S. Orbital Launch Vehicles in Development

SUBORBITAL REUSABLE VEHICLES

Suborbital reusable vehicles carry humans, cargo, or both to the edge of space. These vehicles primarily target markets in science and technology research and space tourism.

On June 26, Virgin Galactic conducted a SpaceShipTwo glide flight test and rocket motor firing on the same day.

Image credit: Virgin Galactic

Suborbital reusable vehicles (SRVs) are creating a new spaceflight industry. SRVs are commercially developed reusable space vehicles that travel just beyond the threshold of space, about 100 kilometers (62 miles) above the Earth. While traveling through space, the vehicles experience between one to five minutes of microgravity and provide clear views of the Earth and stars. Currently planned vehicles can carry ~700 kilograms (~1,543 pounds) of cargo, some will carry people, and some will be able to launch very small satellites. The companies developing SRVs typically target a high flight rate and relatively low cost. Current ticket prices vary between $95,000 to $200,000 per seat. These vehicles have predominantly private investment as well as some government support to encourage the development and market of SRVs.

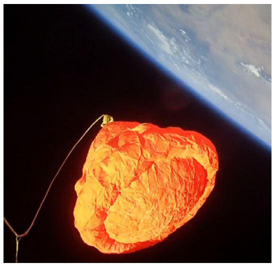
This was a year of gaining momentum for SRVs. The third annual Next-Generation Suborbital Researchers Conference was held February 27-29, in Palo Alto, California, with double the attendees and sponsors of the previous year. On October 6, at New Mexico's Spaceport America, Armadillo Aerospace's STIG-B vehicle made the first FAA-licensed suborbital launch from Spaceport America. Blue Origin, Masten Space Systems, and UP Aerospace all conducted tests of their vehicles under amateur rocket regulations. Scaled Composites conducted seven unpowered flight tests of SpaceShipTwo under an FAA experimental airworthiness certificate.

Operator	SRV	Seats*	Maximum Cargo kg (lb)	Price	Announced Operational Date
Armadillo Aerospace	STIG B	--	50** (110)	Not announced	2013
	Hyperion	2	200** (441)	$102,000 per seat	2014
Blue Origin	New Shepard	3+	120** (265)	Not announced	Not announced
Masten Space Systems	Xaero	--	12 (26)	Not announced	Not announced
	Xogdor	--	25 (55)	Not announced	Not announced
UP Aerospace	SpaceLoft XL	--	36 (79)	$350,000 per launch	2006 (actual)
Virgin Galactic	SpaceShipTwo	6	600 (1,323)	$200,000 per seat	2013
XCOR Aerospace	Lynx Mark I	1	120 (265)	$95,000 per seat	2013
	Lynx Mark II	1	120 (265)	$95,000 per seat	2013
	Lynx Mark III	1	770 (1,698)	$95,000 per seat, $500,000 for small sat. launch	2015-2016

* Passengers only; several vehicles are piloted
** Net of payload infrastructure

Table 5. SRVs and Providers

Armadillo Aerospace: STIG and Hyperion



A video still from STIG-A flight in January 2012, near apogee.

Image credit: Armadillo Aerospace

Armadillo Aerospace, founded by CEO John Carmack, is developing two SRVs: the Suborbital Transport Inertially Guided (STIG) rocket (not crewed) and the Hyperion (crewed). The STIG family of vehicles are vertical takeoff, vertical landing (VTVL) suborbital vehicles, with parachutes for landing. The STIG B is a larger version of the STIG A vehicle and is capable of launching 50 kilograms (110-pound) payloads to an altitude of 100 kilometers (62 miles).

The Hyperion is also a VTVL vehicle. It is capable of carrying payloads of approximately 200 kilograms (441 pounds) or two passengers to an altitude of 100 kilometers. The current advertised cost is $102,000 per seat, and over 200 reservations have been made through Space Adventures. The vehicle is not piloted; it is fully autonomous. Armadillo Aerospace's launch site is Spaceport America.

Armadillo Aerospace: 2012 Highlights

In January, Armadillo Aerospace launched the STIG-A rocket to between 90 and 95 kilometers (56 and 59 miles) altitude. However, due to a recovery system failure during descent, the rocket was destroyed. In July, the company received an FAA suborbital reusable launch operator license for its STIG-B rocket.

Armadillo Aerospace launched the STIG-B from Spaceport America on October 6. This was Armadillo Aerospace's first licensed launch and also the first licensed launch from Spaceport America. The launch experienced an in-flight abort and did not reach the planned altitude, but the vehicle was successfully recovered. The vehicle also successfully launched on November 4.

Blue Origin: New Shepard

Blue Origin's Crew Capsule escape system test in October 2012.

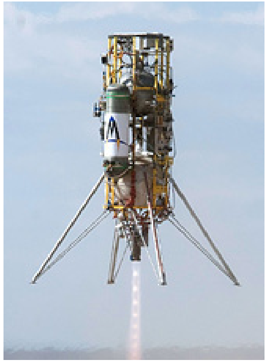
Image credit: Blue Origin

Blue Origin is developing a VTVL vehicle named *New Shepard*. *New Shepard* will carry approximately 200 kilograms (441 pounds) of payload mass or three or more crew to an altitude of 100 kilometers (62 miles). Separate propulsion and crew modules will launch together; the propulsion module will separate and land autonomously with a rocket-powered vertical landing, while the crew module will land with parachutes.

The company was founded in 2000 by Jeff Bezos, who also founded Amazon.com. Blue Origin is headquartered in Washington State, and the company's West Texas Launch Site is near Van Horn, Texas.

Blue Origin: 2012 Highlights

On October 22, Blue Origin performed the first test of the company's suborbital Crew Capsule escape system. The "pusher escape system" reached an altitude of 2,307 feet (703 meters) and then landed softly using a parachute.



Masten's Xaero vehicle.

Image credit: Masten Space Systems

Masten Space Systems: Xaero and Xogdor

Masten Space Systems (Masten), located in Mojave, California, is developing a line of SRVs. Xaero is currently available for 10 kilogram payload flights. Masten is developing a larger vehicle, Xogdor, capable of carrying heavier payloads to higher altitudes, and intends to have a production vehicle in the future named Extreme Altitude 1.0 (XA-1.0)

Xaero and Xogdor are both uncrewed VTVL vehicles. Unlike other VTVL vehicles, throttle-able engines will allow Xaero and Xogdor to perform soft landings via deceleration, instead of parachute landings.

	Xaero	Xogdor
Max altitude	30 km	100 km
Flight Duration	5 to 6 minutes	TBA
Microgravity Duration	5 to 12 seconds	TBA
Payload Mass	10 kg	35 kg

Table 6: Masten Suborbital Vehicle Specifications

Masten Space Systems: 2012 Highlights

In June, a test flight of the Xaero vehicle reached an altitude of 444 meters (1,457 feet). In September, another test flight of the Xaero vehicle reached 1 kilometer (0.6 miles) altitude and met test objectives, but was lost during landing. Masten is now developing the follow-on vehicle, Xaero B.

Launch of SpaceLoft-6 on April 5, 2012. Image credit: NASA

UP Aerospace: SpaceLoft

UP Aerospace offers the SpaceLoft launch platform. The SpaceLoft is an operational, single-stage, VTVL, unguided rocket. The SpaceLoft can transport up to 36 kilograms (79 pounds) of payload to a standard mission altitude of 115 kilometers (71 miles). The vehicle has launched a total of six times since its inaugural launch in September 2006. UP Aerospace was founded in 1998 and is headquartered in Denver, Colorado, with launch facilities at Spaceport America.

UP Aerospace: 2012 Highlights

The sixth SpaceLoft launch was on April 5. SpaceLoft-6 carried payloads for the Operationally Responsive Space office in the DoD. SpaceLoft-6 also flew the Suborbital Flight Environment Monitor, the first space-flown payload for NASA's Flight Opportunities Program.

Virgin Galactic: SpaceShipTwo

Powered configuration glide test of SpaceShipTwo, December 2012

Image credit: Scaled Composites

Virgin Galactic was founded in 2004 by Sir Richard Branson as part of parent company Virgin Group. Virgin Galactic will offer commercial suborbital flights with SpaceShipTwo, air-launched from a carrier vehicle called WhiteKnightTwo. SpaceShipTwo is a horizontal takeoff, horizontal landing (HTHL) piloted craft, with the capacity for 600 kilograms of payload or six passengers and two pilots. SpaceShipTwo will fly to a maximum altitude of 110 kilometers, allowing approximately three to four minutes of microgravity. The total flight duration is approximately 120 minutes, with a maximum of 5 Gs experienced.

SpaceShipTwo was developed by Scaled Composites. For the manufacture of additional vehicles, Virgin Galactic, in collaboration with Scaled Composites, founded The Spaceship Company. In August 2012, Virgin Galactic acquired full ownership of The Spaceship Company. So far, over 550 individuals have purchased tickets or placed deposits to fly with Virgin Galactic.

Virgin Galactic: 2012 Highlights

Throughout 2012, Virgin Galactic continued developing SpaceShipTwo. In February, Virgin Galactic announced a partnership with NanoRacks to construct a rack system for flying research payloads on SpaceShipTwo. Thirteen hot fire tests of RocketMotorTwo were conducted in 2012. In May, the FAA granted Scaled Composites an experimental launch permit. In June, glide tests of SpaceShipTwo commenced after a hiatus since September 2011. According to Scaled Composites, "All objectives achieved. Great return to flight!" Five other glide tests were done in June, July, and August. In October, Virgin Galactic founder Sir Richard Branson confirmed "that all major components of SpaceShipTwo's rocket system have been qualified for powered flight." On December 19, SpaceShipTwo conducted the first glide test in the ship's powered glide configuration, which was SpaceShipTwo's 23rd glide flight.

Commercial Space Highlights: NanoRacks LLC

NanoRacks offers two permanently installed research platforms on the ISS for commercial and educational use. In 2012, NanoRacks announced the development of its External Platform Program (EPP), which will allow researchers to expose experiments to the weightlessness and vacuum of space.

Artist's conception of the Lynx Mark III suborbital vehicle with dorsal pod payload.

Image credit: XCOR Aerospace

XCOR Aerospace: Lynx

XCOR Aerospace is developing three versions of their Lynx suborbital vehicle: the Mark I (prototype vehicle), Mark II (production vehicle), and Mark III (production derivative vehicle with a dorsal pod). The Lynx family of vehicles are piloted HTHL vehicles designed to carry one pilot and one participant. The initial test vehicle will not cross the boundary of space, but the Mark II and Mark III are designed to reach over 100 kilometers altitude.

XCOR Aerospace is headquartered in Mojave, California, and plans to first operate the Lynx at Mojave Air and Space Port. In 2012, XCOR announced two new locations: it will establish Research and Development Center Headquarters in Midland, Texas in late 2013, and an operations and manufacturing base will open in Florida in late 2014.

On January 11, 2013, the Unilever Group and Space Expedition Corporation (SXC) announced a 22-flight purchase on XCOR Aerospace's Lynx Mark II for Unilever's space-themed AXEApollo™ campaign for the AXE brand of men's personal care products.

XCOR Aerospace: 2012 Highlights

Throughout 2012, XCOR continued to develop the Lynx Mark I. XCOR announced in February that it completed a Series A round of equity funding totaling $5 million. The company stated it has sufficient funds for the production of the Mark I. "We are progressing quickly on building and fielding the Lynx and flying it in [2013]," said XCOR COO Andrew Nelson at the International Symposium for Personal and Commercial Spaceflight (ISPCS) in Las Cruces, New Mexico in October. Mr. Nelson also announced the company had completed a test firing of the LOX and kerosene engines using LOX piston pumps.

In February, SwRI and XCOR agreed to fly SwRI payload specialists aboard one or two test missions in the Lynx Mark I. In June, XCOR announced Space Expedition Corporation (SXC) would be their General Sales Agent for personal spaceflight sales. Also in June, XCOR announced they and Excalibur Almaz signed a Memorandum of Understanding for training services.

Throughout 2012, XCOR announced several contracts for manufacturing components of the Lynx: ATK will be the Lynx Mark I wing detailed design/build contractor, FiberDyne Advanced Composites will manufacture the wing strake assemblies, and AdamWorks will manufacture the cockpit.

OTHER SUBORBITAL VEHICLES IN DEVELOPMENT

Operator / Vehicle	Remarks	Vehicle Details
Booster Space Industries ***Sub-orbital Spacecraft*** 	Booster Space Industries is developing a "sub-orbital aircraft." Booster is planning a two-stage system; the first stage will be a conventional commercial jet aircraft, similar to an Airbus A300-600, capable of carrying the sub-orbital aircraft to an altitude of approximately 12 kilometers (7.5 miles) for launch. Booster is primarily based in Spain, with a European-United States consortium.	**Seats**: ~10 **- Pilots**: 2 **- Passengers**: ~8 **Altitude**: 115 – 150 km (71-93 mi) **Payload**: 1,200 kg (2,645 lb) **Propulsion**: 2 rocket engines, liquid hydrogen (LH_2) and LOX **Duration of microgravity**: ~4 minutes **HTHL** **Operational flights target dates**: 2016/2017
Copenhagen Suborbitals ***Tycho Brahe*** 	Copenhagen Suborbitals is developing the Tycho Brahe, a capsule that will carry one person to 100 kilometers (62 miles) altitude. The person will stand in the vehicle for the entire mission and will be able to see through a 360-degree dome at the top. The company is based in Denmark.	**Seats**: 1 **Altitude**: 100 km (62 mi) **Mass**: ~300 kg (~661 lb) **Payload**: ~70 kg (~154 lb) **Propulsion**: LOX/polyurethane **Off-shore VTVL (parachute landing)** **Operational flights target date**: 2015
Garvey Spacecraft Corp. ***P-18*** 	Garvey Spacecraft Corp. is developing the Prospector 18 (P-18) vehicle. The latest P-18 flight was on December 8, 2012 at the Friends of Amateur Rocketry (FAR) test site outside Mojave, CA. This launch was performed for NASA's Launch Services Program (LSP) High Altitude Launch Service (HALS) for Demonstration Nano-Satellites program. The company is also developing a Nanosat Launch Vehicle (NLV) for launch of up to 10 kilograms (22 pounds) payloads to LEO.	**Seats**: N/A **Altitude**: 4.6 km (2.9 mi) **Mass**: TBD **Propulsion**: LOX/ethane propellant launch vehicle using aerospike engine technology **VTVL**
Rocketplane Global: ***Rocketplane XP*** 	The Rocketplane XP is similar to a business jet but includes a single rocket engine, a reaction control system (RCS), and an internal air supply.	**Seats**: 6 **Altitude**: 100 km (62 mi) **Mass**: 9,072 kg (20,000 lb) **Payload**: TBD **Propulsion**: 2 jet engines, LOX/ kerosene **HTHL** **Operational flights**: TBD
Whittinghill Aerospace ***mCLS*** 	Whittinghill is developing the minimum Cost Launch System (mCLS) designed to send nano-satellites into LEO. The system uses a cluster of standardized propellant modules. For the Flight Opportunities Program, Whittinghill will modify one of the propellant modules for a suborbital flight. Whittinghill Aerospace is located in Camarillo, CA.	**Seats**: N/A **Altitude**: TBD **Mass**: TBD **Payload**: TBD **Propulsion**: N_2O/rubber **Vertical takeoff or rail launch, parachute landing** **Operational flights**: TBD

Table 7. Other Suborbital Vehicles in Development

Image Credits (from top to bottom) Booster Space Industries, Copenhagen Suborbitals, Garvey Spacecraft Corp., Rocketplane Global, and Whittinghill Aerospace

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ON-ORBIT VEHICLES AND PLATFORMS

On-orbit vehicles and platforms transport or contain cargo, crew, or both in low Earth orbit. Most of these spacecraft are developed with some funding from or partnership with NASA.

On May 25, SpaceX became the first commercial company to dock a spacecraft to the ISS.

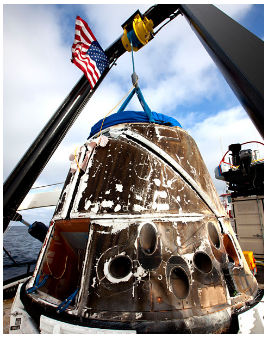
Image credit: NASA

NASA started the commercial crew and cargo program to help commercial companies develop new capabilities for transporting crew and cargo to the ISS. These services are intended to replace some of the ISS resupply services performed by the Space Shuttle. The first of these vehicles, SpaceX's Dragon vehicle, became operational this year, restoring NASA's ability to deliver and retrieve cargo in LEO. Crewed vehicles made many advances this year but will not become operational for at least two more years.

Operator	Vehicle	Launch Vehicle	Maximum Cargo kg (lb)	Maximum Crew Size	First Flight
SpaceX	Dragon	Falcon 9	6,000 (13,228)	0	2010
SpaceX	Dragon/ Crew Dragon	Falcon 9	TBD	7	2015
Orbital	Cygnus (Standard)	Antares	2,000 (4,409)	0	2013
Orbital	Cygnus (Enhanced)	Antares	2,700 (5,952)	0	2014
Boeing	CST-100	Atlas V Delta IV Falcon 9	TBD	7	2016
SNC	Dream Chaser	Atlas V	TBD	7	2016
Blue Origin	Space Vehicle	Atlas V Blue Origin RBS	TBD	7	TBD
Excalibur Almaz	Almaz Reusable Return Vehicle	TBD	10,000 (22,046)	3	TBD
Operator	**Platform**	**On-Orbit Vehicle**	**Maximum Volume m^3 (ft^3)**	**Maximum Crew Size**	**First Flight**
Bigelow Aerospace	BA 330	Dragon CST-100	330 (11,653)	6	TBD
Bigelow Aerospace	BEAM	Dragon	32 (1,125)	TBD	2015

Table 8. On-Orbit Vehicles and Platforms

SpaceX: Dragon



SpaceX's Dragon spacecraft on the recovery boat, after splashdown into the Pacific Ocean on October 28, 2012.

Image credit: SpaceX

Dragon is a free-flying reusable spacecraft designed to take pressurized cargo, unpressurized cargo, and/or a crew of up to seven to and from LEO. The cargo version is capable of carrying 6,000 kilograms (13,228 pounds) of payload to LEO and transporting 3,000 kilograms (6,614 pounds) of material back to Earth. The crewed version is almost identical to the cargo version, but includes a life support system, crew escape system, and onboard controls for the crew to take over from the flight computer when needed.

SpaceX began developing Dragon internally in 2005. As part of NASA's Commercial Crew and Cargo Program (C3PO), the company has since received NASA funding for Dragon's development and operation, including a $1.6 billion contract to provide at least 12 cargo resupply missions to the ISS. The Dragon spacecraft launches on SpaceX's Falcon 9 vehicle. In 2013, Dragon will be launching on an upgraded version of Falcon 9.

SpaceX: 2012 Highlights

Dragon achieved firsts for commercial space this year. On May 25, Dragon became the first commercial spacecraft to berth with the ISS, the final step in proving the vehicle ready for transporting cargo to and from the ISS. In October, Dragon completed its first of 12 contracted CRS missions to deliver cargo to the ISS and safely return ISS cargo to Earth. Dragon completed splashdown and was recovered on October 28. It is the only operational spacecraft in the world capable of retrieving significant amounts of supplies from the ISS.

Orbital: Cygnus

Three complete Cygnus modules in Orbital's Dulles, Virginia facility.

Image credit: Orbital

Cygnus is an advanced maneuvering spacecraft designed to transport pressurized cargo to the ISS. With SpaceX, Orbital is the only other space company to develop an orbital vehicle to provide cargo to the ISS under NASA's C3PO. With these contracts, Orbital is developing the Cygnus spacecraft and Antares, a new medium-class launch vehicle. Scheduled to begin in 2013, Antares will launch Cygnus and a Pressurized Cargo Module (PCM), which can deliver up to 2,700 kilograms (5,952 pounds) of cargo to the ISS. The Cygnus system consists of a service module based on Orbital's LEOStar and GEOStar spacecraft avionics, propulsion, and power technologies and a PCM based on the multipurpose pressurized logistics module developed by Thales Alenia Space for the ISS. Dutch Space will build the solar arrays that provide 3.5 kW of power to Cygnus. In addition to delivering cargo, Cygnus will dispose of ISS trash, which will burn up with the spacecraft on reentry. Orbital is preparing to conduct its first launch of the Antares vehicle in early 2013 and the first COTS demonstration of Cygnus shortly after.

Orbital: 2012 Highlights

Orbital conducted various tests and reviews to prepare the Cygnus module for a 2013 flight demonstration, including thermal vacuum testing, an end-to-end test, joint avionics software validation testing, and a safety hazard assessment for the ISS Safety Review Panel. By the end of 2012, Orbital nearly finished production of three Cygnus modules, and the first PCM, which will fly aboard the COTS demonstration mission in 2013, was delivered to the launch site at WFF.

An artist's conception of Boeing's CST-100 spacecraft.

Image credit: Boeing

Boeing: CST-100

Crew Space Transportation (CST)-100 is a reusable capsule consisting of a crew module and service module. It is designed for transportation of up to seven crew or a combination of people and cargo to and from LEO. CST-100 is designed to be reused up to 10 times and includes a launch escape system. The CST-100 design uses proven flight components from heritage systems, such as an Apollo parachute system and Orion's airbag landing system. CST-100 will launch initially on the Atlas V launch vehicle, but the design is compatible with a variety of launch vehicles. When CST-100 is in full-scale development, Space Adventures will market trips to LEO in the vehicle to private citizens, according to an agreement with Boeing from 2010. Boeing plans to have CST-100 operational in 2016.

Boeing: 2012 Highlights

Boeing completed several major tests of CST-100 this year. In May, CST-100 successfully demonstrated its entire landing system with a 4,267-meter (14,000-foot) descent onto a dry lake bed. In June, CST-100 performed another parachute drop test to demonstrate the reusability of its parachute system. Also in June, Pratt & Whitney Rocketdyne completed a series of tests on a thruster for CST-100. In August, Boeing completed a jettison test of CST-100's forward heat shield, which will protect the spacecraft's parachutes. Other significant events this year included water drop tests and a safety review of CST-100's total system design.

An artist's conception of Sierra Nevada's Dream Chaser.

Image credit: Sierra Nevada

Sierra Nevada Corporation: Dream Chaser

Dream Chaser is a reusable, piloted lifting-body spacecraft designed to fly up to seven crew and cargo to and from LEO using non-toxic propellant. Its design derives from NASA's HL-20 experimental aircraft concept. Dream Chaser will launch vertically on an Atlas V launch vehicle, maneuver in LEO, dock to the ISS, provide a low-g reentry (<1.5 Gs), and then land horizontally on a conventional runway. The onboard propulsion system is derived from SNC's SpaceShipOne and SpaceShipTwo hybrid rocket motor technology. Dream Chaser will complete its first free flight test in early 2013.

Sierra Nevada: 2012 Highlights

In May, Dream Chaser completed its first captive-carry demonstration, when an Erickson Air-Crane helicopter lifted the full-scale spacecraft to verify proper aerodynamic flight performance. Later in the year, Dream Chaser also completed two of its nine Commercial Crew Integrated Capability (CCiCap) milestones: a program implementation plan review detailing the system's planned tests and activities, and an integrated system baseline review, which covered the Atlas V launch vehicle, ground and mission systems, and the Dream Chaser spacecraft.

Blue Origin: Space Vehicle

Blue Origin's Space Vehicle is a reusable, biconic-shaped vehicle designed to carry up to seven crew, cargo, or a combination of crew and cargo to and from LEO. Space Vehicle will initially launch on an Atlas V, but Blue Origin is also developing a reusable first stage booster to loft the capsule in the future. Space Vehicle will use parachutes to land on land.

Blue Origin's Composite Crew Pressure Vessel

Image credit: Blue Origin

Blue Origin: 2012 Highlights

In October, Blue Origin performed a successful pad escape test of Space Vehicle, as part of its CCDev2 contract with NASA. Blue Origin also completed Space Vehicle's System Requirements Review and a full-power test firing of the thrust chamber for its new 445 kilonewtons (100,000 pound-force) BE-3 LOX/LH2 engine.

Excalibur Almaz: Almaz Reusable Return Vehicle

Excalibur Almaz is developing a cargo module and service module based on the heritage systems of the three-person Almaz Reusable Return Vehicle (RRV), originally developed in the Soviet Union in the mid-1970s. These modules are reusable up to 15 times. Excalibur Almaz also plans to develop space stations, to provide platforms for microgravity research and as destinations for exploration missions. Although NASA has not awarded the company any funding for the development of these vehicles, NASA and Excalibur Almaz have collaborated through an unfunded SAA from the CCDev2 program.

An artist's conception of Excalibur Almaz's human spacecraft concept for low Earth orbit crew transportation.

Image credit: Excalibur Almaz

Excalibur Almaz: 2012 Highlights

In June 2012, Excalibur Almaz became the first CCDev2 participant to complete all of its milestones. During the partnership, Excalibur Almaz and NASA reviewed the design of the new RRV, its system requirements, and its compatibility with launch vehicle alternatives.

In preparation for BA 330, Bigelow Aerospace launched two inflatable module prototypes, Genesis I in 2006 and Genesis II in 2007, which still orbit Earth today.

Image credit: Bigelow Aerospace

Bigelow Aerospace: BA 330

BA 330 is an inflatable orbital platform designed to support up to six passengers. With a volume of 330 cubic meters (11,653 cubic feet), BA 330 can function as an independent habitat or connect to other inflatable modules to create a larger space station structure. The design of BA 330 derives from NASA’s inflatable transit habitats project, TransHab. Bigelow Aerospace began working on the project when it was founded in 1999. In addition to launching a module for NASA, Bigelow intends to deploy BA 330s for private investors when a crew transportation capability, such as Boeing’s CST-100 or SpaceX’s Dragon, becomes available.

Bigelow Aerospace: 2012 Highlights

In May, Bigelow Aerospace and SpaceX agreed to conduct a joint marketing effort to international customers, offering rides on the Dragon spacecraft, launched on a Falcon 9, to visit an orbiting BA 330 habitat.

In December, NASA awarded a $17.8 million contract to Bigelow Aerospace to provide and operate an inflatable platform, the Bigelow Expandable Activity Module (BEAM), onboard the ISS. BEAM will launch on the Dragon’s eighth CRS mission, currently planned for 2015, and will remain installed on the ISS for two years. During that time, ISS crew members, ground-based engineers, and instruments inside BEAM will gather data on the module’s structural integrity, leak rate, radiation levels, and temperature changes.

Commercial Space Highlights: Space Adventures

Since 1998, this company has arranged private spaceflight and space tourism, including eight flights on Soyuz vehicles to the ISS for seven private citizens. In October 2012, Space Adventures announced the next spaceflight participant to visit the ISS will be Sarah Brightman, a recording artist and the world’s biggest selling Soprano.

LAUNCH SITES

Launch sites are sites dedicated to launching orbital or suborbital vehicles into space. FAA AST licenses commercial launch and reentry sites in the United States.

On October 6, Spaceport America hosted its first FAA-licensed launch, as Armadillo Aerospace launched the STIG-B rocket.

Image credit: Spaceport America

Launch sites are sites dedicated to launching orbital or suborbital vehicles into space. These sites often also provide the capability to integrate launch vehicle components, fuel and maintain vehicles, and integrate vehicles with payloads. Many launch sites are also reentry sites—VTVL or HTHL vehicles can land there. From the launch site, an orbital launch vehicle travels over an area called the launch range, which typically includes tracking and telemetry assets. These range assets monitor the vehicle's performance until it safely delivers a payload into orbit or returns to Earth. Tracking and telemetry assets may also facilitate recovery of reusable stages.

2012 Highlights

Significant events for U.S. launch sites in 2012 involved new funding, new and renewed licensing, and new construction. In September, FAA AST awarded nearly $500,000 in Space Transportation Infrastructure Matching (STIM) Grants to the East Kern Airport District in California; the Front Range Airport Authority in Colorado; and the Hawaii Department of Business, Economic Development and Tourism. In October, Armadillo Aerospace's STIG-B vehicle made the first FAA-licensed launch from New Mexico's Spaceport America. In December, the Virginia Commercial Space Flight Authority received a license renewal for operation of the Mid-Atlantic Regional Spaceport (MARS) through 2017. Construction of the Antares pad at MARS was also completed in 2012.

FAA AST licenses commercial launch and reentry sites in the United States. By January 2013, FAA AST issued eight launch site operator licenses. The table below lists all orbital and suborbital FAA-licensed commercial launch sites, often called spaceports, in the United States. Figure 1 identifies the locations of federal and non-federal launch sites in the United States.

Launch Site	Operator	State	License First Issued	Expires
California Spaceport	Spaceport Systems International	California	1996	18-Sep-2016
Mid-Atlantic Regional Spaceport	Virginia Commercial Space Flight Authority	Virginia	1997	18-Dec-2017
Kodiak Launch Complex	Alaska Aerospace Corporation	Alaska	1998	24-Sep-2013
Cape Canaveral Spaceport	Space Florida	Florida	1999	30-Jun-2015
Mojave Air and Space Port	East Kern Airport District	California	2004	16-Jun-2014
Oklahoma Spaceport	Oklahoma Space Industry Development Authority	Oklahoma	2006	11-Jun-2016
Spaceport America	New Mexico Spaceport Authority	New Mexico	2008	14-Dec-2013
Cecil Field Spaceport	Jacksonville Aviation Authority	Florida	2010	10-Jan-2015

Table 9. FAA-licensed Commercial Launch Sites

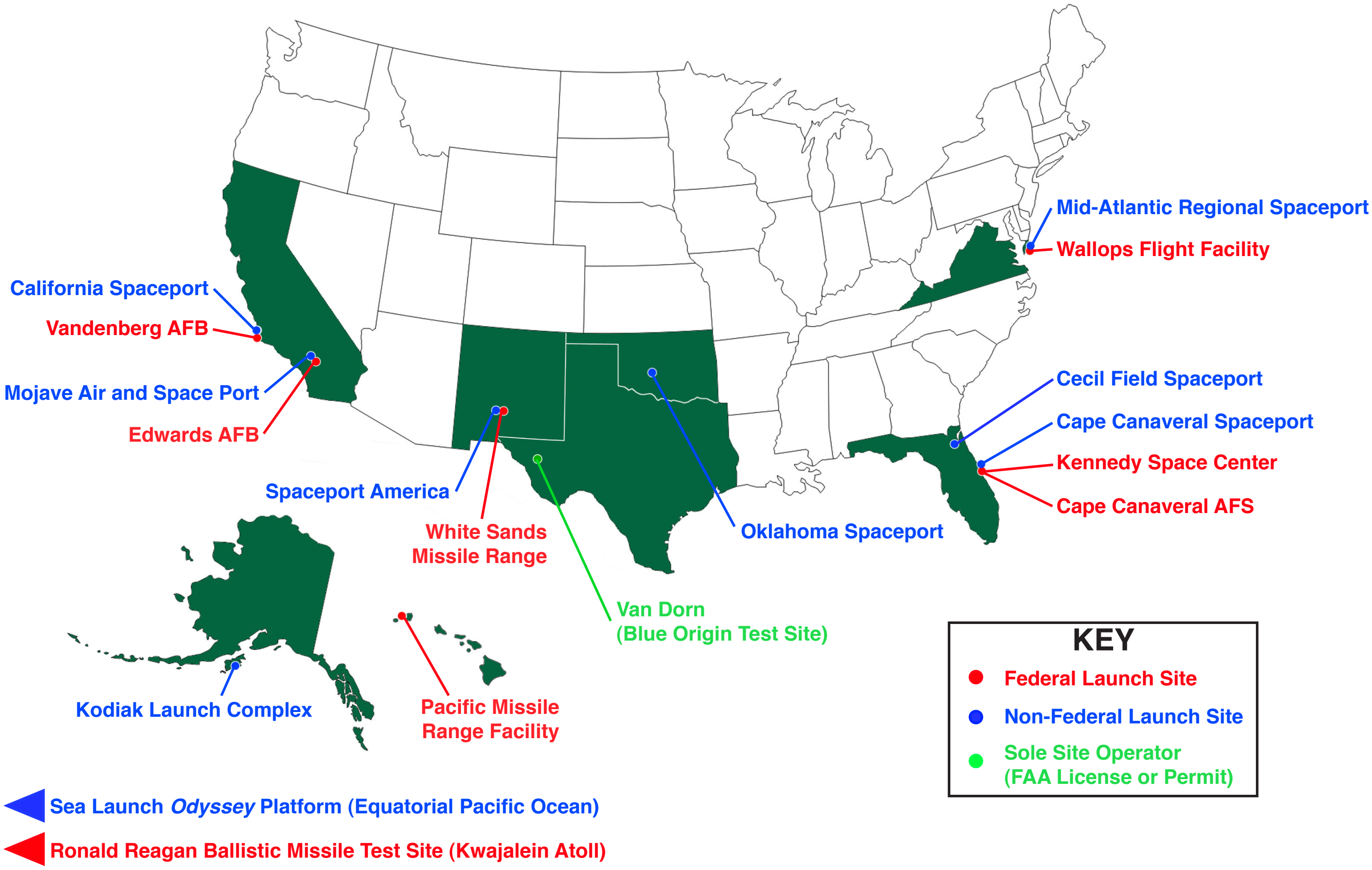


Figure 1. Launch Sites in the United States

FAA-licensed launch and reentry sites are often co-located with federal locations, including CCAFS in Florida, VAFB in California, and WFF in Virginia.

Of the 17 active launch and reentry sites, U.S. Government manages 8, state agencies manage 8 FAA-licensed commercial sites in partnership with private industry, and a university manages 1. Four sites are dedicated to orbital launch activity, eight do suborbital launches only, and five can do both types of operations.

In addition to these sites, there are three sites where individual companies conduct launches with FAA AST licenses or permits. Each of these sites is owned by the company that launches from it. The Odyssey Launch Platform

Launch Site	Operator	State/ Country	Type of Launch Site	Type of Launches Supported	Currently Available for Commercial Operations
California Spaceport	Spaceport Systems International	California	Commercial	Orbital	Yes
Cape Canaveral Spaceport	Space Florida	Florida	Commercial	Orbital/Suborbital	Yes
Cape Canaveral Air Force Station	U.S. Air Force	Florida	Government	Orbital	SLC-41 (Atlas V) SLC-37B (Delta IV) SLC-40 (Falcon 9)
Cecil Field Spaceport	Jacksonville Aviation Authority	Florida	Commercial	Suborbital	Yes
Edwards Air Force Base	U.S. Air Force	California	Government	Suborbital	No
Kennedy Space Center	NASA	Florida	Government	Orbital	No
Kodiak Launch Complex	Alaska Aerospace Corporation	Alaska	Commercial	Orbital/Suborbital	Yes
Mid-Atlantic Regional Spaceport	Virginia Commercial Space Flight Authority	Virginia	Commercial	Orbital	Yes
Mojave Air and Space Port	East Kern Airport District	California	Commercial	Suborbital	Yes
Oklahoma Spaceport	Oklahoma Space Industry Development Authority	Oklahoma	Commercial	Suborbital	Yes
Pacific Missile Range Facility	U.S. Navy	Hawaii	Government	Suborbital	No
Poker Flat Research Range	University of Alaska Fairbanks Geophysical Institute	Alaska	University	Suborbital	Five pads available for suborbital launches
Ronald Reagan Ballistic Missile Defense Test Site	U.S. Army	Republic of the Marshall Islands	Government	Orbital/Suborbital	Omelek Island launch pad
Spaceport America	New Mexico Spaceport Authority	New Mexico	Commercial	Suborbital	Yes
Vandenberg Air Force Base	U.S. Air Force	California	Government	Orbital/Suborbital	SLC-2 (Delta II) SLC-3E (Altas V) SLC-4E (Falcon 9; Falcon Heavy) SLC-6 (Delta IV) SLC-8 (Minotaur) SLC-576E (Taurus)
Wallops Flight Facility	NASA	Virginia	Government	Orbital/Suborbital	Six pads available for suborbital launches
White Sands Missile Range	U.S. Army	New Mexico	Government	Suborbital	No

Table 10. U.S. Active Launch and Reentry Sites

exclusively supports Sea Launch's Zenit 3SL vehicles on the Central Pacific Ocean. SpaceX conducts flight tests of its Grasshopper vehicle at its McGregor, Texas site. Blue Origin conducts FAA-permitted flight tests from its site near Van Horn, Texas.

Several proposed launch and reentry sites in the United States are in various stages of development, summarized in the table below.

Specific details for launch and reentry sites in the U.S. are located in the Appendix section.

Proposed Launch Site/ Spaceport	Operator	State	Status
Brownsville	SpaceX	Texas	SpaceX is exploring the proposed site for conducting commercial launches.
Ellington Field	City of Houston	Texas	The City of Houston has begun a feasibility study of using the airport at Ellington Field to support a wide range of commercial space activities.
Front Range Spaceport	Front Range Airport Authority	Colorado	This proposed suborbital spaceport is located just east of the Denver metropolitan area. FAA AST awarded the State of Colorado a STIM grant for an environmental assessment in preparation for the launch site application process.
Midland Spaceport	City of Midland	Texas	The City of Midland is in the process of applying for a launch site license. XCOR signed an agreement in July 2012 to be a tenant at the spaceport.
Roosevelt Roads Naval Station	Puerto Rico	Puerto Rico	This proposed spaceport is located at the former Roosevelt Roads Naval Station in Puerto Rico.
Spaceport Kalaeloa	Hawaiian Office of Aerospace Development	Hawaii	A funding bill to support an application for a launch site license became law on July 16, 2009. FAA AST awarded the State of Hawaii a STIM grant for an environmental assessment in preparation for the launch site application process.
Titusville-Cocoa Beach Airport	Titusville-Cocoa Beach Airport	Florida	This proposed spaceport would support commercial SRV activities.
West Texas Spaceport	Pecos County/ West Texas Spaceport Development Corporation	Texas	To develop this proposed spaceport, Blue Origin would build upon test site infrastructure established for NASA/USAF rocket testing. A Pecos County/West Texas Spaceport Development Corporation seat remains active on the county board.

Table 11. Proposed Launch and Reentry Sites in the United States

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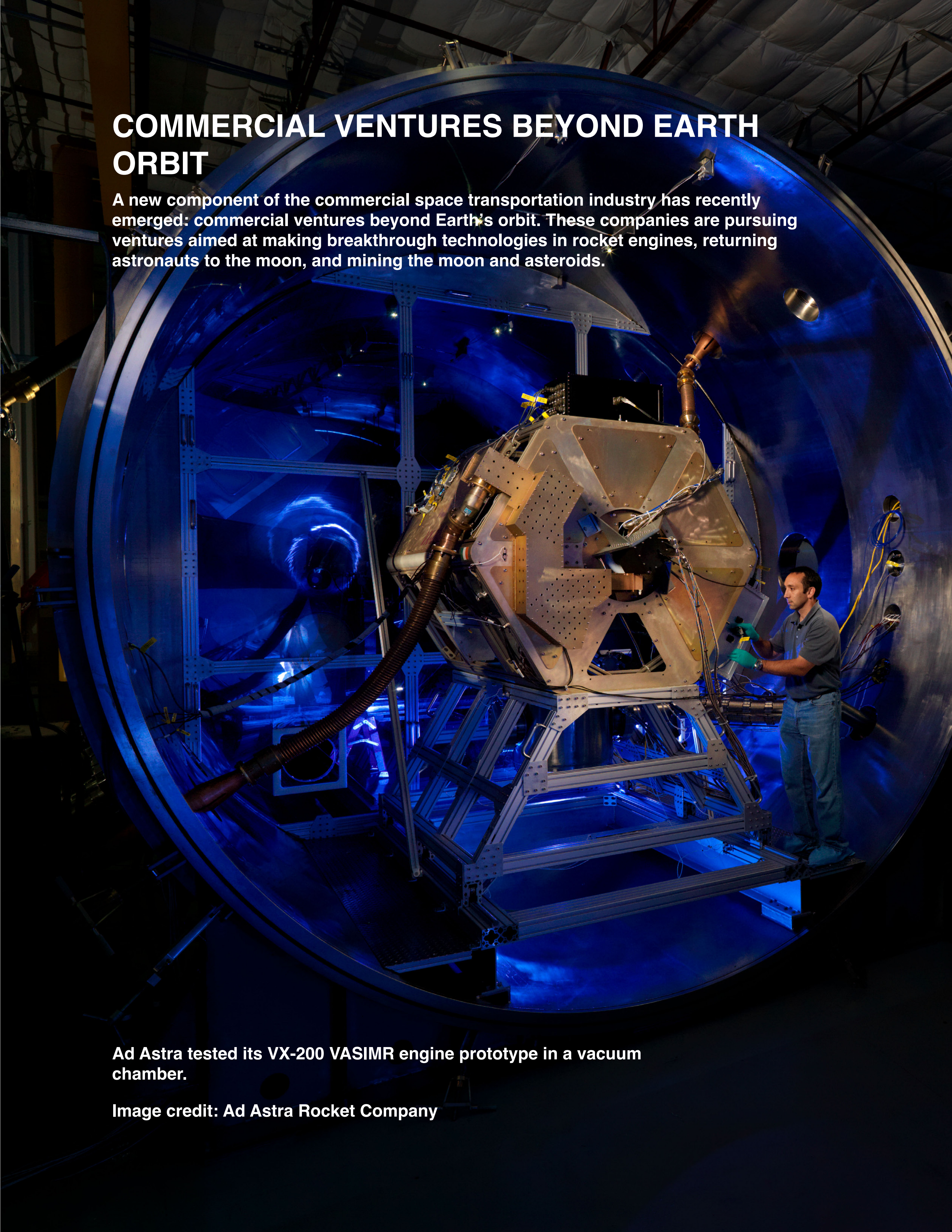
COMMERCIAL VENTURES BEYOND EARTH ORBIT

A new component of the commercial space transportation industry has recently emerged: commercial ventures beyond Earth's orbit. These companies are pursuing ventures aimed at making breakthrough technologies in rocket engines, returning astronauts to the moon, and mining the moon and asteroids.



Ad Astra tested its VX-200 VASIMR engine prototype in a vacuum chamber.

Image credit: Ad Astra Rocket Company

This compendium has summarized the main components of the commercial space transportation industry: orbital launch vehicles, SRVs, on-orbit space vehicles and platforms, and launch sites. Commercial space transportation activities, from launching communication satellites, resupplying the ISS, building space stations, and sending tourists to the edge of space, have all focused on activities in Earth's orbit. However, a new component of the commercial space transportation industry has recently emerged: commercial ventures beyond Earth's orbit. These companies are pursuing ventures aimed at making breakthrough technologies in rocket engines, returning astronauts to the moon, and mining the moon and asteroids. Examples of new ventures that garnered attention in 2012 are highlighted below.

Lunar Efforts

Artist's conception of Golden Spike Lunar Lander.

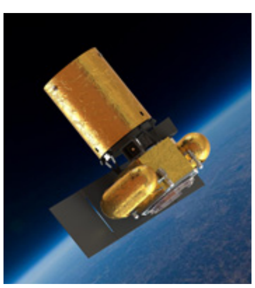
Image credit: Golden Spike

Golden Spike: 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, and its board is led by former Johnson Space Center director Gerry Griffin. 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 has contracted with Northrop Grumman for the design of a new lunar lander.

Google Lunar X PRIZE: The X PRIZE Foundation is a nonprofit organization whose mission is to "bring about radical breakthroughs for the benefit of humanity." Google and the X PRIZE Foundation formally announced the Google Lunar X PRIZE in 2007. A total of $30 million in prizes are available to the first privately funded teams to successfully land a robot on the surface of the Moon, travel 500 meters (1,640 feet), and send video, images, and data back to Earth. The original deadline for the Prize was the end of 2012, which has since been modified to the end of 2015. In 2012, teams consolidated, resulting in 23 active teams.

Shackleton Energy Company: Shackleton was formed in 2007 in Texas by Bill Stone, Dale Tietz, and Jim Keravala. Their idea was to create the first operational "gas station" on the Moon by 2020. Stone estimates this will take $25 billion of total investments. The plan is to mine the ice on the Moon and then use it to make LOX/LH propellants for distribution to spacecraft. They also hope to provide life support, consumables, and services in LEO and on the Moon.

Cis-Lunar Efforts



Artist's conception of Arkyd-100 Series LEO space telescope.

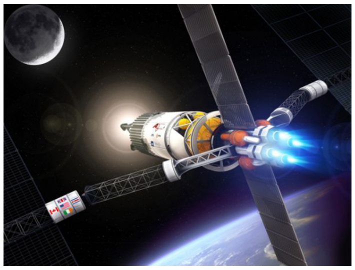
Image credit: Planetary Resources

Planetary Resources: In April 2012, Planetary Resources, Inc., a company formed by Space Adventures founder Eric Anderson and X PRIZE Chairman Peter Diamadis, introduced its plans to mine near-Earth asteroids for raw materials. The company believes asteroid mining will create a trillion-dollar industry. Planetary Resources plans to launch several constellations of Arkyd-100 Series LEO space telescopes on Virgin Galactic's LauncherOne.

The B612 Foundation: The B612 foundation is a non-profit that intends to create the first comprehensive, dynamic map of our inner solar system and show the current and future locations and trajectories of Earth-crossing asteroids. The foundation's Chairman and CEO is former astronaut Ed Lu. The B612 Foundation expects its Sentinel mission will be the first privately funded deep space mission. This mission would launch an infrared telescope into a Venus-like orbit around the sun in 2017 or 2018.

New Engine Technologies

Ad Astra Rocket Company: Ad Astra is developing the Variable Specific Impulse Magnetoplasma Rocket (VASIMR), a new type of electric thruster. The engine is designed to be more efficient than conventional chemical rockets, allowing twice the payload mass for lunar delivery and half the transit time to Mars. In July 2012, Ad Astra reported advances in the performance of the VASIMR prototype and a first demonstration of Constant Power Throttling.

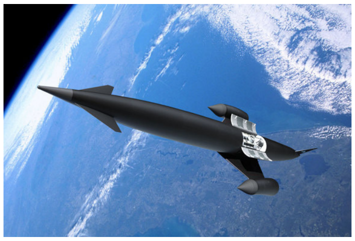


Artist's conception of 10 MW Nuclear Powered VASIMR.

Image credit: Ad Astra Rocket Company

Reaction Engines Ltd: The British Reaction Engines company is developing an advanced combined cycle air-breathing rocket engine called SABRE. SABRE will be used in the SKYLON, an unpiloted, reusable, single stage to orbit spaceplane. The goal of SKYLON is to reduce the cost of payloads to orbit. In November 2012, Reaction Engines Ltd completed critical tests of the heat exchanger technology for the SABRE engine.

Space Propulsion Group Inc.: Established in 1999, Space Propulsion Group is developing a LOX/paraffin-based advanced hybrid rocket motor, in addition to other hybrid propulsion technologies to reduce the cost and environmental impact of access to space. In July 2012, Space Propulsion Group completed an 11-second test firing of the rocket motor.



Artist's conception of SKYLON.

Image credit: Reaction Engines Ltd

In recent years, the commercial space transportation industry has broadened its scope from delivering commercial communication satellites to orbit to launching satellites for a variety of Earth remote sensing purposes. Now the industry is set to deliver supplies, and ultimately crew, to the ISS, and it is aiming to bring tourists to the edge of space and deploy inflatable space stations in the near future. By the end of the decade, the industry seeks to extend its reach beyond Earth's orbit, with commercial missions to the surface of the Moon and asteroids.

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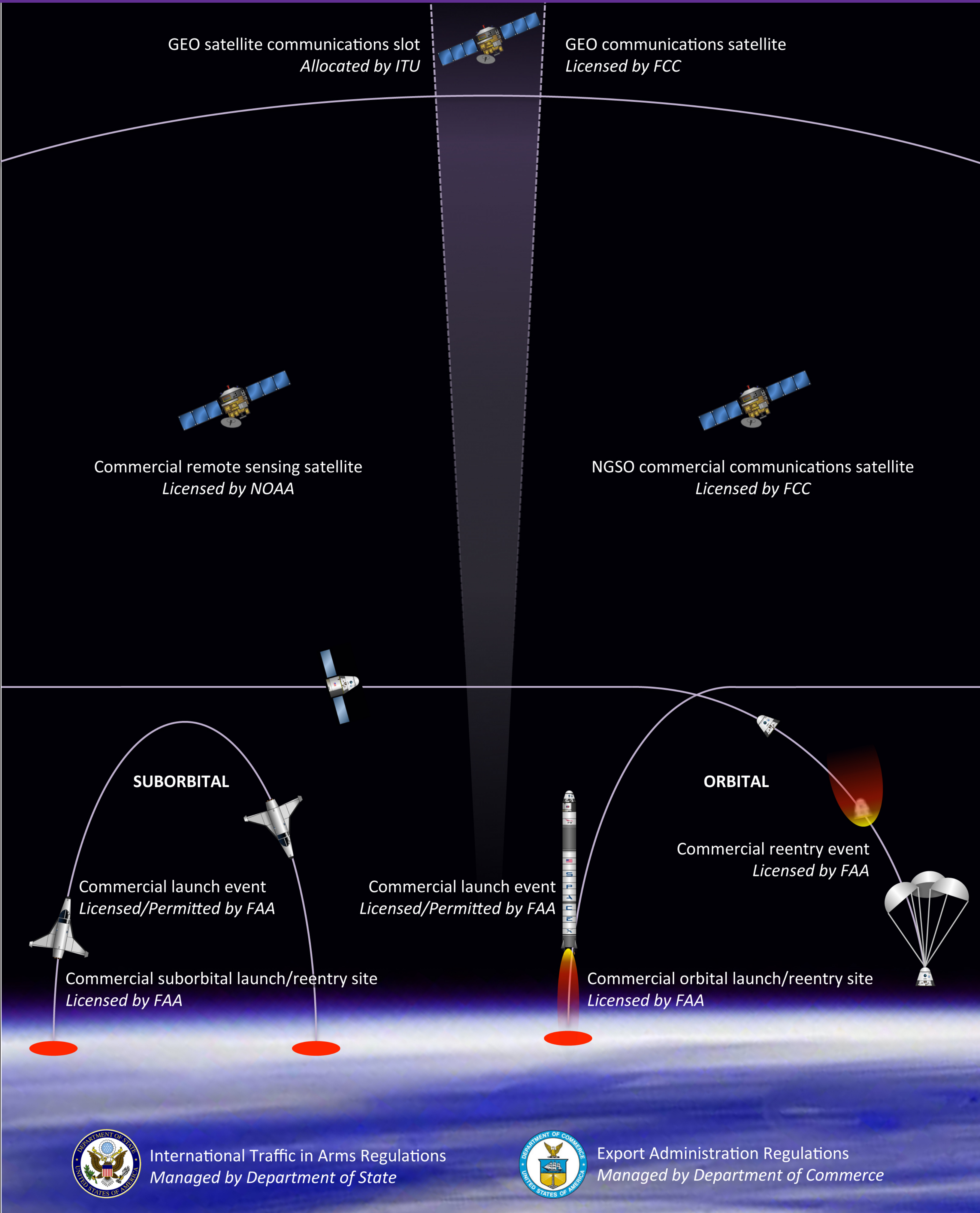
REGULATION AND POLICY

Commercial space-related activities are regulated in the United States by several agencies, including the FAA, FCC, NOAA, the Department of State, and Department of Commerce.

On July 3, Masten Space Systems launched its Xaero rocket under an FAA AST waiver for small rocket launches.

Image credit: NASA

Federal Aviation Administration's Office of Commercial Space Transportation



Commercial space-related activities—from launches and ground stations to satellite communications and capsule reentries—are regulated in the United States by several agencies, including the FAA, the Federal Communications Commission (FCC), the National Oceanic and Atmospheric Administration (NOAA), the Department of State, and Department of Commerce. (See Figure 2 on facing page.) Laws at the state level also impact commercial space transportation.

FEDERAL AVIATION ADMINISTRATION

FAA AST regulates all commercial launches conducted by U.S. entities in the United States or abroad. The licenses and permits issued by FAA AST include a launch- or reentry-specific license, launch or reentry operator license, launch site license, experimental permit, Class 2 or Class 3 waiver, and safety approval.

Launch- or Reentry-Specific License

This license authorizes one or more launches or reentries for a specific launch or reentry activity on a specific vehicle type operating from a specific site. The license identifies, by name or mission, each activity authorized by the license. The license expires when it reaches its expiration date or when the activities authorized by the license are completed, whichever happens first.

Launch or Reentry Operator License

This license allows an operator to perform multiple launches or reentries of the same or similar type. The license authorizes launches or reentries from a specific site, using vehicles from the same family, and transporting specific classes of payloads or performing specific activities. This license remains in effect for two to five years from the date it is issued.

Launch Site License

This license authorizes a launch site to host vehicle launches and reentries. In addition to safety concerns, FAA AST considers the environmental impact of a potential launch site before issuing this license, as required by the National Environmental Policy Act. Most launch site licenses are up for renewal every five years.

Operator	Type of FAA Authorization	Issue Date	Vehicle/ Launch Site
SpaceX	Launch License	18-Apr-2012 05-Sep-2012	Falcon 9
Armadillo Aerospace	Launch Operator License	24-Jul-2012	STIG-B
Space X	Reentry License	17-Sep-2012	Dragon
Virginia Commercial Space Flight Authority	Launch Site License	28-Nov-2012	Mid-Atlantic Regional Spaceport

Table 12. FAA AST License Activity in 2012

Figure 2. (right) Regulation of Space-Related Activities in the United States.

Experimental Permit

This permit allows SRVs to launch or reenter while conducting research and development, showing compliance to obtain a license, or training crew. An alternative to licensing, this permit is processed faster than licenses, allows an unlimited number of launches and reentries for a particular vehicle design, and is valid for a one-year renewable term.

Airworthiness Certificate

This certificate authorizes an aircraft to operate in flight. There are two classifications of airworthiness certificates: standard and special. The FAA can grant special airworthiness certificates to experimental aircraft, such as SRVs in development.

Class 2 or Class 3 Waiver

Although certain classes of small rockets are exempt from licensing requirements, Class 2 and Class 3 rockets must obtain an FAA AST waiver before launch. "Class 2" rockets are defined as, "a high power rocket, other than a model rocket, that is propelled by a motor or motors having a combined total impulse of 40,960 Newton-seconds (9,208 pound-seconds) or less." Class 3 rockets are defined as "an advanced high power rocket, other than a model rocket or high-power rocket." The purpose of this waiver is to ensure these rockets, some of which use liquid propulsion and reach suborbital altitudes, do not affect air traffic or jeopardize public safety.

Safety Approval

This document determines that an identified safety element will not jeopardize the safety of public health or property when used or employed within a defined parameter or situation. FAA AST can issue a safety approval for a launch vehicle; a reentry vehicle; a safety system, process, service, or component thereof; qualified and trained personnel performing a process or function related to licensed launch activities; or any combination of the above.

Operator	Type of FAA Authorization	Launch Date	Vehicle
Scaled Composites	Airworthiness Certificate	26-Jun-2012 29-Jun-2012 08-Jul-2012 02-Aug-2012 07-Aug-2012 11-Aug-2012 19-Dec-2012	SpaceShipTwo
SpaceX	Experimental Permit	01-Nov-2012 17-Dec-2012	Grasshopper
Entity	**Type of FAA Authorization**	**Issue Date**	**Facility**
NASTAR	Safety Approval	21-Sep-2012	Falcon 12/4 Altitude Chamber

Table 13. Other FAA AST Regulatory Activity in 2012

Launch Indemnification

FAA AST also administers the financial responsibility and risk-sharing requirements for commercial launch and reentry operators as part of the FAA's licensing and permitting authority. The Commercial Space Launch Amendments Act of 2004 (CSLAA) provides the Government's authority to indemnify commercial launch operators against certain third party claims in the event of a launch accident. Companies must purchase insurance to cover claims up to a maximum of $500 million. Under the indemnification provision, the Government covers claims between $500 million and $1.5 billion. (Since the original bill, the upper limit has been adjusted for inflation to approximately $2.7 billion). The indemnification regime has been extended several times, most recently to December 31, 2013. Section 3 ("Extension of Certain Launch Liability Provisions") of the Space Exploration Sustainability Act (H.R. 6586) extends FAA AST's authority.

Occupant Safety

In 2012, FAA AST began hosting a teleconference with its industry advisory group, Commercial Space Transportation Advisory Committee (COMSTAC), to discuss topics related to its regulatory focus of protecting the safety of the public, not the persons on board. These topics include "what level of safety should FAA target?" and "what should FAA oversight look like?" FAA has a moratorium on proposing regulations that addresses occupant safety until 2015.

FEDERAL COMMUNICATIONS COMMISSION

The FCC is responsible for managing and licensing the electromagnetic spectrum, and The Communications Act requires a license for any commercial communications transmitted via satellite to, from, and within the United States. The FCC licenses both space stations and earth stations.

In 2012, the FCC released a Notice of Proposed Rulemaking (NPRM), the first comprehensive review of satellite regulations since 1996. The NPRM seeks to simplify regulations and expedite the licensing process.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

The Assistant Administrator for NOAA Satellite and Information Services (NESDIS) is responsible for licensing private space-based remote sensing systems. The Commercial Remote Sensing Regulatory Affairs Office does NOAA's remote sensing licensing, compliance, and monitoring.

Operator	Satellite(s)	Date License Granted or Updated
Ball Aerospace	SAR	21-Nov-2000
California Polytechnic State University	IPEX	04-Dec-2012
Cosmogia	Dove-1 Dove-2 Dove-3 Dove-4	10-Feb-2012 04-May-2012 05-Sep-2012 05-Sep-2012
DigitalGlobe	QuickBird-II follow-on (2 satellites) WorldView (4 satellites)	14-Dec-2000 29-Sep-2003
DISH Operating	EchoStar-11	02-Feb-2010
Drexel University	Dragonsat-1	30-Mar-2012
GeoEye	IKONOS GeoEye-1 GeoEye-2 and -3	10-Jan-2006 12-Aug-2004 14-Jan-2010
GeoMetWatch	GMW 1-6	15-Sep-2010
Kentucky Space	KySat-2	19-Oct-2010
Northrup Grumman	Continuum Trinidad	20-Feb-2004 24-Aug-2009
Skybox Imaging	SkySat-1	20-Apr-2010
University of California, Irvine	UCISAT-1	17-Nov-2010
University of Michigan	M-Cubed	11-Aug-2011

Table 14. Active NOAA Licensees

EXPORT CONTROL

The Department of Commerce and Department of State oversee two different export control regimes.

	Department of State Directorate of Defense Trade Controls	Department of Commerce Bureau of Industry and Security
Controlled Items	Defense articles, services, and related technical data	Commercial items (including dual-use)
Statute	Arms Export Control Act	Export Administration Act International Emergency Economic Powers Act
Implementing Regulations	International Traffic in Arms Regulations	Export Administration Regulations
Control List	U.S. Munitions List	Commerce Control List

Table 15. U.S. Export Control Regimes

Exporters must obtain licenses to export items on the Departments' control lists. The U.S. Munitions List (USML) has 20 categories and generally covers items specially designed or modified for military applications. Export Administration Regulations (EAR) cover most commercial items, although the majority of exported commercial items do not need a license. The Commerce Control List, which has 10 categories, covers dual-use items, which have both commercial and military applications.

In December 2012, U.S. Congress passed the Fiscal Year 2013 National Defense Authorization Act (NDAA), which includes provisions to reform the export control framework for satellites and related items. This act repeals section 1513(a) of the FY 1999 Strom Thurmond National Defense Authorization Act. That act uniformly regulated satellites and related items as munitions, controlled by the Department of State's USML, and therefore subject to International Traffic in Arms Regulations (ITAR). Satellites and related items may now return to the Commerce Control List. The U.S. President has the authority to remove these items from the USML.

STATE REGULATORY ACTIONS

Several states have pursued commercial spaceflight liability indemnification laws. Florida, Texas, and Virginia have passed laws offering some indemnification from lawsuits for commercial spaceflight providers. New Mexico passed the "New Mexico Space Flight Informed Consent Act" in 2010, and in early 2013, state legislators presented a revised bill that extends indemnification to suppliers.

INTERNATIONAL TELECOMMUNICATION UNION

The International Telecommunication Union (ITU) is the United Nations specialized agency for information and communication technologies. It allocates global radio spectrum, assigns satellite orbits, and assists in the development of technical standards that ensure telecommunication networks and technologies interconnect.

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FUNDING

Major sources of public funding and publicly announced private funding for commercial vehicles and spaceports are summarized in this section.

On May 2, Boeing's CST-100 completed one of its CCDev-2 milestones with a parachute drop test from 14,000 feet.

Image credit: NASA

The U.S. commercial space transportation industry includes companies that build and operate orbital launch vehicles, SRVs, and on-orbit vehicles and platforms. These vehicles launch from commercial spaceports and government launch sites. Major sources of public funding and publicly announced private funding for commercial vehicles and spaceports are summarized below.

PUBLIC FUNDING SOURCES

The U.S. Government is both a customer of the space transportation industry and a source of investment. As a customer, the Government can procure space transportation services for satellite, cargo, and eventually human spaceflight missions. The following is a summary of major sources for recent public funding for commercial orbital launch vehicles, SRVs, on-orbit vehicles and platforms, and spaceports.

Space Transportation Infrastructure Matching Grants Program

The STIM Grants Program was established to ensure the resiliency of the space transportation infrastructure in the United States. Legislation authorizes the distribution of federal funding in conjunction with matching state, local government, and private funds. Money from STIM grants can be used for technical and environmental studies; construction, improvement, and design and engineering of space transportation infrastructure, including facilities and associated equipment; and real property to meet the needs of the U.S. commercial space transportation industry. The program first appropriated funds in fiscal year (FY) 2010.

FAA AST awarded about $500,000 in STIM grants in September 2010, August 2011, and September 2012.

Launch Site Authority	State	Value	Year of Award	Purpose
Alaska Aerospace Corporation	Alaska	$227,195	2010	Construction of a solid rocket motor storage facility at Kodiak Launch Complex
East Kern Airport District	California	$125,000	2010	Acquisition of an emergency rescue vehicle based at Mojave Air and Space Port
Jacksonville Aviation Authority	Florida	$104,805	2010	Draft Cecil Field Spaceport Master Plan
New Mexico Spaceport Authority	New Mexico	$43,000	2010	Installation of an Automated Weather Observing System (AWOS) located at Spaceport America
Virginia Commercial Space Flight Authority	Virginia	$125,000	2011	Security and remote monitoring improvements at MARS
East Kern Airport District	California	$125,000	2011	Development of a Supplemental Environmental Assessment
New Mexico Spaceport Authority	New Mexico	$249,378	2011	Construction of a mobile structure to process launch vehicles before launch
East Kern Airport District	California	$23,750	2012	Acquisition of specialized firefighting equipment at Mojave Air and Space Port
Front Range Airport Authority	Colorado	$200,000	2012	Environmental assessment to prepare for Front Range Spaceport FAA launch site application
Hawaii Department of Business, Economic Development and Tourism	Hawaii	$250,000	2012	Environmental assessment to prepare for Spaceport Kalaeloa FAA launch site application

Table 16. FAA AST STIM Grants

Center of Excellence for Commercial Space Transportation

Congress authorized the establishment of Air Transportation Centers of Excellence (COE) under the Federal Aviation Administration Research, Engineering and Development Authorization Act of 1990. COEs are 10-year partnerships with academia, their industry partners, and government to create consortiums to conduct research in environment, aviation safety, access to space, and other activities to ensure a safe and efficient air transportation system.

In August 2009, the FAA Administrator signed a memo agreeing to the creation of a COE for Commercial Space Transportation (CST) that would be supported at a minimum level of $1 million per year for 10 years. In August 2010, the FAA announced the establishment of the COE CST and cooperative agreements were signed with nine member universities in September 2010. COE CST provides grants in four distinct research areas: space traffic management and operations; space transportation operations, technologies, and payloads; human spaceflight; and space transportation industry viability.

A unique attribute of the COE program is the one-to-one matching requirement for every federal dollar granted to a COE university. The matching requirement can be satisfied through direct or in-kind contributions from any non-federal funding source, including industry, universities, or state and local government organizations.

University	2010 Award	2011 Award	2012 Award
Florida Institute of Technology	$150,000	--	$215,216
Florida State University	$100,000	$125,000	$256,891
New Mexico Institute of Mining and Technology	$150,000	--	$121,227
New Mexico State University	$400,000	--	$101,688
Stanford University	$400,000	$140,000	$395,995
University of Central Florida	$100,000	$10,000	$156,000
University of Colorado at Boulder	$300,000	$130,000	$404,372
University of Florida	$100,000	$60,000	$218,500
University of Texas Medical Branch	$300,000	$35,000	$44,111
Total	**$2,000,000**	**$500,000**	**$1,914,000**

Table 17. FAA COE CST Grants

COE CST Member Universities

The nine COE CST member universities are:

- Florida Institute of Technology
- Florida State University
- New Mexico Institute of Mining and Technology
- New Mexico State University
- Stanford University
- University of Central Florida
- University of Colorado at Boulder
- University of Florida
- University of Texas Medical Branch at Galveston

The COE CST member universities provide a comprehensive distribution of geographical coverage representing the entire Commercial Space Transportation Industry, including the top four civil space states (California, Colorado, Texas, and Florida) and New Mexico, the state leading the suborbital industry and with a significant level of military space activity. Combined, the 9 universities bring over 50 other government, industry, and academic organizations as research partners. In 2012, McGill University of Montréal, Canada, joined the COE CST as the first Affiliate University.

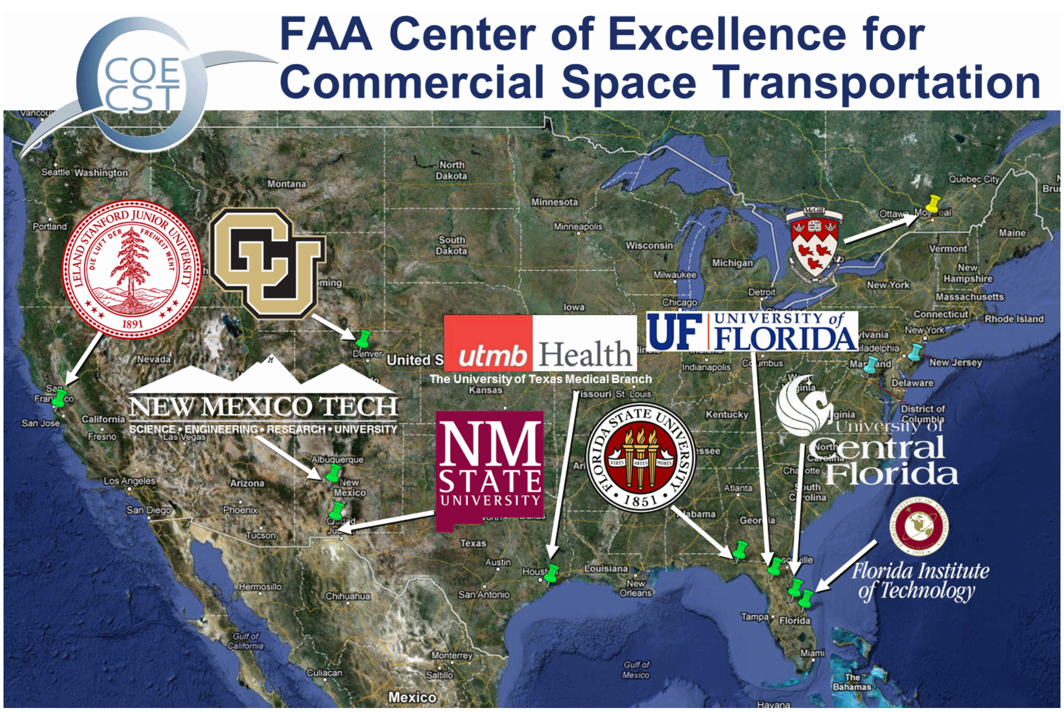


Figure 3. COE CST Member and Affiliate University Geographic Distribution

FAA COE CST: 2012 Highlights

The following are the major milestones for the FAA COE CST in its second year:

- *Second Annual Administrative Meeting held at Florida State University in Tallahassee, Florida on April 25-26.*
- *Creation of the Executive Committee, consolidating the Coordinating and Planning Committees into a single entity, and creation of three subcommittees: Self-Governance, Strategic Planning, and Collaboration.*
- *First full year of operation for the COE CST Industry Advisory Committee.*
- *Second Annual Technical Meeting held at NMT in Socorro, New Mexico on October 31-November 1.*
- *Nine new tasks begun, 24 ongoing tasks continued from the previous year, and 10 tasks were completed.*
- *COE CST benefited from the services of 37 students, 17 research partners, and 28 industry partners. The combined effort resulted in 38 technical or programmatic papers published in journals or presented at conferences.*

Commercial Crew and Cargo Transportation Development

In 2006, NASA unveiled the COTS program. COTS focused exclusively on the design and development of commercial cargo services to the ISS. Total SAA funding under this program, distributed according to a milestone schedule, was $891 million. Work on COTS directly led to the awarding of CRS contracts in 2008. These contracts cover 20 cargo flights to the ISS. The first CRS mission flew in 2012, and the final COTS mission is expected to fly in 2013, when Orbital's Antares vehicle launches the Cygnus capsule.

To stimulate commercial development of a crew transportation capability, NASA initiated the CCDev effort in 2010, with $50 million of 2009 American Recovery and Reinvestment Act funding. In 2011, after completion of the initial CCDev effort, NASA continued investing in commercial crew transportation development with the follow-on CCDev2 program, to mature the design and development of systems elements such as launch vehicles and spacecraft. The total value of CCDev2 was $315 million.

In 2012, NASA announced the next phase of commercial crew development, CCiCap. This initiative is to facilitate industry's development of an integrated crew transportation system. The total award value is over $1.1 billion, to be allocated as each milestone is completed.

Program	Year of Award	Total Potential Value (in $M)	Payments Through FY 2011 (in $M)	Operator	Vehicles and Technologies
COTS	2006	$396	$376	SpaceX	Cargo transportation system development (Dragon spacecraft)
COTS	2006	$207	$32	Rocketplane Kistler	K-1
COTS	2008	$288	$261	Orbital	Cargo transportation system development (Cygnus spacecraft)
CRS	2008	$1,500	N/A (contract, not milestone based)	SpaceX	Dragon (12 flights)
CRS	2008	$1,900	N/A (contract, not milestone based)	Orbital	Cygnus (8 flights)
CCDev	2010	$20	$20	SNC	Mature commercial crew transportation system
CCDev	2010	$18	$18	Boeing	Mature commercial crew transportation system
CCDev	2010	$6.7	$6.7	United Launch Alliance (ULA)	Mature emergency detection system
CCDev	2010	$3.7	$3.7	Blue Origin	Mature pusher escape system and composite pressure vessel
CCDev	2010	$1.4	$1.4	Paragon Space	Mature air revitalization system concept
CCDev2	2011	$112.9	$52.5	Boeing	CST-100 design maturation across 13 milestones
CCDev2	2011	$105.6	$42.5	SNC	Dream Chaser design maturation across 11 milestones
CCDev2	2011	$75	$40	SpaceX	Mature Falcon 9-Dragon transportation system focusing on developing an integrated, side-mounted launch abort system across 8 milestones
CCDev2	2011	$22	$11.2	Blue Origin	Mature space vehicle design, mature pusher escape system, and accelerate engine development for Reusable Booster System (RBS) across 9 milestones
CCDev2	2011	Unfunded	N/A	ULA	Advancement of commercial crew space transportation across 6 milestones
CCDev2	2011	Unfunded	N/A	ATK	Advancement of commercial crew space transportations across 5 milestones
CCDev2	2011	Unfunded	N/A	Excalibur Almaz, Inc	Advancement of commercial crew space transportation across 5 milestones
CCiCap	2012	$460	TBD	Boeing	Mature CST-100 crewed spacecraft and infrastructure across 19 milestones
CCiCap	2012	$440	TBD	SpaceX	Mature Dragon crewed spacecraft and infrastructure across 14 milestones
CCiCap	2012	$212.5	TBD	SNC	Mature Dream Chaser crewed spacecraft and infrastructure across 9 milestones
CPC	2012	$10	TBD	Boeing	Crew certification
CPC	2012	$10	TBD	SpaceX	Crew certification
CPC	2012	$10	TBD	SNC	Crew certification

Table 18. NASA Commercial Crew and Cargo Funding

Other NASA funding

NASA and Bigelow Aerospace agreed to a fixed-price contract worth $17.8 million for Bigelow Aerospace to build the inflatable module BEAM. During its two-year installation at the ISS, BEAM will be compared to traditional aluminum modules, in terms of its structural integrity and how it protects against radiation and extreme temperatures.

Flight Opportunities Program

NASA's Flight Opportunities Program provides flight opportunities for technology payloads. In addition to offering flights on parabolic aircraft and high altitude craft, this program helps foster the commercial suborbital industry by offering flight opportunities on SRVs. The Flight Opportunities Program currently has $10 million available for flight purchases.

In 2011, the Flight Opportunities Program solicited proposals for flight and payload integration from the commercial suborbital industry and selected six SRV providers in August 2011:

- Armadillo Aerospace
- Masten Space Systems
- UP Aerospace Inc.
- Virgin Galactic
- Whittinghill Aerospace LLC
- XCOR

Small Business Innovation Research and Small Business Technology Transfer Programs

Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs are competitive programs that encourage U.S. small businesses to engage in research and development with the potential for commercialization. The value of individual contracts and grants range from $50,000 to about $4 million.

SBIRs and STTRs are structured in phases. The structure sets budget and time guidelines. Guidelines are set at $150K (DoD) and six months to complete proposed work for Phase I grants, and up to $1M (DoD) and two years to complete proposed work for Phase II agreements. Agencies must report and receive waivers for all awards exceeding the guideline amounts. Phase II proposal submissions are usually by invitation only or after successfully completing Phase I.

SBIR/STTR Recipient	Award Amount	Funding Source/Type/ Phase	Year of Award
Armadillo Aerospace	$93,000	USAF/SBIR/Phase I	2007
Garvey Spacecraft Corporation	$95,000 $95,000 $99,000 $1,000,000	USAF/SBIR/Phase I USAF/SBIR/Phase I NASA/SBIR/Phase I USAF/SBIR/Phase II	2003 2005 2008 2008
Masten Space Systems	$97,000 $73,000	DARPA/SBIR/Phase I NASA/SBIR/Phase I	2009 2011
Whittinghill Aerospace	$99,000 $599,000 $99,000 $600,000	NASA/SBIR/Phase I NASA/ SBIR/Phase II NASA/SBIR/Phase I NASA/SBIR/Phase II	2008 2009 2009 2010
XCOR Aerospace	$750,000 $99,000 $100,000 $99,000 $100,000 $750,000 $100,000	DARPA/STTR/Phase II USAF/SBIR/Phase I USAF/SBIR/Phase I DoD (OSD)/SBIR/Phase I USAF/SBIR/Phase I USAF/SBIR/Phase II NASA/SBIR/Phase I	2003 2005 2007 2008 2008 2008 2011

Table 19. Select SBIR/STTR Funding by Company

PRIVATE FUNDING SOURCES

The largest sources of private funding come from corporate investment, individual contributions by company founders, and angel investors. The table below summarizes publically available information on private funding for commercial space transportation by company. It is likely there are additional investment, contracts, loans or grants that have not been publically announced.

Operator	Private Funding Comments
Suborbital	
Armadillo Aerospace	~$2M, invested John Carmack
Virgin Galactic/ Scaled Composites	~$100M, invested by Sir Richard Branson $280M, invested by Aabar Investments (from UAE) in 2009 $110M, additional investment by Aabar Investments in 2011 $10M, Ansari X PRIZE for flights of SpaceShipOne, by Scaled Composites
XCOR	$7M, from private investors through 2009 $5M, additional investment from private investors in 2012
Orbital	
Stratolaunch Systems	Vulcan, Inc., founded by Paul Allen, has invested in Stratolaunch Allen expects budget for production of first vehicle to be ~$300M
Bigelow Aerospace	~$215M, invested by Robert Bigelow, and could invest up to $500 million into the effort by 2015
Excalibur Almaz	"Tens of millions of dollars" invested by Art Dula and partners, as stated by Dula in 2005 interview
SpaceX	$200M, invested by Elon Musk $200M, invested by private investors as of 2010

Table 20. Summary of Publicly Available Information on Private Funding

LAUNCH DATA AND TRENDS

This section provides summaries of 2012 worldwide launch activities and forecasts for commercial space transportation launches in the next ten years. The summaries are from previously released FAA AST reports, including:

- **Commercial Space Transportation: 2012 Year in Review**
- **2012 Commercial Space Transportation Forecasts**
- **Suborbital Reusable Vehicles: A 10-Year Forecast of Market Demand**

On May 22, SpaceX's Falcon 9 made the first of two U.S. commercial launches in 2012.

Image credit: SpaceX

SUMMARY OF *COMMERCIAL SPACE TRANSPORTATION: 2012 YEAR IN REVIEW*

WORLDWIDE ORBITAL LAUNCH ACTIVITY

Launch providers from the United States, Russia, Europe, China, Japan, India, Iran, North Korea, and one multinational provider conducted a total of 78 launches in 2012, 20 of which were commercial. (See Figures 4 and 5, and Tables 21 and 22.) This is consistent with the 5-year average of 77 total launches and 21 commercial launches per year. The following is a summary of worldwide orbital commercial launches in 2012, by country.

- The United States had 13 launches in 2012, which is five fewer launches than in 2011. Two of the 13 launches were commercial; there were no commercial U.S. launches in 2011.
- Russia continues to have the most launches annually (24) as well as most commercial launches (7). Russia experienced two launch failures, including a partial failure in which the payload eventually reached its intended orbit. In 2011, Russia had 31 launches.
- Europe conducted 10 launches in 2012, 6 of which were commercial. The first launch of the new Vega vehicle took place in 2012. Europe had six launches in 2011.
- China had the same number of launches, 19, including commercial launches (2), in 2011 and 2012.
- The multinational Sea Launch Zenit 3SL launch vehicle performed three commercial launches.
- India and Japan each had two non-commercial launches.
- Iran attempted to launch its Safir 2 vehicle three times and had two failures.
- North Korea conducted two launch attempts of its Unha 3 rocket. The first attempt failed, but the second placed the first North Korean payload into orbit.

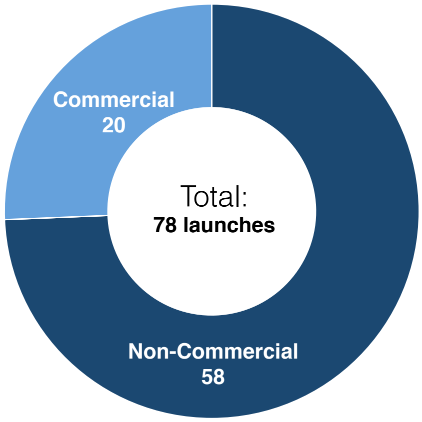


Figure 4. 2012 Total Worldwide Launch Activity

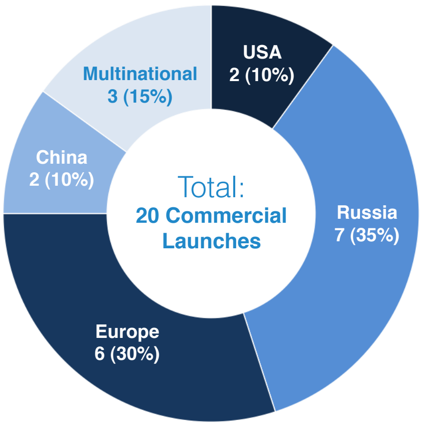


Figure 5. 2012 Worldwide Commercial Launch Activity

Country/Region	Commercial Launches	Non-Commercial Launches	Launches
United States	2	11	13
Russia	7	17	24
Europe	6	4	10
China	2	17	19
Japan	0	2	2
India	0	2	2
Iran	0	3	3
North Korea	0	2	2
Multinational	3	0	3
TOTAL	***20***	***58***	***78***

Table 21. 2012 Worldwide Orbital Launch Events

Date	Vehicle	Launching Country/ Region	Payload(s)	Orbit	Launch Outcome
14-Feb-12	Proton M	Russia	SES-4	GEO	Success
25-Mar-12	Proton M	Russia	Intelsat 22	GEO	Success
31-Mar-12	Long March 3B	China	APSTAR 7	GEO	Success
23-Apr-12	Proton M	Russia	Yahsat 1B	GEO	Success
15-May-12	Ariane 5	Europe	JCSAT 13 Vinasat 2	GEO GEO	Success
17-May-12	Proton M	Russia	Nimiq 6	GEO	Success
22-May-12	Falcon 9	USA	Dragon COTS Demo 2/3	LEO	Success
1-Jun-12	Zenit 3SL	Multinational	Intelsat 19	GEO	Success
5-Jul-12	Ariane 5	Europe	Echostar XVII MSG 3	GEO GEO	Success
9-Jul-12	Proton M	Russia	SES-5	GEO	Success
2-Aug-12	Ariane 5	Europe	HYLAS 2 Intelsat 20	GEO GEO	Success
18-Aug-12	Zenit 3SL	Multinational	Intelsat 21	GEO	Success
28-Sep-12	Ariane 5	Europe	Astra 2F GSAT 10	GEO GEO	Success
7-Oct-12	Falcon 9	USA	Dragon ISS 1D ORBCOMM OG2-01	LEO LEO	Success
14-Oct-12	Proton M	Russia	Intelsat 23	GEO	Success
16-Nov-12	Ariane 5	Europe	Star One C3 Eutelsat 21B	GEO GEO	Success
20-Nov-12	Proton M	Russia	Echostar XVI	GEO	Success
3-Dec-12	Zenit 3SL	Multinational	Eutelsat 70B	GEO	Success
19-Dec-12	Long March 2D	China	Gökturk 2	SSO	Success
19-Dec-12	Ariane 5	Europe	SkyNet 5D MexSat 3	GEO GEO	Success

Table 22. 2012 Worldwide Commercial Launch Events

The 2012 orbital launch activity by launch vehicle is presented in Figure 6.

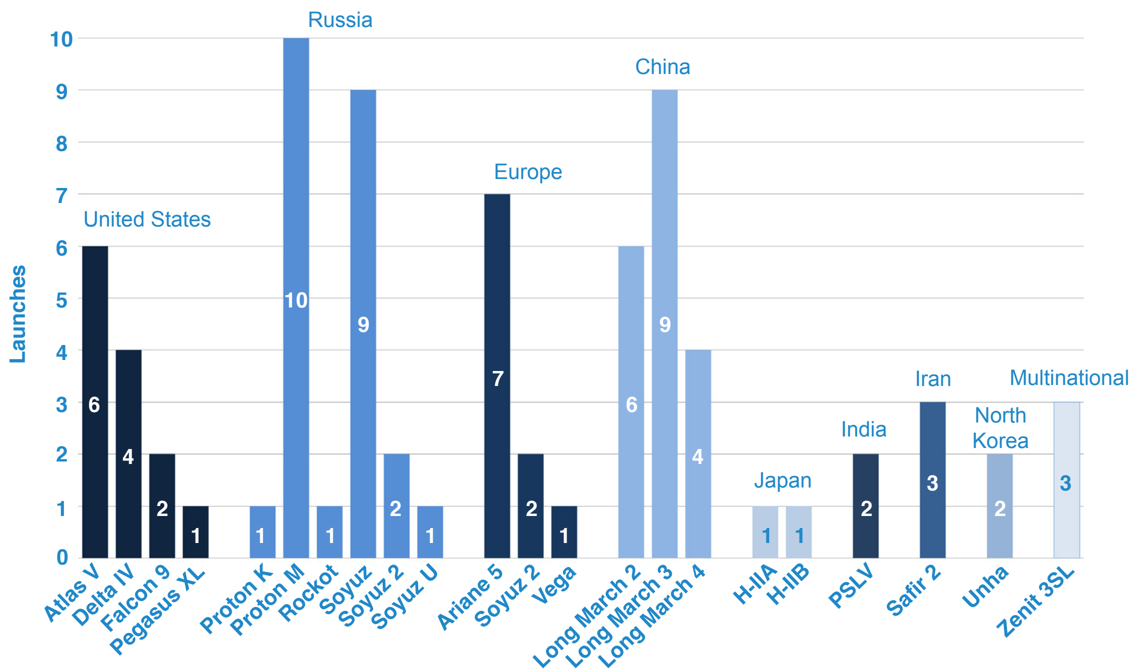


Figure 6. 2012 Launch Vehicle Use

In the Appendix, the Worldwide Orbital Launches Events table shows all 78 orbital launches worldwide in 2012, including commercial, civil, and military missions.

Worldwide Launch Revenues

Estimated revenues from the 20 commercial launch events in 2012 amounted to approximately $2.4 billion. These revenues are consistent with commercial launch revenue in 2009 and 2010 but show a nearly half-billion dollar increase over 2011. (See Figure 7.) More detail on five-year revenue trends can be found in the Space Transportation Trends section. The following are 2012 revenues by country:

- Commercial launch revenues in the United States amounted to $108 million.
- Russian commercial launch revenues were approximately $595 million, down about 15 percent from last year, primarily due to Proton failures causing commercial launches to slip to 2013.
- European revenues were approximately $1.3 billion, a 50 percent increase over 2011 revenues.
- Chinese revenues dropped from 2011 by $50 million, for an estimated total of $90 million.
- Multinational (Sea Launch) revenues were approximately $300 million, up from $200 million in 2011.

Payments for launch services are typically spread over one to two years before the launch, but for the purposes of this report, revenue is counted in the year a customer's payload launches. Launch revenues are attributed to the country or region where the primary vehicle manufacturer is based. These revenues are assessed based on commercial launch price estimates for each launch vehicle using publically available information.

Most launch vehicles today are manufactured, sold, and launched by the same organization in one country or within a particular economic region.[1] Sea Launch AG, however, is a multinational launch service corporation.

[1] International Launch Services (ILS) and Arianespace constitute an exception. ILS is a Russian-owned company incorporated in the United States and selling launches of the Russian Proton vehicles. Arianespace markets launches of a Russian-manufactured Soyuz 2 vehicle from the Kourou launch site in French Guiana.

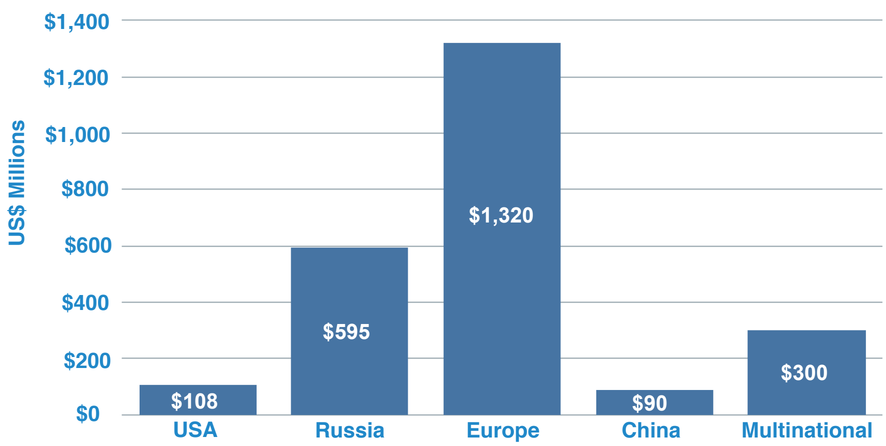


Figure 7. Estimated 2012 Commercial Launch Revenues

Worldwide Orbital Payload Summary

In 2012, 78 launches carried a total of 139 payloads to orbit (see Table 23 and Figures 9 and 10). Approximately 20 percent (27 payloads) provide commercial services. (See Figure 11 for these payloads by launch country.) The remaining 80 percent (112 payloads) were used for non-commercial civil government, military, or non-profit purposes.

The 2012 worldwide orbital launch activity by payload use type is presented in Figure 8.

Country/ Region	Commercial Payloads	Non-Commercial Payloads	Total Payloads
United States	3	25	28
Russia	10	24	34
Europe	7	18	25
China	3	27	30
Japan	0	10	10
India	1	3	4
Iran	0	3	3
North Korea	0	2	2
Multinational	3	0	3
TOTAL	***27***	***112***	***139***

Table 23. Payloads Launched by Country in 2012

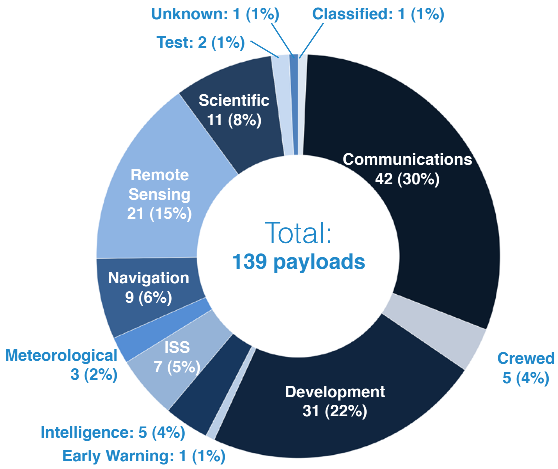


Figure 8. Payload Use Type

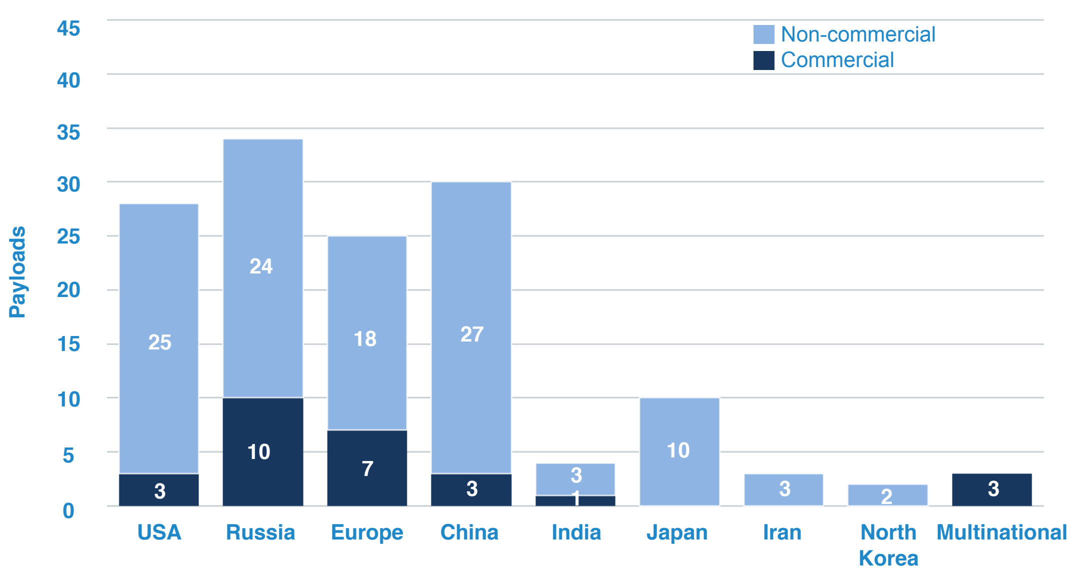


Figure 9. 2012 Total Worldwide Launch Activity by Payload

Commercial Launch Payload Summary

Twenty commercial launches carried a total of 27 commercial and non-commercial payloads into orbit. Four of these commercially launched payloads were deployed in non-geosynchronous orbits (NGSO) and 23 were launched to a geostationary orbit (GEO) (see Table 22). Two of the NGSO payloads were launches of the Dragon capsule, as part of NASA's COTS and CRS program. The other two NGSO payloads were Turkey's Gökturk-2 satellite and the ORBCOMM OG2-1 satellite. All but one GEO payload (MSG 3, a European meteorological satellite) were communications satellites.

ORBCOMM OG2-01, a communications satellite, was launched as a secondary payload on SpaceX's mission to the International Space Station (ISS). The launch was considered a success because it met its primary objective of transporting the Dragon capsule to the ISS, but it failed to place the ORBCOMM satellite into its intended orbit due to an anomaly on one of the Falcon 9's first stage engines. Because of the engine shutdown, and to remain in compliance with the plan approved for Dragon delivery to the ISS, the rocket was not allowed to execute the second burn. For this reason, the satellite was deployed in an orbit lower than intended.

Of the 27 commercially launched payloads, 21 provide commercial services and 6 are non-commercial (civil or defense). The governments of India, Mexico, United Kingdom, and Vietnam launched communications satellites commercially, all on Ariane 5 vehicles. Europe's meteorological agency, Eumetsat, launched a weather satellite on an Ariane 5, and Turkey launched a military satellite on a Long March 2C vehicle. (See Table 24.)

Launch Vehicle	Payload	Service Type	Use
Ariane 5	Vinasat 2	Civil	Communications
Ariane 5	MSG 3	Civil	Meteorological
Ariane 5	GSAT 10	Civil	Communications
Ariane 5	SkyNet 5D	Military	Communications
	MexSat 3	Civil	Communications
Long March 2D	Gökturk 2	Military	Intelligence

Table 24. Commercially Launched Government Civil and Military Payloads

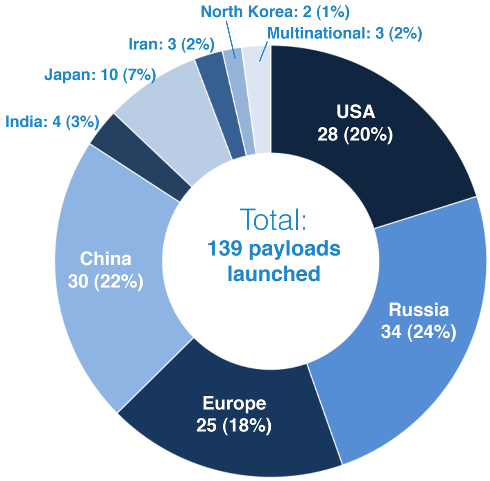


Figure 10. Total Payloads Launched by Country in 2012

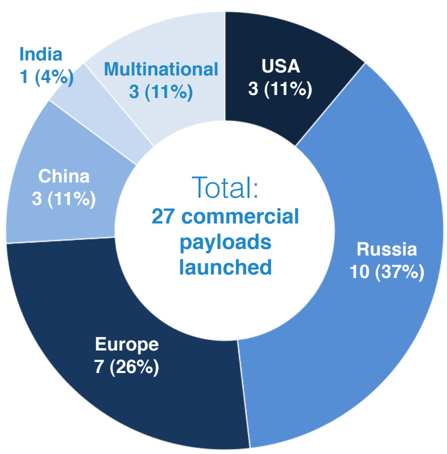


Figure 11. Commercial Payloads Launched by Country in 2012

Non-Commercial Launches

In 2012, there were 58 non-commercial launches carrying a total of 112 payloads. Fifty-five payloads were for civil government purposes, 37 payloads were for military use, and 14 payloads were for non-profit missions (universities). Six payloads were commercial: five communications satellites—ORBCOMM's Vesselsat 2, Indonesia's Telkom 3, APT Satellite's APStar 7B (Chinasat 12), and Gazprom Space System's Yamal 300K and 402—and one remote sensing satellite, France's SPOT 6. (See Figure 12 and Table 25.)

In 2012, all five launch failures were non-commercial launches. Iran's Safir vehicle failed twice, in May and September, and North Korea's Unha 3 rocket failed once. The other two failures were with Russia's Proton M vehicle. The August Proton failure resulted in the loss of Indonesia's Telkom 3 and Russia's Express MD2 communications satellites. The December failure was considered partial because the Yamal 402 satellite used its own propulsion system to reach its target orbit. The Proton M also experienced failures in 2010 and 2011.

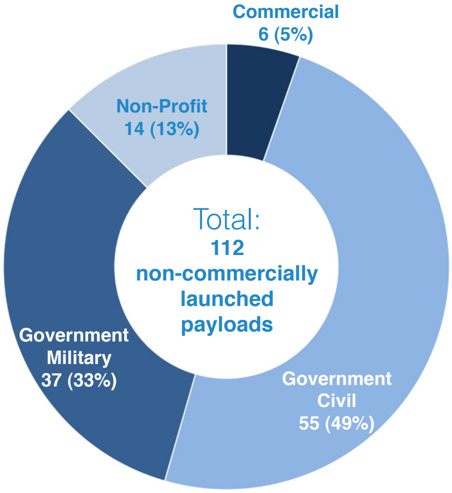


Figure 12. Non-commercially Launched Payloads by Service Type

Country	Service Type	Payload(s)
United States	Civil (8)	Aerocube 4A, 4B, and 4C; NuSTAR; OUTSAT; STARE A; and Van Allen Probe A and B
	Military (13)	AEHF 2; AENEAS; MUOS 1; Navstar GPS 2F-03; NRO L-15, L-25, L-36/NOSS 3-6A, L-36/NOSS 3-6B, L-38; SMDC-ONE 2.1, -ONE 2.2; WGS 4; and X-37B/OTV 3
	Non-Profit (4)	CINEMA 1; CISSWE; CP 5; and CXBN
Russia	Civil (20)	Belka 2; ExactView 1; Express MD 2; Gonets M-03 and M-04; Kanopus B1; Luch 5B; MetOp B; MIR; Progress M-14M, -15M, -16M, and -17M; SFERA-53; Soyuz TMA-04M, -05M, -06M, and -07M; TET-1; and Zond PP
	Military (4)	Cosmos 2479, 2480, 2481; and Meridian 6
Europe	Civil (5)	ATV 3; LARES; Galileo 3 and 4; and Pleiades HR 2
	Non-Profit (8)	ALMASat 1; E-ST@R; GOLIAT; MaSat; PW-Sat 1; ROBUSTA; UNICUBESAT GG; and XATCOBEO
China	Civil (11)	Fengniao 1B and 1A; Feng Yun 2F; Huan Jing 1C; Shenzhou 9 Decent Module and Orbital Module; Tian Hui 1B; Tianlian-1C; VRSS 1; Xinyan-1; and Zi Yuan 3
	Military (15)	Beidou 2C-M3, -M4, -M5, and -M6; Beidou 2-G5 and -G6; Chinasat 2A; Shijian 9A and 9B; Tiantuo 1; Yaogan 14, 15, 16 Main, 16 Subsat 1, and 16 Subsat 2
India	Civil (2)	mRESINS and Proiteres
	Military (1)	Risat 1
Japan	Civil (8)	F-1; FitSat-1; GCOM-W1; HTV-3; Kompsat 3; SDS-4; TechEdSat; and We-Wish
	Non-Profit (2)	Horyu 2 and RAIKO
Iran	Civil (1)	Navid-E Elm-O Sanat
	Military (2)	Fajr and Unknown Iranian Satellite
North Korea	Military (2)	Kwangmyongsong 3 and Kwangmyongsong 3-2

Table 25. Non-commercially Launched Payloads for Government Civil, Military, or Non-Profit Use

U.S. AND FAA-LICENSED ORBITAL LAUNCH AND REENTRY ACTIVITY

FAA-Licensed Orbital Launch Summary

There were five FAA-licensed orbital launches in 2012. SpaceX's Falcon 9 vehicle made two licensed launches to the ISS. In May, SpaceX completed its second flight under NASA's COTS program, and in October, the company launched its first flight under NASA's CRS program. Sea Launch's Zenit 3SL vehicle performed three licensed launches, which carried Intelsat 19, Intelsat 21, and Eutelsat 70B communications satellites to GEO (see Table 26).

Over the past five years, FAA has on average licensed four or five launches per year. However, in 2008, FAA licensed 11 launches, including 5 Sea Launch Zenit 3SL launches of commercial GEO communications satellites. A Sea Launch Zenit 3SL performed the only FAA-licensed launch in 2011, which launched a commercial GEO communications satellite, Atlantic Bird 7, for Eutelsat. Figures 13 and 14 summarize the number of FAA-licensed orbital launches and revenue from 2008-2012.

Date	Vehicle	Primary Payload	Orbit	Launch Outcome
22-May-12	Falcon 9	Dragon COTS Demo 2/3	LEO	Success
1-Jun-12	Zenit 3SL	Intelsat 19	GEO	Success
18-Aug-12	Zenit 3SL	Intelsat 21	GEO	Success
7-Oct-12	Falcon 9	Dragon ISS 1D	LEO	Success
03-Dec-12	Zenit 3SL	Eutelsat 70B	GEO	Success

Table 26. 2012 FAA-Licensed Orbital Launch Events

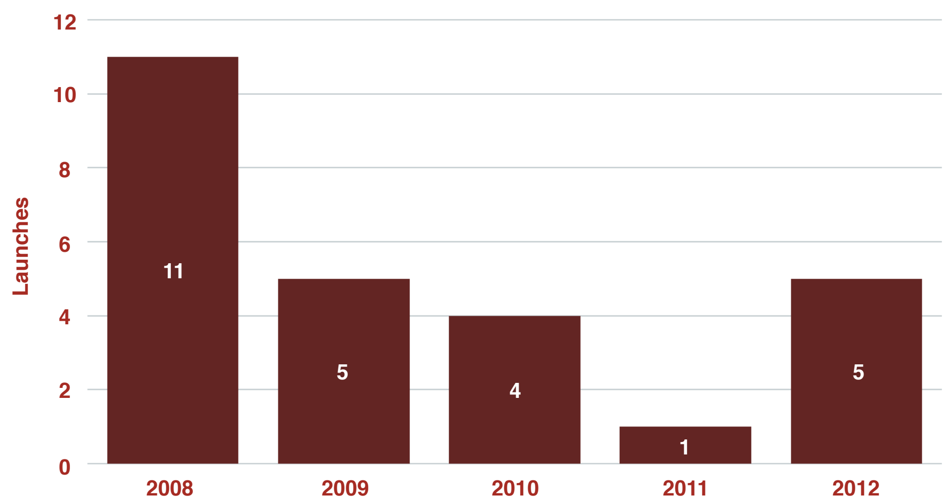


Figure 13. FAA-licensed Orbital Launch Events, 2008-2012

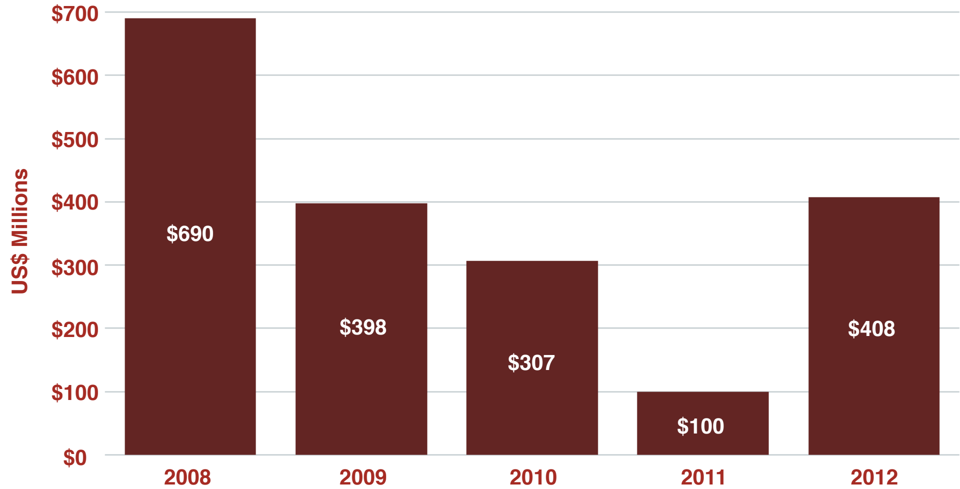


Figure 14. Estimated Revenue for FAA-licensed Orbital Launch Events, 2008-2012

FAA Reentry License Summary

There were two reentries conducted under FAA reentry licenses in 2012. SpaceX's Dragon spacecraft performed both licensed reentries, in May and October, completing its final COTS and first CRS missions to the ISS. (See Table 27 for details.)

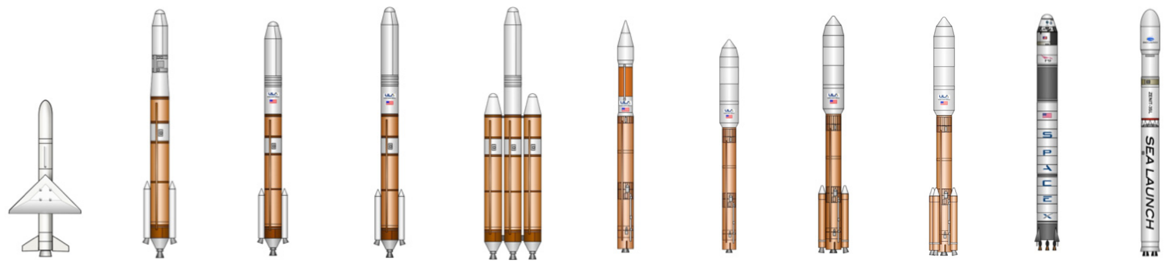
United States

U.S. launch vehicles provided 11 U.S. government launches and 2 commercial launches in 2012. The U.S. Department of Defense (DoD) had nine launches, which was the same number as last year. These nine missions carried four National Reconnaissance Office (NRO) payloads and five DoD or DoD-sponsored payloads, including payloads for the U.S. Navy and U.S. Air Force. NASA had two launches in 2012, down from last year's unusually high number of nine. (NASA's two launches do not count the two commercial SpaceX launches to the ISS, which NASA paid for.) Table 28 summarizes U.S. and FAA-licensed launch vehicles active in 2012.

The following is a list of U.S.-based launch service providers, highlighting their launch activity in 2012. It includes all companies that launch from the United States or under the regulatory oversight of the FAA AST.

Vehicle	SpaceX Dragon
2012 Total Reentries	2
2012 Licensed Reentries	2
Launch Reliability (2012)	2/2 100%
Reentry Reliability (Last 10 Years)	3/3 100%
Year of First Reentry	2010
Reentry Sites	Pacific Ocean
Payload to LEO, kg (lbs)	6,000 (13,228)
Payload from LEO, kg (lbs)	3,000 (6,614)

Table 27. FAA-Licensed Reentry Vehicles Active in 2012



Vehicle	Pegasus XL	Delta IV Medium+ (4,2)	Delta IV Medium+ (5,2)	Delta IV Medium+ (5,4)	Delta IV Heavy	Atlas V 401	Atlas V 501	Atlas V 531	Atlas V 551	Falcon 9 Dragon	Zenit 3SL
2012 Total Launches	1	1	1	1	1	3	1	1	1	2	3
2012 Licensed Launches	0	0	0	0	0	0	0	0	0	2	3
Launch Reliability (2012)	1/1 100%	1/1 100%	1/1 100%	1/1 100%	1/1 100%	3/3 100%	1/1 100%	1/1 100%	1/1 100%	2/2 100%	3/3 100%
Launch Reliability (Last 10 Years)	11/11 100%	9/9 100%	1/1 100%	2/2 100%	5/6 83%	14/14 100%	4/4 100%	2/2 100%	3/3 100%	4/4 100%	26/27 96%
Year of First Launch	1994	2002	2012	2009	2004	2002	2010	2011	2006	2010	1999
Active Launch Sites	CCAFS, Kwajalein Island, VAFB	CCAFS, VAFB	CCAFS, VAFB	CCAFS, VAFB	CCAFS, VAFB	CCAFS, VAFB	CCAFS, VAFB	CCAFS, KSC	CCAFS	CCAFS	Odyssey Pacific Ocean Platform
LEO kg (lbs)	443 (976)	10,430 (22,974)	11,062 (25,387)	13,774 (30,365)	22,560 kg (49,740 lb)	9,797 (21,598)	8,123 (17,908)	--	--	10,450 (21,586)	15,246 (33,541)
GTO kg (lbs)	--	5,845 (12,874)	5,433 (11,978)	7,434 (16,389)	12,980 kg (28,620 lb)	4,750 (10,470)	3,775 (8,320)	7,980 (17,593)	8,670 (19,114)	4,540 (10,296)	6,100 (13,440)

Table 28. U.S. and FAA-Licensed Launch Vehicles Active in 2012

Orbital Sciences Corporation

Orbital provides the Minotaur, Pegasus, and Taurus vehicles for orbital launch. In 2013, Orbital plans to launch a new vehicle, Antares, as part of NASA’s commercial cargo program.

Orbital performed one launch in 2012. In June, a Pegasus XL launched NASA’s X-ray telescope, NuSTAR, from Kwajalein Island.

Space Exploration Technologies Corporation

SpaceX performed two Falcon 9 launches in 2012, in May and October, carrying supplies to the ISS in the Dragon capsule. These missions were performed under NASA’s COTS and CRS programs and were the first commercial missions to the ISS.

United Launch Alliance

United Launch Alliance (ULA) conducts launches for the non-commercial U.S. government launch market. ULA manufactures and operates Boeing-heritage Delta vehicles and Lockheed Martin-heritage Atlas vehicles. ULA is a partnership between Boeing and Lockheed Martin.

In 2012, ULA conducted 10 non-commercial U.S. government launches:

- Delta IV vehicles placed four DoD payloads into orbit: WGS 4, NRO L-25, NRO L-15, and Navstar GPS 2F-3.
- Atlas V vehicles placed six payloads, five DoD and one NASA, into orbit: MUOS 1, AEHF 2, NRO L-38, NRO L-36, X-37B/OTV 3, and Van Allen Probe A and B.

FAA-Licensed Multinational Launches: Sea Launch AG

Zenit 3SL, a launch vehicle operated by multinational commercial launch provider Sea Launch AG, deployed three commercial GEO communications satellites for commercial operators Intelsat and Eutelsat. These launches were performed under FAA licenses.

NON-U.S. ORBITAL LAUNCH ACTIVITIES

The following section of the report highlights non-U.S. launch activity on a country-by-country basis.

Russia

In 2012, there were 24 Russian launches. Twenty-two of these were successful, one Proton M failed, and one Proton M experienced a partial failure. Eleven launches were with Proton vehicles, 12 with Soyuz vehicles, and 1 with a Rockot vehicle. Twenty-two of the missions launched from Baikonur Cosmodrome, and two Russian Space Forces missions launched from Plesetek. Table 29 summarizes 2012 Russian launch activity by vehicle.

Seven launches were commercial and 17 were non-commercial. The non-commercial missions are detailed below:

- Eight Soyuz launches were dedicated ISS missions, involving four Progress M cargo missions and four Soyuz spacecraft crew exchange missions.
- Russian military conducted four missions. A Proton vehicle launched communications satellite Cosmos 2479. Two Soyuz vehicles launched two communications satellites, Cosmos 2480 and Meridian 6. A Rockot vehicle launched communications satellite Cosmos 2481 (with three government civil secondary payloads co-manifesting).
- Russia executed three launches for civil purposes. Two Soyuz vehicles launched a remote sensing satellite, Kanopus B1, and a meteorological satellite, MetOp B. A Proton M launched Luch 5B (co-manifested with a commercial payload, the communications satellite Yamal 300K.)
- One non-commercial launch with a Proton M deployed a communications satellite, Yamal 402.
- One more Proton M vehicle attempted to launch two communications satellites, Express MD2 for Russian Satellite Communications Company (RSCC) and Telkom 2 for PT Telkom of Indonesia. The launch attempt resulted in a failure.

International Launch Services (ILS) provided launch services for eight Proton M launches. All eight missions were telecommunications satellites to GEO. Two of the satellites were for SES, two for Intelsat, and one each for Telesat Canada, Echostar Communications, and United Arab Emirates Yahsat. Under FAA's definition for a commercial launch, seven of these launches are considered commercial missions. The launch of the Yamal 402 satellite for Gazprom Space Systems is not considered commercial because it did not meet FAA's criteria of an internationally competed launch. Typically, all Russian commercial Proton launches are under a contract with ILS.

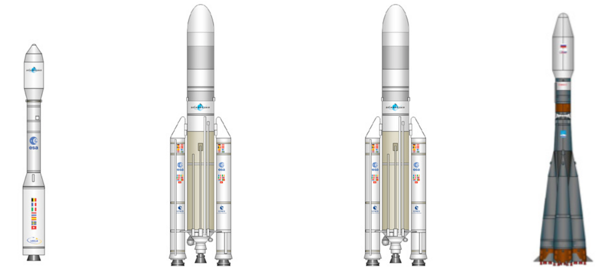
Vehicle	Rockot	Soyuz	Soyuz 2	Soyuz U	Proton K	Proton M
Country/Region	Russia	Russia	Russia	Russia	Russia	Russia
2012 Total Launches	1	9	2	1	1	10
Launch Reliability (2012)	1/1 100%	9/9 100%	2/2 100%	1/1 100%	1/1 100%	9/10 90%
Launch Reliability (Last 10 Years)	14/15 93%	92/95 97%	15/17 88%	4/4 100%	18/18 100%	60/67 90%
Year of First Launch	1994	1963	2004	2009	1967	2000
Active Launch Sites	Baikonur, Plesetsk	Baikonur, Plesetsk	Baikonur, Plesetsk	Plesetsk	Baikonur	Baikonur
LEO kg (lbs)	1,850 (4,075)	6,708 (14,758)	7,800 (17,100)	6,700 (14,740)	19,760 (43,570)	21,000 (46,305)
GTO kg (lbs)	--	1,350 (2,975)	1,700 (3,800)	--	4,430 (9,770)	5,500 (12,125)

Table 29. Russian Launch Vehicles Active in 2012

Europe

Europe conducted 10 launches in 2012 from its spaceport in French Guiana. Seven were with Ariane 5 vehicles, two with Soyuz vehicles, and the Vega rocket made its inaugural launch. Six of the Ariane 5 launches were commercial. The other four European launches were non-commercial, carrying payloads for the European Space Agency, French Space Agency, and Italian Space Agency. Table 30 summarizes 2012 European launch activity by vehicle. More details on European launches are below:

- Six Ariane 5 ECA launch vehicles placed 12 satellites in GEO, including seven commercial telecommunications satellites, one military communications satellite, three civil government communications satellites, and a meteorological satellite. All Ariane 5 ECA launches were dual manifests of GEO satellites.
- An Ariane 5 ES launched the third Automated Transfer Vehicle bringing cargo to the ISS.
- The first Soyuz 2 launched two Galileo satellites.
- The second Soyuz 2 carried the Pleiades 1B remote sensing satellite.
- Vega launched nine satellites to LEO, including one civil and eight non-profit payloads.



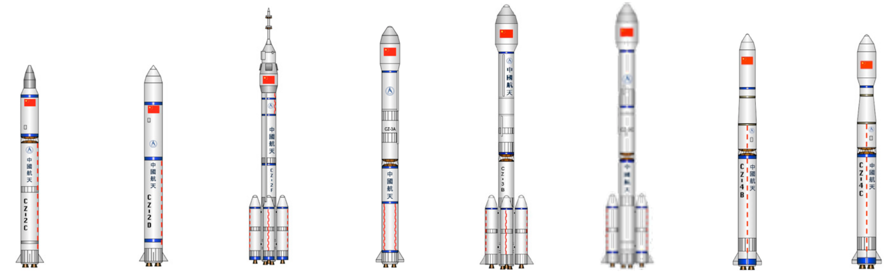
Vehicle	Vega	Ariane 5 ECA	Ariane 5 ES-ATV	Soyuz 2
Country/Region	Europe	Europe	Europe	Europe
2012 Total Launches	1	6	1	2
Launch Reliability (2012)	1/1 100%	6/6 100%	1/1 100%	2/2 100%
Launch Reliability (Last 10 Years)	1/1 100%	38/39 97%	3/3 100%	4/4 100%
Year of First Launch	2012	2002	2008	2011
Active Launch Sites	Kourou	Kourou	Kourou	Kourou
LEO kg (lbs)	1,500 (3,307)	17,250 (37,950)	21,000 (46,297)	7,800 (17,100)
GTO kg (lbs)	--	10,500 (23,127)	8,000 (17,637)	1,700 (3,800)

Table 30. European Launch Vehicles Active in 2012

China

China conducted 19 orbital launches, including 2 commercial launches, in 2012—the same number as in 2011. Nine launches were conducted from the Xichang Satellite Launch Center, five from the Jiuquan Satellite Launch Center, and five from the Taiyuan Satellite Launch Center. Table 31 summarizes 2012 Chinese launch activity by vehicle. More details on Chinese launches are below.

- Nine launches were for China's military. These launches deployed five Beidou navigation satellites, five Yaogan remote sensing satellites, three scientific and development satellites, and one communications satellite, Chinasat 2A.
- Six launches were for China's civil government agencies. One was a human misson: the Shenzhou 9 vehicle launched three crew, including China's first female astronaut, and docked for the first time with the Tiangong 1 space module. The other five civil launches deployed satellites, including one meteorological satellite, three remote sensing satellites, and one communications satellite for CAST. A communications microsatellite, Vesselsat 2, for ORBCOMM was launched as a piggyback payload co-manifesting with one of the three remote sensing satellites (Ziyuan 3).
- Two launches were commercial. One launch deployed the APSTAR 7 satellite for APT Satellite Holdings Ltd. of Hong Kong. The second commercial launch deployed the Gökturk-2 satellite for Turkey's Ministry of Defense.
- One non-commercial launch deployed the VRSS 1 satellite built by China for Venezuela, and another non-commercial launch deployed APSTAR 7B, the second satellite for APT Satellite Holdings Ltd. APSTAR 7B was originally ordered as a back-up to APSTAR 7. It was transferred to the Chinese Government and will be operated as Chinasat 12.



Vehicle	Long March 2C	Long March 2D	Long March 2F	Long March 3A	Long March 3B	Long March 3C	Long March 4B	Long March 4C
Country/Region	China	China	China	China	China	China	China	China
2012 Total Launches	2	3	1	1	5	3	2	2
Launch Reliability (2012)	2/2 100%	3/3 100%	1/1 100%	1/1 100%	5/5 100%	3/3 100%	2/2 100%	2/2 100%
Launch Reliability (Last 10 Years)	16/17 94%	15/15 100%	8/8 100%	17/17 100%	18/18 100%	10/10 100%	16/16 100%	8/8 100%
Year of First Launch	1975	1992	1999	1994	1996	2008	1999	2007
Active Launch Sites	Jiuquan, Taiyuan, Xichang	Jiuquan	Jiuquan	Taiyuan, Xichang	Xichang	Xichang	Taiyuan	Taiyuan
LEO kg (lbs)	3,200 (7,048)	3,500 (7,700)	8,400 (18,500)	7,200 (15,859)	13,562 (29,900)	3,700 (8,200)	2,500 (5,512)	4,595 (10,130)
GTO kg (lbs)	1,000 (2,203)	1,250 (2,750)	--	2,500 (5,506)	4,491 (9,900)	--	1,500 (3,300)	1,500 (3,300)

Table 31. Chinese Launch Vehicles Active in 2012

Japan

Japan had two launches this year: one H-IIA launch of payloads to sun-synchronous orbit (SSO) and one H-IIB ISS cargo resupply mission. Japan also had two launches in 2011, one H-IIA and one H-IIB. In September, the Japan Aerospace Exploration Agency (JAXA) and Mitsubishi Heavy Industries LTD. (MHI) announced an effort to privatize the H-IIB launch service. Under the new arrangement, JAXA will procure the H-IIB transportation and launch service from MHI when it launches a payload on the H-IIB.

India

The Indian Space Research Organization (ISRO) performed two PSLV launches in 2012. The primary payloads were remote sensing satellites to SSO. In April, ISRO launched its C-band synthetic aperture Radar RISAT 1, which is intended primarily for natural resource planning. The second PSLV launch deployed France's remote sensing satellite, SPOT 6. India had three PSLV launches in 2011.

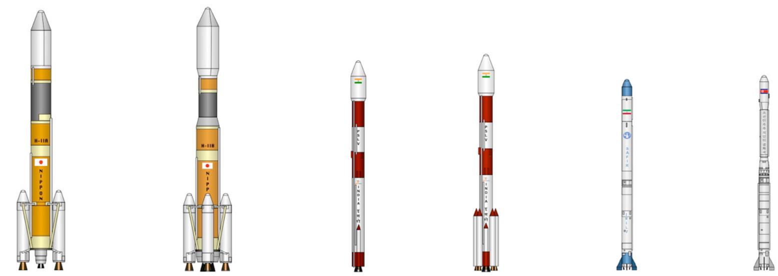
Iran

Iran's Safir 2 rocket attempted to launch three times. The February launch deployed Navid-e Elm-o Sanat, a remote sensing satellite, in LEO. Two other attempts in May and September resulted in failures.

North Korea

The North Korean Unha 3 rocket made two launch attempts. The first, in April, failed. The second launch, in December, appeared to put a payload in LEO, a first for North Korea.

Table 32 summarizes the launch vehicles of Japan, India, Iran, and North Korea that were active in 2012.



Vehicle	H IIA	H IIB	PSLV CA	PSLV XL	Safir 2	Unha
Country/Region	Japan	Japan	India	India	Iran	North Korea
2012 Total Launches	1	1	1	1	3	2
Launch Reliability (2012)	1/1 100%	1/1 100%	1/1 100%	1/1 100%	1/3 33%	1/2 50%
Launch Reliability (Last 10 Years)	19/20 95%	3/3 100%	2/2 100%	1/1 100%	3/6 50%	1/3 33%
Year of First Launch	2001	2009	2009	2012	2009	2009
Active Launch Sites	Tanegashima	Tanegashima	Satish Dhawan	Satish Dhawan	Semnan Providence	Musudan-ri
LEO kg (lbs)	11,730 (25,860)	19,000 (42,000)	2,100 (4,630)	1,800 (3,968)	27 (60)	100 (220)
GTO kg (lbs)	5,800 (12,800)	8,000 (17,600)	--	1,140 (2,513)	--	--

Table 32. Japanese, Indian, Iranian, and North Korean Launch Vehicles Active in 2012

FAA SUBORBITAL FLIGHT SUMMARY

On October 6 and November 4, Armadillo Aerospace conducted the first ever licensed launches out of Spaceport America with their STIG-B suborbital reusable vehicle (SRV). The October STIG-B flight was the first licensed launch from Spaceport America. The launch experienced an in-flight abort, meaning it did not reach its planned altitude, but the vehicle was successfully recovered intact and later used to conduct launch tests in November. Armadillo successfully launched its STIG-A vehicle as a class 3 amateur rocket in January 2012, but the vehicle was lost during recovery.

Due to the changes in the amateur rocket regulations in 2009 that removed the 15 second burn time limit, Armadillo Aerospace, Blue Origin, SpaceX, Masten, and UP Aerospace were all able to conduct some of their launches under the amateur rocket regulations. An amateur rocket is an unmanned rocket that has less than 200,000 pound-seconds of total impulse and cannot reach an altitude greater than 150 kilometers above the earth's surface. There are three different amateur rocket classes in 14 CFR Part 101. Class 1 is a model rocket that uses no more than 4.4 ounces of propellant; uses a slow-burning propellant; is made of paper, wood, or breakable plastic; contains no substantial metal parts; and weighs no more than 53 ounces including the propellant. Class 2 is a high-power rocket, other than a model rocket, that is propelled by a motor or motors having a combined total impulse of 9,208 pound-seconds or less. Class 3 is an advanced high-power rocket, other than a model rocket or high-power rocket.

SpaceX successfully tested its Grasshopper vehicle three times during 2012 at the company's testing facilities in McGregor, Texas. The first test was conducted under the amateur rocket regulations and all subsequent tests were conducted under an FAA experimental permit because of the size and power of the Merlin 1D engine. In its third test, on December 17, Grasshopper lifted off vertically to an altitude of 40 meters (131 feet), hovered, and successfully landed vertically back on the pad. The Grasshopper is a flight test vehicle that supports the company's program to develop a reusable Falcon 9 first stage.

Operator	Type of FAA Authorization	Launch Date	Vehicle
Armadillo Aerospace	Launch Operator License	6-Oct 4-Nov	STIG-B
Scaled Composites	Airworthiness Certificate	19-Dec 11-Aug 7-Aug 2-Aug 8-Jul 29-Jun 26-Jun	SpaceShipTwo
SpaceX	Experimental Permit	17-Dec 1-Nov	Grasshopper

Table 33. FAA 2012 Suborbital License and Flight Summary

Blue Origin successfully tested its launch escape system for the New Shepard SRV at its launch facility in West Texas under the amateur rocket regulations.

Masten Space Systems conducted several tests from its location at Mojave Air and Space Port. The company successfully fired its Katana engine (KA5S) that will be used for its Xogdor SRV and Xeus lunar lander demonstrator. Masten's Xaero SRV succeeded in reaching an altitude of 444 meters (1,457 feet) in July, and topped one kilometer in altitude in September. A throttle valve failure occurred during the last flight, ultimately destroying the vehicle upon impact with the ground. The company is constructing the Xaero-B, which will be powered by Masten's new Scimitar engine. Finally, Masten successfully conducted a translation flight using its Xombie vehicle, which launched vertically to an altitude of 477 meters (1,565 feet), translated horizontally 750 meters (2,460 feet), and landed vertically on another pad. So far, all Masten flights have launched as amatuer rockets.

On April 5, UP Aerospace conducted its tenth launch from Spaceport America, carrying payloads for DoD, NASA, the FAA Center of Excellence for Commercial Space Transportation, and the University of Texas. The company launches its SpaceLoft vehicle as a class 3 amateur rocket.

Scaled Composites continues to conduct flight tests of SpaceShipTwo and its carrier aircraft WhiteKnightTwo from its base at Mojave Air and Space Port in California. While not technically launches, seven unpowered flight tests of SpaceShipTwo were conducted during 2012 under an FAA experimental airworthiness certificate. The final glide test of SpaceShipTwo in 2012 featured a fully integrated propulsion system. Scaled Composites was granted an Experimental Permit in May 2012 for rocket-powered flights. Scaled Composites was the first commercial company to fly humans in space in 2004 and is now the first to exercise the new human space flight regulations that were issued in response to the Commercial Space Launch Amendments Act of 2004.

2012 SPACE TRANSPORTATION TRENDS

FIVE-YEAR WORLDWIDE SPACE TRANSPORTATION TRENDS

There were 383 orbital launches in the past five years. Between 2008 and 2012, there has been an average of 77 orbital launches per year worldwide. (See Figure 15.)

Russia and the United States have conducted the most orbital launches, followed by China and Europe (see Figure 16). Russia and Europe have conducted the most commercial launches. There were 113 commercial orbital launches from 2008 to 2012, with the highest number of launches, 28, occurring in 2008, and the lowest number of launches, 18, in 2011. In 2012, there were 21 commercial launches. (See Figure 17.)

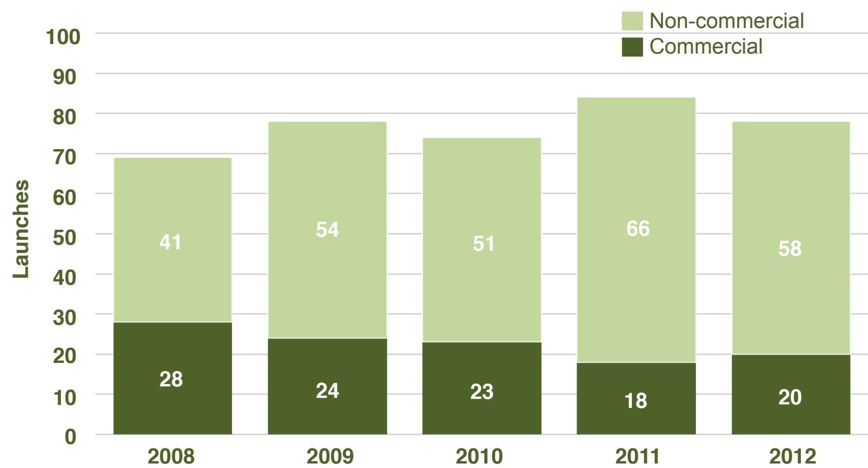


Figure 15. Five-Year Summary (2008-2012) of Commercial and Non-Commercial Launch Events

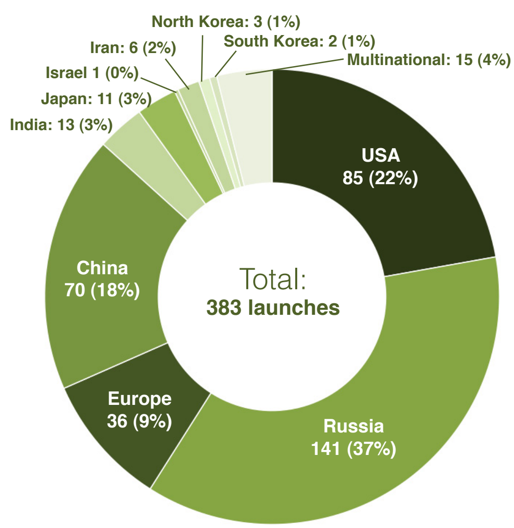


Figure 16. Five-Year Worldwide Total Orbital Launch Market Share (2008-2012)

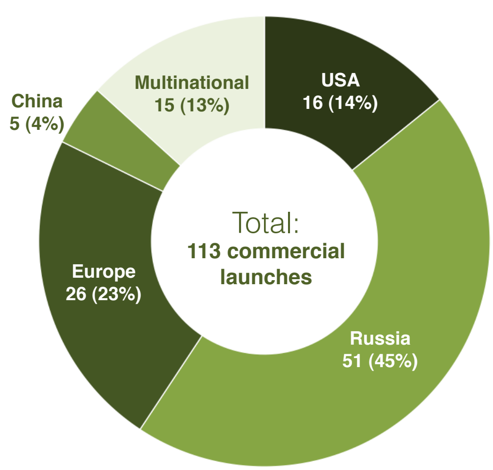


Figure 17. Five-Year Worldwide Commercial Orbital Launch Market Share (2008-2012)

Sea Launch has re-entered the market place and appears to have taken market share from Russia. Commercial launches overall have been steady, but dipped slightly in 2012. After having no commercial launches in 2011, the United States had two commercial launches in 2012, both launches were part of NASA's program to encourage the development of commercial cargo and crew services to the ISS.

There have been at least three launch failures per year over the last five years. (The definition of a launch failure is in Appendix.) Five launches failed in 2012, and six failed in 2011. The only recent year with a higher number of failures was 1999, in which eight failures occurred. The 2012 launch failures included two Russian launches (including one partial), two Iranian, and one North Korean launch failure. Over the past five years, the overall failure rate for commercial launches is 3.5 percent, compared to a slightly higher failure rate of 6 percent for all launches. If one removes launches by North Korea and Iran, the failure rate drops to slightly under 5 percent. Figure 18 presents a five-year trend of orbital launch successes and failures. Launch failures from the last five years are broken down by launch vehicle in Figure 19.

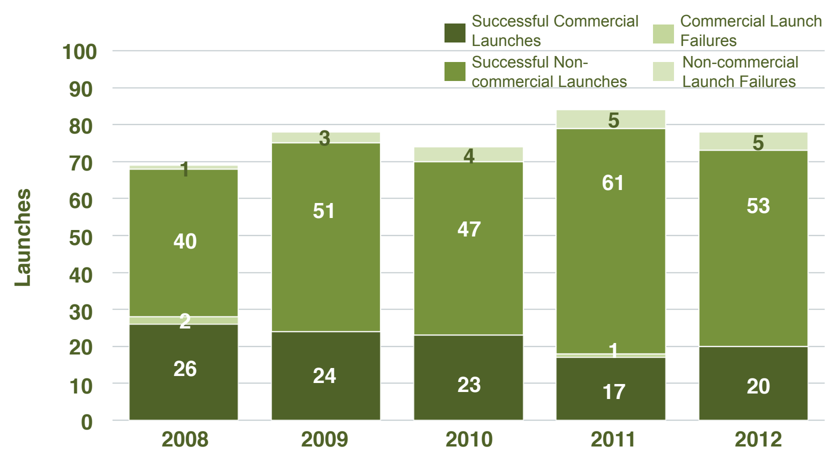


Figure 18. Five-Year Summary (2008-2012) of Commercial and Non-Commercial Launch Events, Successes and Failures

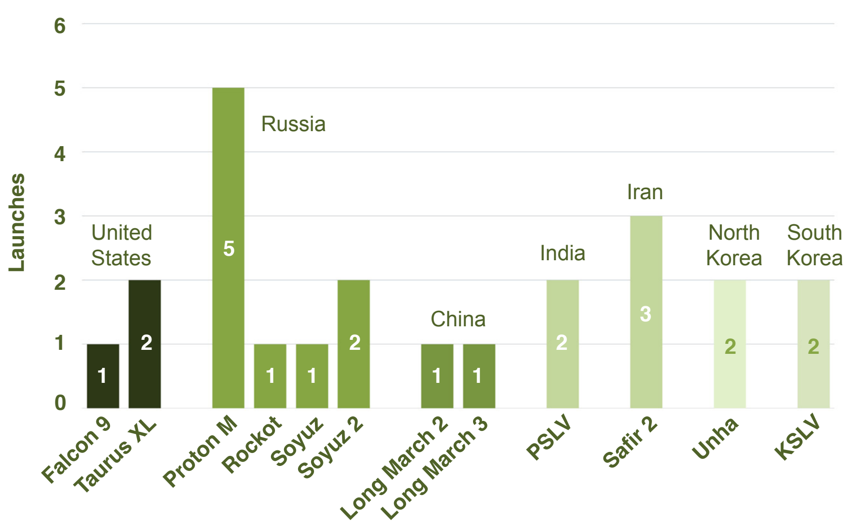


Figure 19. Launch Failures by Vehicle, 2008-2012

Table 34 lists commercial and non-commercial launch failures of the most actively launching countries and regions from 2008 to 2012. The United States, Russia, and China experienced both commercial and non-commercial launch failures in this five-year period, while Europe had none. Russia had the largest number of launches, commercial and non-commercial, and the largest number of failures. The United States and China had occasional launch failures that did not follow any particular pattern.

Country/ Region	Launches	2008	2009	2010	2011	2012
United States	Total/Failed: Non-commercial	9/0	20/1	11/0	18/1	11/0
	Total/Failed: Commercial	6/1	4/0	4/0	0/0	2/0
Russia	Total/Failed: Non-commercial	15/0	19/0	18/1	21/3	17/2
	Total/Failed: Commercial	11/1	10/0	13/0	10/1	7/0
Europe	Total/Failed: Non-commercial	1/0	2/0	0/0	3/0	4/0
	Total/Failed: Commercial	5/0	5/0	6/0	4/0	6/0
China	Total/Failed: Non-commercial	11/0	5/0	15/0	17/1	16/0
	Total/Failed: Commercial	0/0	1/1	0/0	2/0	3/0

Table 34. Five-Year Summary of Orbital Launch Failures by Country and Launch Type, 2008-2012

Commercial launch revenues increased almost $1 billion between 2006 and 2010, from $1.4 billion to about $2.4 billion. Revenues dropped in 2011 to approximately $2 billion, due to several commercial launches being pushed back. In 2012, revenue returned to the $2.4 billion level. (See Figure 20 and Table 35.) With the number of commercial launches relatively constant or slightly decreasing, the commercial launch revenues have increased, with less small class launch vehicles used and more launches performed by more expensive larger vehicles, including those providing dual manifest services to GEO.

The five-year average of commercial GSO launches is 17 and has remained fairly consistent, while the number of commercial NGSO launches per year has fluctuated significantly. The demand for commercial NGSO launches, which peaked in the late 1990s, was low until a sharp increase in 2007, 2008, and again in 2010. These high levels were mostly driven by the launch of replacement satellites for existing constellations, such as ORBCOMM and Globalstar, and by the launch of new constellations, such as SAR-Lupe and COSMO-SkyMed. (Figure 21 breaks down commercial launches by orbit type for the last five years.) The demand for commercial NGSO launches is also affected by NASA's Commercial Crew and Cargo Program, which has ordered 20 commercial cargo flights to the ISS under CRS contracts and will eventually charter crewed flights as well. SpaceX conducted its first cargo flight this year, and Orbital plans to begin flying to the ISS next year. The number of NGSO launches is expected to slightly increase in 2013 as NASA's COTS and CRS flights continue, and Globalstar continues to replace its constellation.

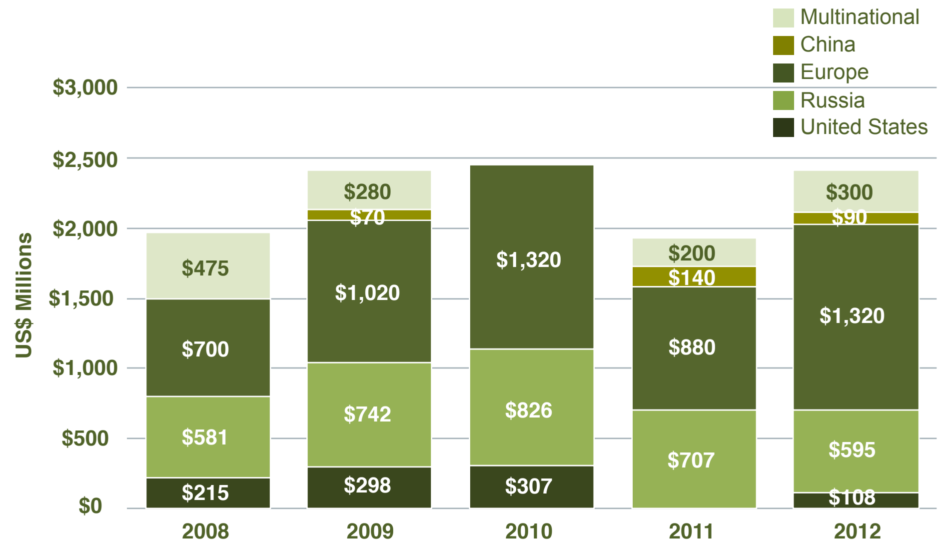


Figure 20. Approximate Launch Revenues for Commercial Launch Events (2008-2012)

Country/Region	2008	2009	2010	2011	2012
United States	$215	$298	$307	$0	$108
Russia	$581	$742	$826	$707	$595
Europe	$700	$1,020	$1,320	$880	$1,320
China	$0	$70	$0	$140	$90
Multinational	$475	$280	$0	$200	$300
TOTAL	***$1,971***	***$2,410***	***$2,453***	***$1,927***	***$2,413***

Table 35. Estimated Commercial Launch Revenues, 2008-2012 (US$ Millions)

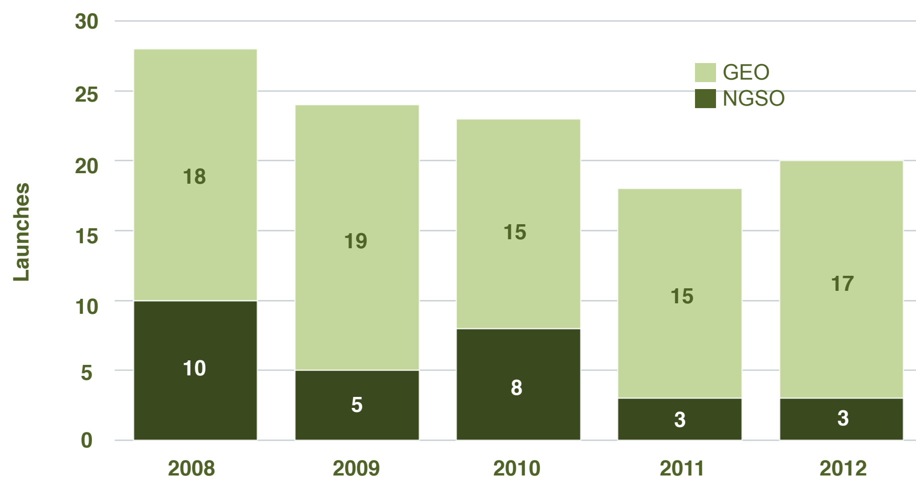


Figure 21. Five-Year Global Commercial Launch Events by Orbit (2008-2012)

Figure 22 shows the number of payloads providing commercial services launched on commercial and non-commercial vehicles over the past five years. The number of commercial NGSO satellites launched per year fluctuates significantly, mostly because NGSO satellites often are launched on a single vehicle. The launches of Globalstar (6 in 2010 and 12 in 2011), ORBCOMM (6 in 2008) and RapidEye constellation satellites (5 in 2008) account for the increase in the number of payloads launched in 2008, 2010, and 2011.

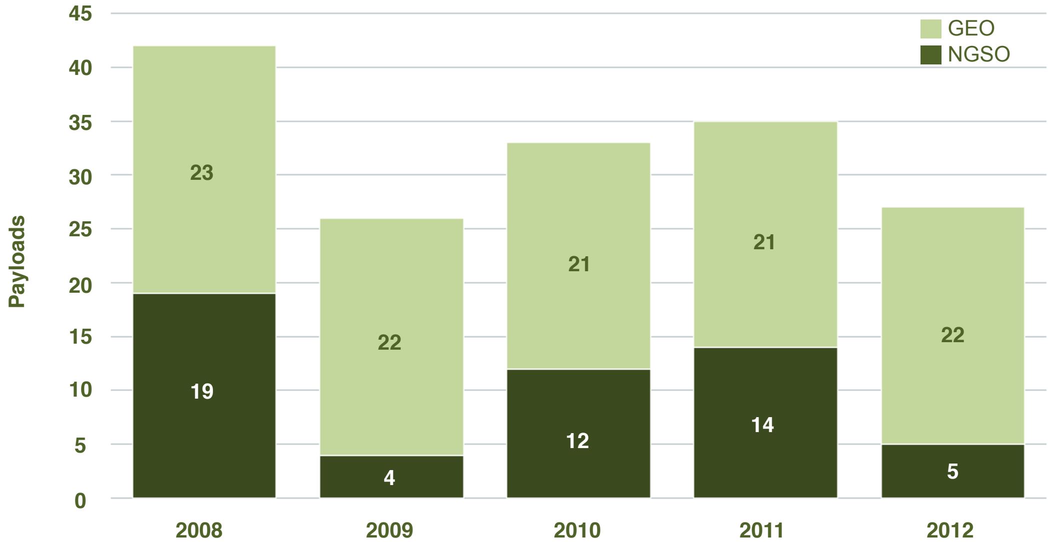


Figure 22. Five-Year Global Commercial Payloads by Orbit (2008-2012)

Commercial Satellite and Launch Trends

The commercial space transportation market is driven largely by the demand for launches of GEO telecommunications satellites and to a lesser, but potentially growing, extent by a variety of NGSO payloads. Historically, the majority of commercial launches have been to GEO. Usually, GEO launches deploy larger payloads and require larger launch vehicles, thus generating more revenue than launches to NGSO.

The supply of launch vehicle options continues to increase, despite only a marginal increase in demand for launches. Competition remains strong between United States, Russian, European, and multinational providers, while new entrants are entering, reentering, or advancing toward the commercial market. For example, the Land Launch version of the Zenit, the Dnepr, the Soyuz (launched and marketed by Arianespace), and the Falcon 9 are all competing for commercial launches. The Japanese are marketing the H-IIB commercially, and Indian and Chinese providers, although limited by United States export control policies, also target commercial launch customers. The newly introduced Vega and Orbital's Antares vehicle, which has yet to make its first flight, are both set to join this diverse set of launch vehicles offered on a commercial basis, with commercial launches planned for each in 2013.

Small Vehicle Commercial Launch Trends

The commercial use of small launch vehicles has declined in the last five years. In 2008, there were eight such launches; that number was cut in half to four in 2009 and 2010; in 2011, there was a single launch; and there was none in 2012. However, in 2013, two commercial Dnepr launches for primary payloads Dubaisat and Kompsat are expected. Vega also intends to launch commercial payloads in 2013. The recent decrease in the number of commercial launches on small vehicles is due to some small vehicles no longer being offered, such as the Falcon 1 and Kosmos 3M, and the increased opportunity for small payloads, especially micro and nano-satellites (cubesats), to fly inexpensively as piggyback payloads on the Atlas V or Falcon 9. The Antares inaugural flight later this year will also fly cubesats as secondary payloads.

New vehicles are expected to become available within the next two to three years. They include Athena and Super Strypi/SPARK (United States), Epsilon (Japan), and Long March 6 (China). These vehicles are designed to launch several micro- and small-class payloads at a time. With many small NGSO satellites launching as piggyback payloads on larger vehicles, existing and upcoming small-class launch vehicles may be limited to the smaller market of time-sensitive delivery of payloads in orbit.

Internationally Competed Launches

The terms "commercial payload" and "commercial launch" are complex and open to interpretation. (See the Appendix for definitions of these terms.) Figure 23 shows trends for each country whose launch providers compete in the international marketplace. The chart reflects only launch service providers competing in the international marketplace for open-bid launch service contracts. From 2008 to 2012, there were 103 internationally competed launch events. Over the past five years, national satellite operators in countries such as Russia and China more often turn directly to the services of their domestic launch providers. NASA's commercial crew and cargo program will result in additional commercial launches; however, since those launches are competed only within the United States, the additional launches will not increase the total number of internationally competed launches.

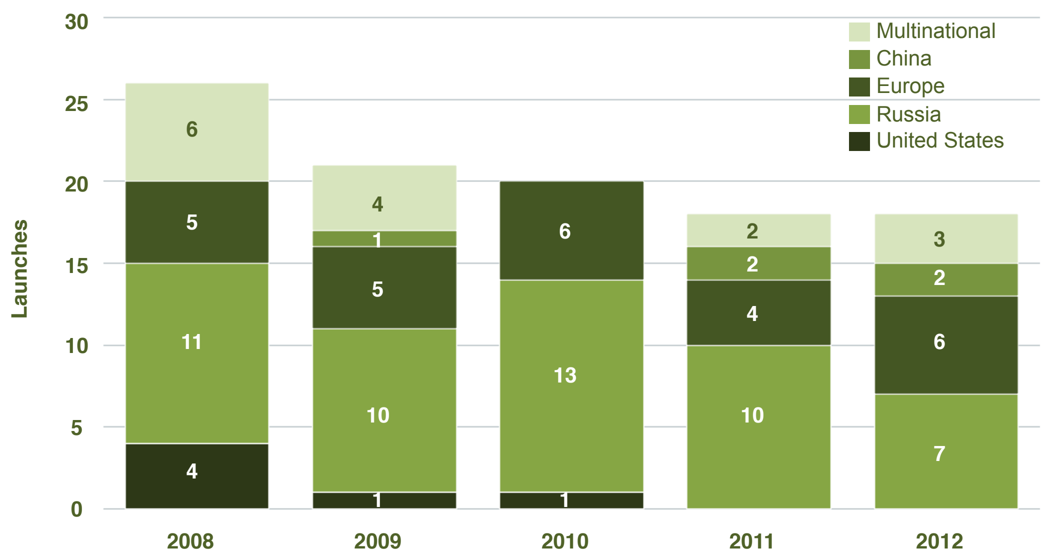


Figure 23. Five-Year Worldwide Internationally Competed Launch Events (2008-2012)

SUMMARY OF *FY 2012 YEAR IN REVIEW*

The previous summary provided an analysis of worldwide launch trends for calendar year 2012. The following summary provides a look by fiscal year (FY). For the full *FY 2012 Year in Review*, please visit: http://www.faa.gov/about/office_org/headquarters_offices/ast/reports_studies/year_review/.

FY 2012 WORLDWIDE ORBITAL LAUNCH ACTIVITY

In FY 2012, the United States, Russia, Europe, China, India, Japan, North Korea, Iran, and one multinational company conducted a total of 80 launches, 21 of which were commercial (see Table 36 and Figures 24 and 25). This number was unchanged from the previous fiscal year, which also saw 80 launches, of which 20 were commercial. This year two launches resulted in failures: North Korea's Unha-3 in April 2012 and Russia's Proton M in August 2012.

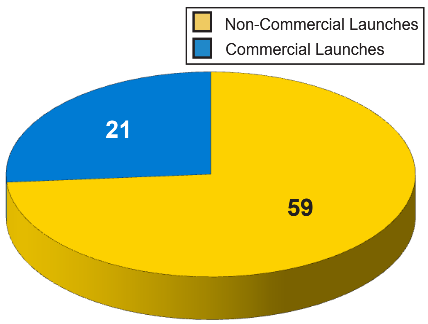


Figure 24. FY 2012 Total Worldwide Launch Activity

	Commercial Launches	Non-Commercial Launches	Total Launches
United States	1	11	12
Russia	10	19	29
Europe	4	4	8
China	3	18	21
India	1	2	3
Japan	0	3	3
North Korea	0	1	1
Iran	0	1	1
Multinational	2	0	2
TOTAL	**21**	**59**	**80**

Table 36. FY 2012 Worldwide Orbital Launch Events

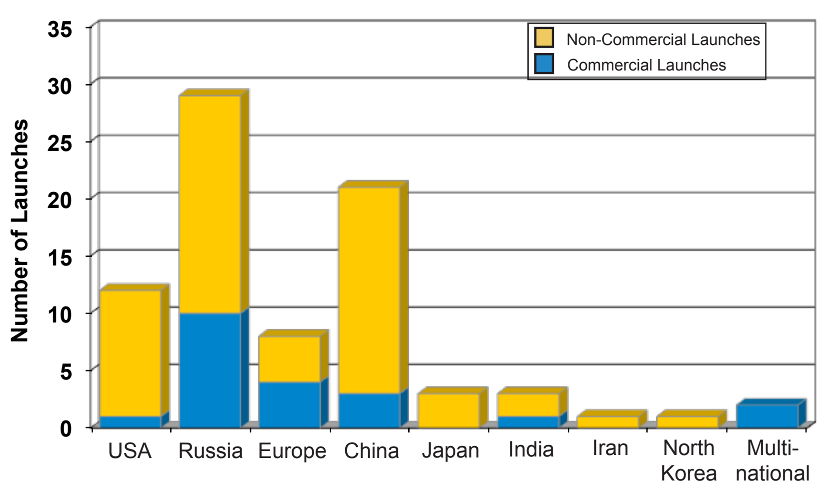


Figure 25. FY 2012 Total Worldwide Launch Activity

FY 2012 WORLDWIDE COMMERCIAL LAUNCH TRENDS

Approximately one quarter of the total launches in FY 2012 were commercial. The following is a summary of the FY 2012 commercial orbital launches by country (see Figures 26 and 27):

- The United States performed a total of 12 launches, including 1 commercial launch to ISS.
- Russia had the highest total orbital (29) and total commercial launches (10).
- Europe conducted eight launches in FY 2012, four of which were commercial.
- China had 21 launches, 3 of which were commercial.
- India had three total launches, one of which was commercial.
- The multinational company, Sea Launch AG, conducted two commercial launches, both FAA-licensed.
- Japan, Iran, and North Korea did not have any commercial launches.

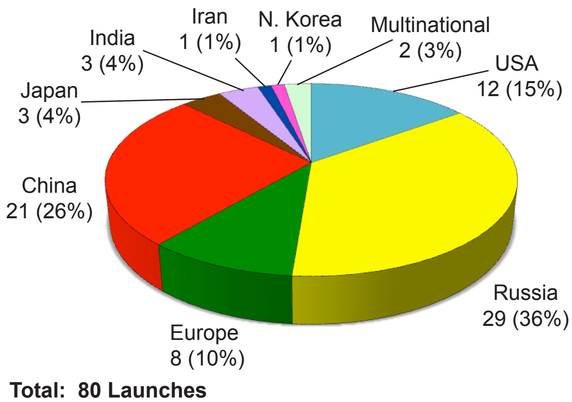


Figure 26. FY 2012 Total Worldwide Orbital Launch Activity

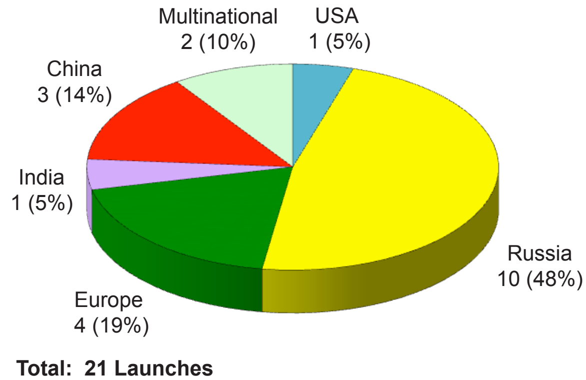


Figure 27. FY 2012 Worldwide Commercial Orbital Launch Activity

The number of launches between FY 2011 and FY 2012 remained relatively steady. In FY 2011, there was a total of 80 worldwide orbital launches, 20 of which were commercial. In FY 2011, the United States conducted 20 orbital launches, 2 of which were commercial. These two commercial launches consisted of the first SpaceX Falcon 9 launch under NASA's COTS program and a Delta II launch of COSMO-Skymed 4.

The decrease of eight U.S. launches in FY 2012, from FY 2011, is primarily related to the retirement of the Space Shuttle in July 2011 and various launch delays. From October to December 2012, six more U.S. launches are planned. Counting by calendar year (CY), there were 18 U.S. launches in CY 2011, and 16 launches are anticipated for CY 2012.

For FY 2013, it is anticipated that the number of overall U.S. launches will remain relatively steady. Although, there is a possibility of a slight increase due to ISS commercial resupply, including a demonstration flight of Orbital Sciences Corporation's (Orbital) new Antares vehicle from the Mid-Atlantic Regional Spaceport in Virginia, and routine replacement of GEO communication satellites.

In FY 2012, 19 (or 90 percent) of the worldwide commercial launches were for commercial telecommunication satellites: 18 launches deployed GEO communications satellites and one delivered communications satellites to NGSO (LEO). One launch (or five percent of the total launches) was for development purposes, and one (or five percent) was a launch of a remote sensing satellite.

FY 2012 COMMERCIAL LAUNCH REVENUES

Revenues from 21 commercial launches, in FY 2012, are estimated to total $2.2 billion (see Figure 28). Over 75 percent of this revenue was for launches conducted by Russia ($790 million) and Europe ($880 million). Russia's $790 million in revenue represents eight Protons, one Soyuz 2, and one Zenit 3SLB (Land Launch) launches. Europe's revenue represents four Ariane 5 launches. United States' revenue represents a Falcon 9 launch.

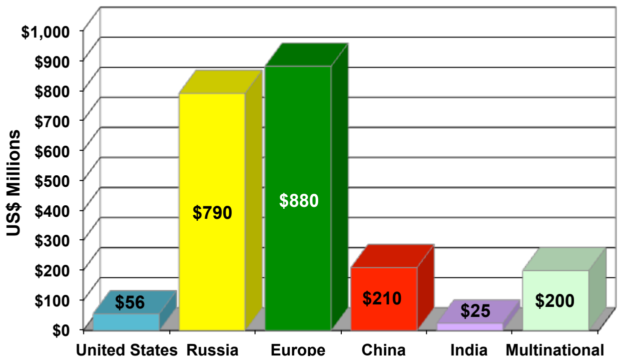


Figure 28. Approximate FY 2012 Commercial Launch Revenues

Payments for launch services are typically spread over one to two years before the launch. For the purposes of this report, however, revenue is shown as earned in the year in which the payload launches. Launch revenues go to the country of the primary vehicle manufacturer. The assessment of the revenues is based on commercial launch price estimates for each launch vehicle from publicly available information.

Most launch vehicles today are manufactured, sold, and launched by the same organization entirely in one country, or in the case of Europe and the former Soviet Union, within a particular economic region. At present, there is one launch service corporation, Sea Launch AG, that is characterized as multinational.

FY 2012 FAA-LICENSED ORBITAL LAUNCH SUMMARY

There were three FAA-licensed launches during FY 2012 as shown in Table 37. One was for SpaceX’s Falcon 9 COTS flight to ISS and two were for Intelsat satellites launched separately by Sea Launch AG, from its *Odyssey* launch platform in the Pacific Ocean. The FAA issued one reentry license, for the Dragon capsule launched in May 2012, on the SpaceX Falcon 9 flight.

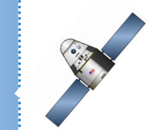
Launch Licenses	UNITED STATES 	MULTI-NATIONAL 	Reentry Licenses	UNITED STATES 
Vehicle	Falcon 9	Zenit 3SL	Vehicle	SpaceX Dragon
FY 2012 Total Launches	1	2	FY 2012 Total Reentries	1
FY 2012 Licensed Launches	1	2	FY 2012 Licensed Reentries	1
FY 2012 Launch Reliability	1/1 (100%)	2/2 (100%)	FY 2012 Reentry Reliability	1/1 (100%)
10-Year Launch Reliability	3/3 (100%)	24/25 (96%)	10-Year Reentry Reliability	2/2 (100%)
Maximum LEO Capacity - kg (lbs)	10,459 (22,990)	15,546 (33,541)	Payload to LEO - kg (lbs)	6,000 (13,228)
Maximum GEO Capacity - kg (lbs)	4,680 (10,296)	6,100 (13,440)	Payload from LEO - kg (lbs)	3,000 (6,614)

Table 37. FAA-Licensed Vehicles Launched and Reentered in FY 2012

Three FAA-licensed U.S. commercial launches are planned for the first quarter of FY 2013. Two are NASA Commercial Resupply Services (CRS) missions to ISS on SpaceX’s Falcon 9, and one is the maiden test flight of the new Antares launch vehicle by Orbital.

Revenues for FAA-licensed flights conducted during FY 2012 include: one Falcon 9 ($56M) and two Zenit 3SL ($100M). For FY 2011, revenues for FAA-licensed flights included the Falcon 9 ($56M), Delta II ($95M), and a Zenit 3SL ($100M).

OTHER FY 2012 FAA LICENSES AND PERMITS

There was one FAA-licensed reentry by SpaceX’s Dragon capsule, which reentered and was successfully recovered on May 31, 2012. A reentry license was issued on September 17, 2012, for the first SpaceX CRS mission to the ISS planned in October 2012. Scaled Composites was issued an experimental flight permit on May 23, 2012, for rocket-powered flight-testing of its SpaceShipTwo suborbital vehicle expected to launch later in the calendar year. This permit will expire on May 23, 2013. There were no FAA-permitted launches performed in FY 2012.

SUMMARY OF *2012 COMMERCIAL SPACE TRANSPORTATION FORECASTS*

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

COMSTAC's Geosynchronous Orbit (GSO) Launch Demand Forecast projects demand for commercial satellites that operate in GSO and the resulting commercial launch demand to GSO. The forecast looks at the global demand for commercial GSO satellites and launches addressable by the U.S. space launch industry – that is, launch service procurements open to internationally-competitive launch service procurements.

The FAA's Forecast for Non-Geosynchronous Orbits (NGSO) projects commercial launch demand for all space systems to be deployed to NGSO, including low Earth orbit (LEO), medium Earth orbit (MEO), elliptical orbits (ELI), and external trajectories (EXT) to the Moon or other solar system destinations. Commercial launches 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).

Together, the COMSTAC and FAA forecasts project an average annual demand of 29.1 commercial space launches worldwide from 2012 through 2021, with an average of 16.3 commercial GSO launches and 12.8 NGSO launches (see Figure 29). This shows a slight elevation from the 2011 forecast of 28.6 annual launches.

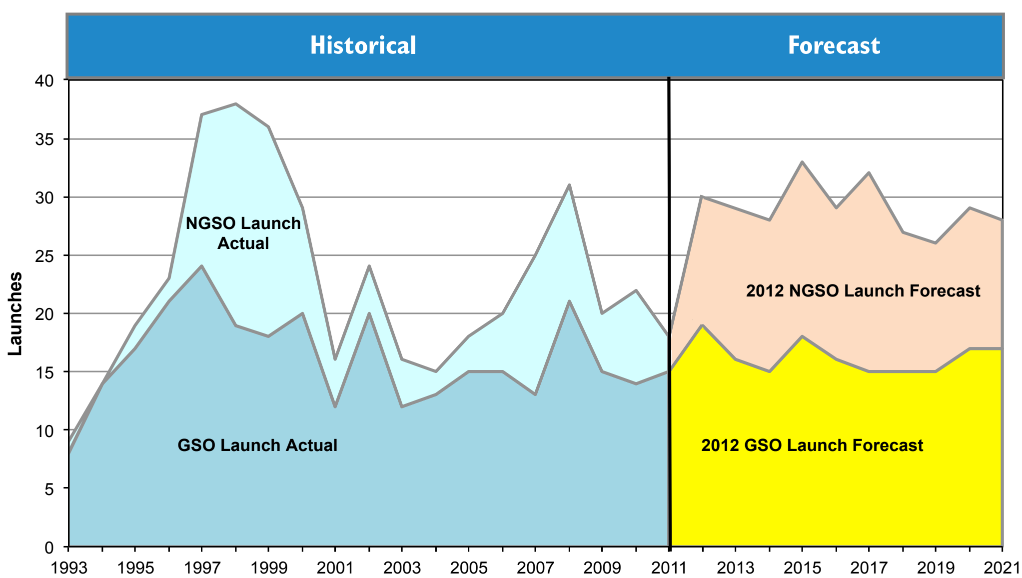


Figure 29. Combined 2012 GSO and NGSO Historical Launches and Launch Forecasts

It is important to distinguish between forecast demand and the number of satellites actually launched. Launch vehicles 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.

Commercial GSO Launch Demand Forecast Results

The GSO market remains stable with a projected demand of 21.2 satellites and 16.3 launches per year, up slightly from last year's projection of 20.5 satellites and 15.6 launches per year. Table 38 provides a summary of the forecast, showing annual projected satellites and launches, including the projected number of dual-manifested launches.

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

Table 38. Forecast Commercial GSO Satellite and Launch Demand Data

Global demand for satellite services continues to be strong, led by substantial growth in Asia and solid growth in the Middle East. New launch vehicle options, available over the new few years, 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.

Addressable vs. Unaddressable

The number of addressable satellites actually launched in the last three years has steadily decreased. The factors that have driven this decrease include launch delays, larger satellites, greater availability of captive international launch capability, and the state of the financial markets.

In 2011, there was a significant increase in unaddressable launches – launch contracts that were not open to international competition – as Chinese and Russian government-owned aerospace companies routinely package satellites, launches, and financing together (see Figure 30). This trend is expected to continue as Chinese, Russian, Indian, and Japanese satellite manufacturers continue to pursue the competitive advantage of being able to structure these types of contracts on a strategic, non-competitive basis.

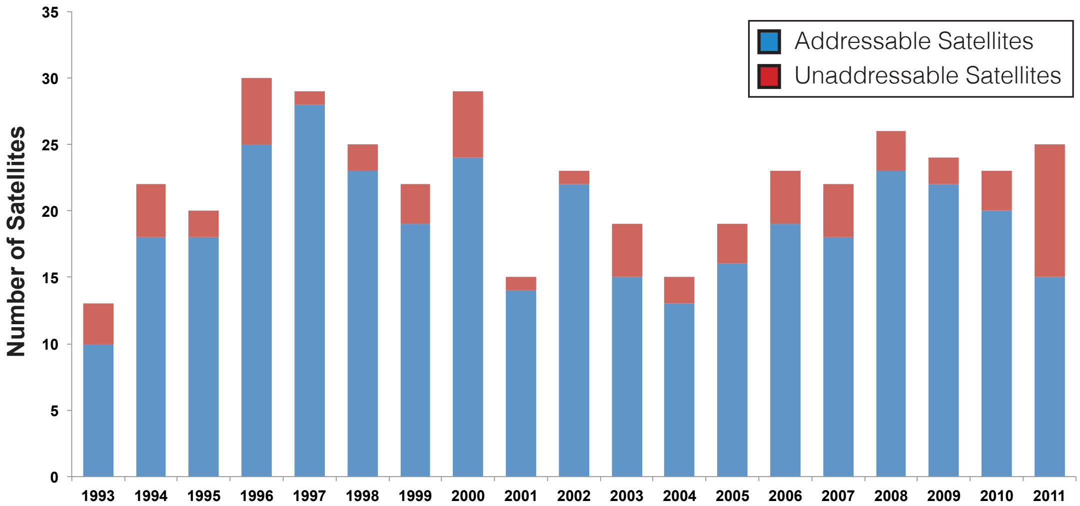


Figure 30. Addressable and Unaddressable Satellites since 1993

Mass Classes

An appropriate metric for determining launch requirements is satellite mass. Mass classes based on ranges of satellite masses have been used in order to analyze developments in satellite and launch demand. Four mass classes are currently used, as shown in the following table.

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

Table 39. Satellite Mass Class Categorization

This year's forecast shows that an average of only one satellite in the smallest mass class will be launched each year for the next ten years. At the same time, the largest mass class is expected to see significant growth, with an average of 9.2 satellites of this mass class expected to launch each year for the next decade, up from 7 per year in the 2011 forecast. Table 40 shows the trends in satellite mass class distribution.

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

Table 40. Trends in Satellite Mass Class Distribution

The average mass of satellites launched in the past eight years has been well over 4,000 kg, reaching a new high in 2011. The average mass in 2012 was expected to increase even further, with the shift to heavier, higher-power satellites. One technical development that may affect this trend is the development of satellites using exclusively electric propulsion rather than using chemical propulsion 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.

Dual-Manifesting

Dual-manifesting is increasing beyond just the Ariane 5, with the Proton and Long March launch vehicles having demonstrated the capability, and Falcon 9 being offered for dual launches to GSO in the next few years.

Given the minimal number of satellites forecasted to launch in the smallest mass class, combined with the introduction of the Soyuz launch vehicle from French Guiana, which is well-suited to launching these smaller satellites, dual-manifesting has the potential to be problematic for heavy payloads, as there is often no viable co-payload for dual-manifested launches on the heaviest satellites.

Figure 31 presents the 2012 satellite and launch demand forecast through 2021 as well as actual launch statistics for 1988 through 2011.

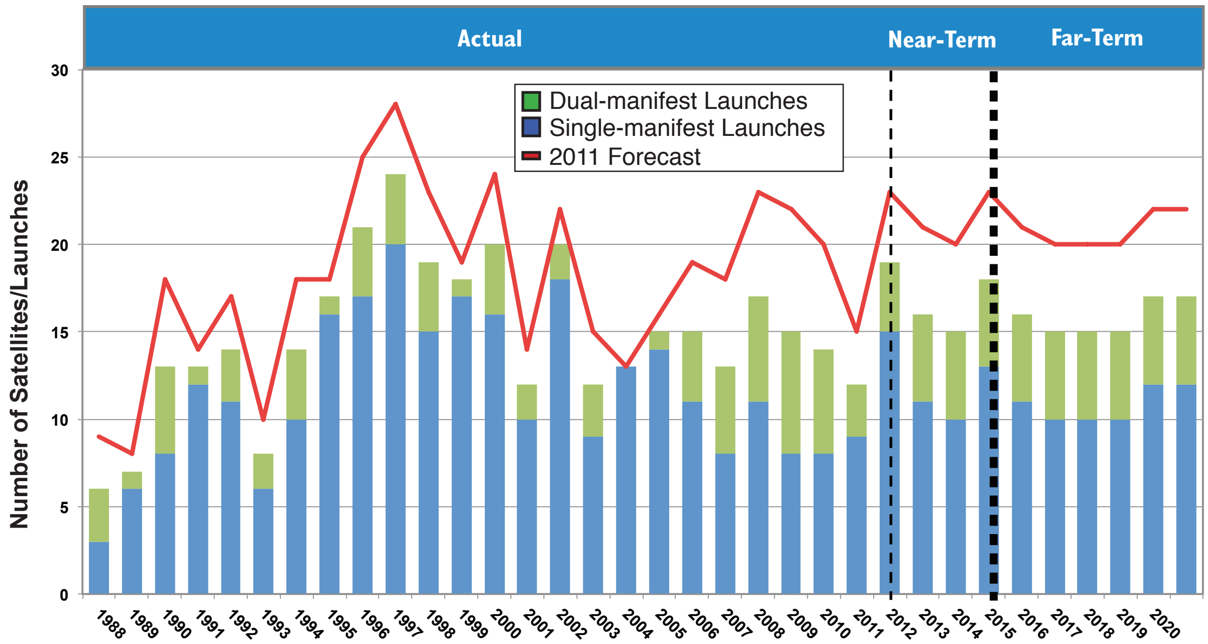


Figure 31. Dual Manifesting and Launch Demand

Commercial NGSO Launch Demand Forecast Results

The NGSO market is divided into five payload segments, defined by the type of service the spacecraft are designed to offer:

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

In the next 10 years, nearly 300 NGSO payloads are projected to launch commercially on 128 launches, making an average demand of 12.8 launches per year worldwide projected for the period of 2012 through 2021. This average is slightly less than last year's average of 13.0 launches per year. The launch demand peaks in 2017, with 17 launches, due to the replacement of the Iridium constellation and frequent commercial crew and cargo launches to the ISS. The annual launch rate during the next 10 years is considerably higher than the previous decade (see Figure 32). Commercial space transportation and telecommunications constellation replenishments drive this increase.

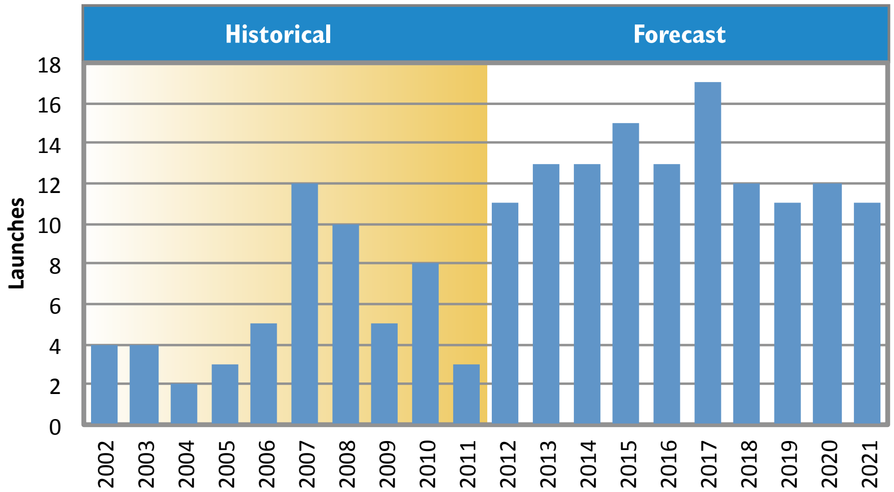


Figure 32. Commercial NGSO Launch History and Projected Launch Plans

It is important to note that 64 launches for commercial cargo and crew services to the ISS are projected from 2012 to 2021. These launches will take place on new vehicles where technical or financial issues could delay ISS resupply launches. Moreover, it is still too early to predict with accuracy new and emerging markets. If NASA's needs for commercial cargo and crew to the ISS grow, Bigelow Aerospace launches its space stations, the space tourism market matures, and commercial companies launch payloads to the Moon, there can be significant growth in NGSO launches in 2018 and beyond.

Launch demand is divided into 2 vehicle size classes, with an average of 12.0 medium- to heavy-class vehicle launches per year and 0.8 small-class vehicle launches per year for 2012 to 2021 (see Table 41). Compared to last year's forecast, the number of small launches decreased slightly, and the number of medium- to heavy-class launches increased.

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

Table 41. Payload and Launch Projections

Commercial Telecommunications Launch Demand

The NGSO telecommunications satellite market is based on large constellations of small-to-medium-sized satellites that provide global or near-global communications coverage.

Telecommunications comprises 37 percent of the satellite market but only 11 percent of the launch market because of multiple-manifesting. From 2012 through 2017, between one and three telecommunications launches will occur each year. There will be an uptick in launches in 2013, as ORBCOMM and O3b replace their satellites, and again in 2016 and 2017 as Iridium replaces its satellites. Replacement constellations finish launching before 2018, so no telecommunications launches are projected for 2018 through 2021.

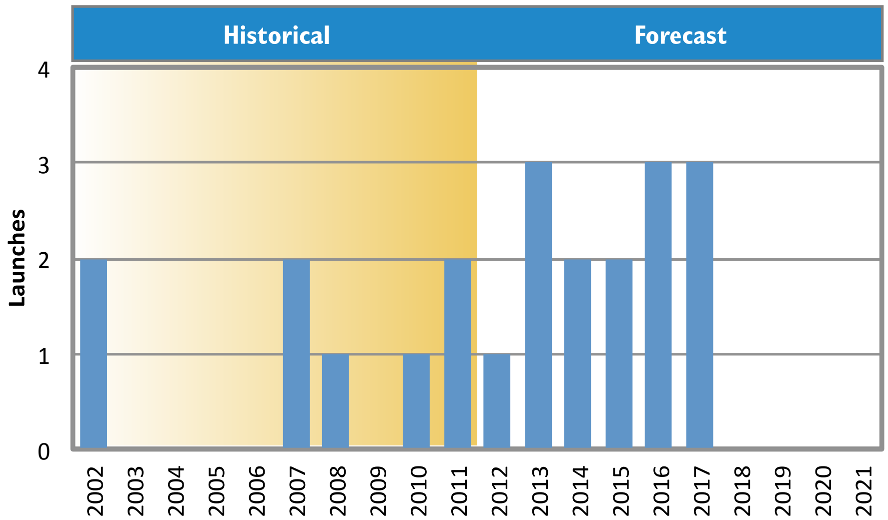


Figure 33. Commercial Telecommunications Launch History and Projected Launch Plans

Commercial Remote Sensing Launch Demand

Remote sensing refers to any orbital platform with optical or radar sensors trained on Earth to gather data for geographic analysis, military use, meteorology, or climatology. The commercial satellite remote sensing market consists of companies that operate satellites with optical or radar sensors trained on Earth to capture imagery used to generate revenue.

Commercial remote sensing satellites account for 7 percent of the payload market and 9 percent of the launch demand market. The commercial remote sensing industry is characterized by relatively stable satellite replacement schedules. Launches of commercial remote sensing satellites will take place at an average of 1.1 per year through the forecast period. A peak in the number of launches can be seen in 2017, reflecting projected deployment of satellites operated by DigitalGlobe, GeoEye, and RapidEye.

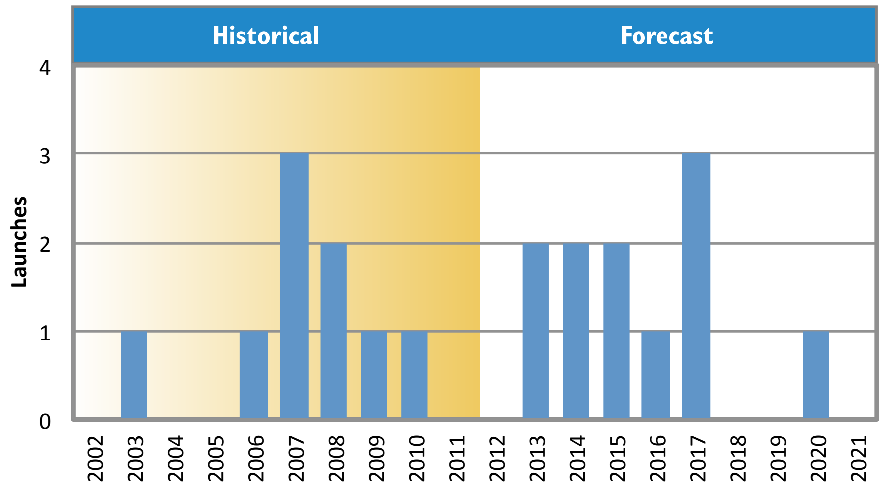


Figure 34. Commercial Remote Sensing Launch History and Projected Launch Plans

Science and Engineering Launch Demand

Science and engineering includes payloads related to basic and applies research and those with missions related to space technology test and demonstration. Payloads with basic research missions include biological and physical research, space science, Earth science, and related fields. Payloads with applied research missions are designed to solve practical problems and are usually driven by government or industry needs. Payloads with missions focused on space technology test and demonstration address engineering questions.

Science and engineering payloads constitute 33 percent of the satellite market and 26 percent of the launch market. These include a steady stream of basic and applied research payloads primarily from countries that do not have indigenous launch capabilities. They also include four launches of new technology test and demonstration missions: Orbital Antares vehicle, SpaceX’s Falcon 9 Heavy, NASA’s uncrewed test of the Orion MPCV on a Delta IV, and a test of Bigelow’s BEAM module.

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

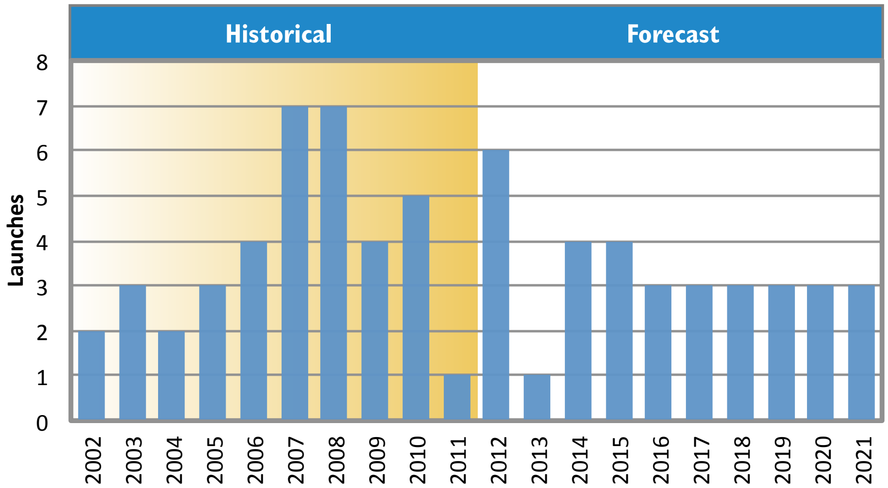


Figure 35. Science and Engineering Launch History and Projected Launch Plans

Commercial Cargo and Crew Transportation Services

Commercial cargo and crew transportation capabilities include commercial launches of cargo and humans to LEO. Specifically, commercial cargo and crew transportation includes NASA's COTS development, Commercial Resupply Services (CRS) to the ISS, and commercial crew development efforts.

Commercial cargo and crew transportation services make up 50 percent of launches in this forecast. This marks a slight increase from 46 percent projected in the 2011 forecast. If commercial vehicles begin launching Bigelow modules to the ISS or Bigelow space stations, the number of launches in this section could grow in the out-years. However, the 64 launches in this section carry significant financial and technical risk, because all of the launches are on new launch vehicles or new spacecraft that are being developed with NASA-appropriated funds. This launch projection represents NASA's current plans for commercial cargo and crew services to the ISS.

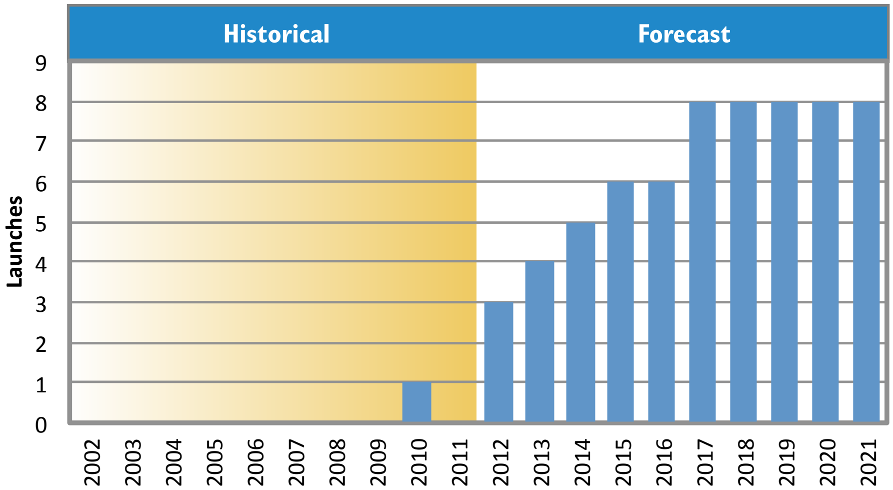


Figure 36. Commercial Cargo and Crew Transportation Services Launch History and Projected Launch Plans

Launch Vehicles Typically Used for NGSO Missions

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

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

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

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

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

SUMMARY OF *SUBORBITAL REUSABLE VEHICLES: A 10-YEAR FORECAST OF MARKET DEMAND*

In August 2012, the Federal Aviation Administration's Office of Commercial Space Transportation (FAA AST) and Space Florida prepared forecasts of demand for suborbital reusable vehicles (SRVs) for a 10-year period.

Suborbital reusable vehicles (SRVs) are creating a new spaceflight industry. SRVs are commercially developed reusable space vehicles that may carry humans or cargo. The companies developing these vehicles typically target high flight rates and relatively low costs. SRVs capable of carrying humans are in development and planned for operations in the next few years. SRVs that carry cargo are operational now, with more planned.

This study forecasts 10-year demand for SRVs. The goal of this study is to provide information for government and industry decision makers on the emerging SRV market by analyzing dynamics, trends, and areas of uncertainty in eight distinct markets SRVs could address. This study was jointly funded by the Federal Aviation Administration Office of Commercial Space Transportation (FAA AST) and Space Florida, and conducted by The Tauri Group.

SUBORBITAL REUSABLE VEHICLE MARKETS

This study analyzes SRV demand in eight markets, which were identified and grouped by similarity of applications, purpose, activities, and customers. Figure 37 summarizes and defines those markets.

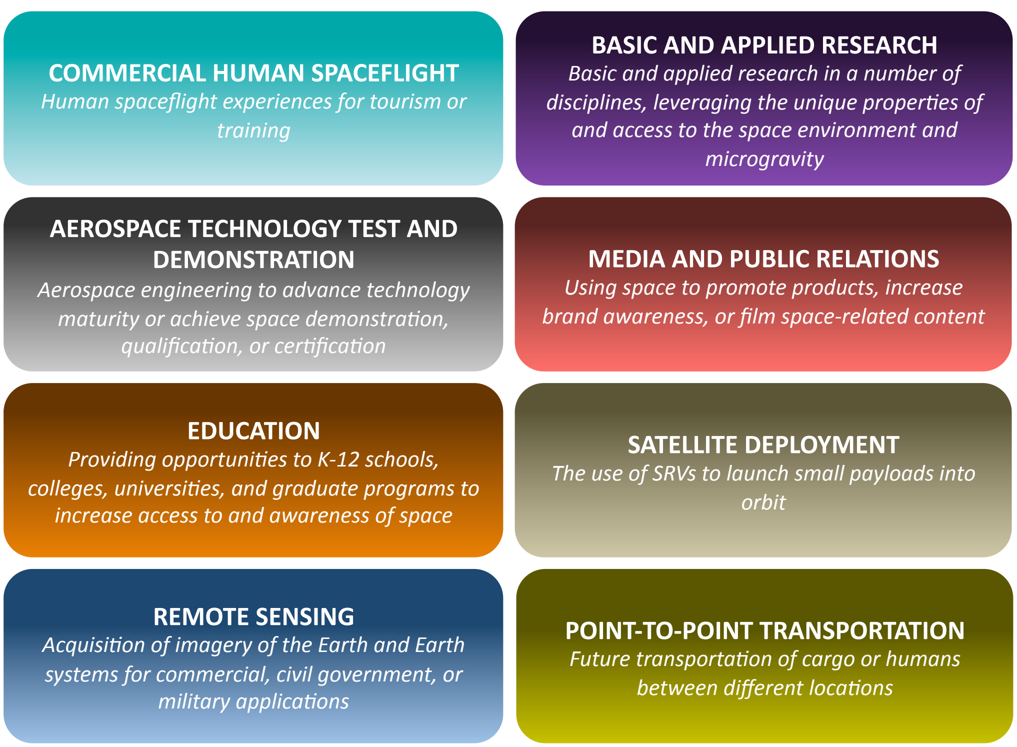


Figure 37. SRV Markets

METHODOLOGY

The Tauri Group combined primary research (more than 120 interviews, a survey of high net worth individuals, and a poll of suborbital researchers) and open source materials (such as market studies and data on analog markets, government budgets, and performance information on competing platforms) to build a full and objective picture of SRV market dynamics. The forecast results are in seat/cargo equivalents based on average capacity of SRVs (see Table 42).

One seat/cargo equivalent can equal =	1 seat
	3 1/3 lockers

Table 42. Seat/Cargo Equivalents

Demand in each market was forecast for three scenarios:

Baseline scenario: SRVs operate in a predictable political and economic environment that is relatively similar to today's. In this scenario, existing trends generate demand for SRVs.

Growth scenario: This forecast reflects new dynamics emerging from marketing, branding, and research successes. Commercial Human Spaceflight has a transformative effect on consumer behavior, and more customers purchase SRV flights. SRV research results are highly productive and attract significant new government, international, and commercial interest for future experiments.

Constrained scenario: SRVs operate in an environment of dramatic reduction in spending compared to today, due, for example, to worsened global economy.

RESULTS

Total projected demand for SRVs, across all eight markets, grows from around 370 seat/cargo equivalents in Year 1 to over 500 seat/cargo equivalents in the tenth year of the baseline case. (Year 1 represents the first year of regular SRV operations.) Demand under the growth scenario, which reflects increases due to factors such as marketing, research successes, and flight operations, grows from about 1,100 to more than 1,500 seat/cargo equivalents over ten years. The constrained scenario, which reflects significantly reduced consumer spending and government budgets, shows demand from about 200 to 250 seat/cargo equivalents per year (see Table 43).

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Baseline Scenario	373	390	405	421	438	451	489	501	517	533	4,518
Growth Scenario	1,096	1,127	1,169	1,223	1,260	1,299	1,394	1,445	1,529	1,592	13,134
Constrained Scenario	213	226	232	229	239	243	241	247	252	255	2,378

Table 43. Total Projected Demand for SRVs Across All Markets

DEMAND BY MARKET

As shown in Figure 38 below, which compares forecasts for all markets by scenario, demand for SRVs is dominated by Commercial Human Spaceflight. Our analysis indicates that about 8,000 high net worth individuals from across the globe are sufficiently interested and have spending patterns likely to result in the purchase of a suborbital flight—one-third from the United States (based on global wealth distribution). The interested population will grow at the same rate as the high net worth population (about 2% annually). We estimate that about 40% of the interested, high net worth population, or 3,600 individuals, will fly within the 10-year forecast period.

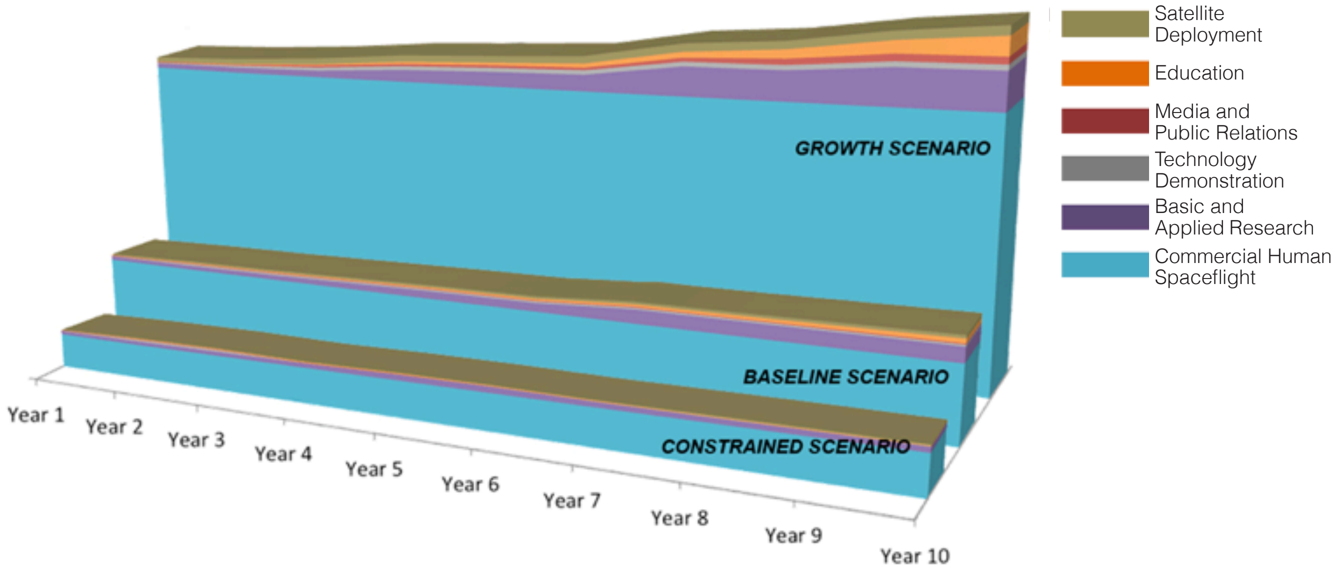


Figure 38. Total SRV Forecast by Market and Scenario

We expect space enthusiasts outside the high net worth population will generate an additional 5% demand.

The resulting baseline forecast is 335 seats in the first year, growing to nearly 400 seats by year 10, totaling about 4,000 over 10 years. The growth scenario predicts a total of 11,000 seats, the constrained scenario a total of 2,000. (About 925 individuals currently have reservations on SRVs.)

Demand for Commercial Human Spaceflight is presented here as a relatively steady state in each scenario, reflecting current levels of interest in the population, assuming individuals are equally likely to choose to fly in any given year within the 10-year time frame.

This convention is useful because of the uncertainty associated with the dynamics of demand as it responds to future events. It is not to suggest that demand will always be steady state; demand may evolve in different, unpredictable ways. For example, demand may shift from the baseline level to the growth level after flight operations have begun. Demand may grow, as we have noted previously, more rapidly than predicted based on viral or “me too” effects, as a function of the social dynamics following successful launch experiences. Demand could decline for similar reasons.

If prices drop, demand will increase. Figure 39 is a demand curve for individuals with at least $5 million in investable assets, showing the effect of changing prices on demand. Additional demand (not shown) would result from individuals with lower levels of net worth.

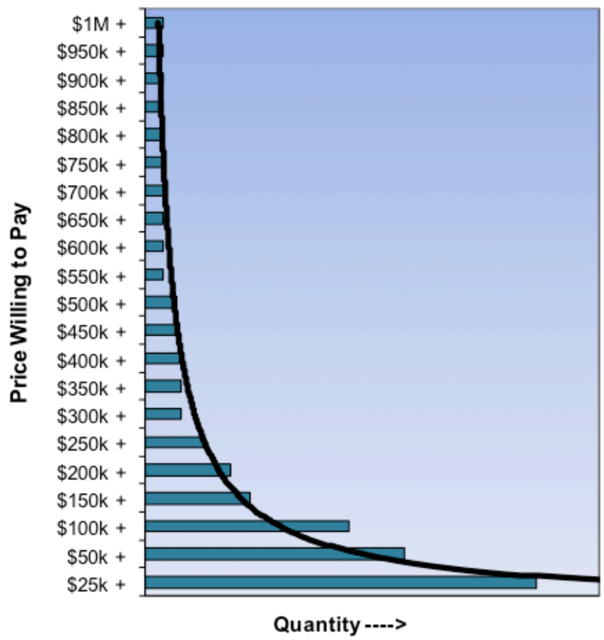


Figure 39. Price Elasticity of Suborbital Tickets for Individuals with $5M in Investable Assets

The second largest area of demand is Basic and Applied Research, funded primarily by government agencies, and also by research not-for-profits, universities, and commercial firms. Basic and Applied Research accounts for about 10% of baseline demand. SRVs can support a wide range of possible activities, but offer unique capability primarily in four areas: atmospheric research, suborbital astronomy, longitudinal human research, and microgravity. These areas enable investigations that would be of immediate interest to space and science government agencies. Commercial firms will seek to test SRVs as research platforms as reflected in the forecast. They could be a source of additional growth (beyond what is forecast) if an economically valuable application emerges. In the growth scenario, demand about doubles due to new government programs, doubled commercial activity, and more rapid uptake by international space agencies, driven by demonstrated research successes. In the constrained scenario, demand about halves.

The remaining 10% of demand is generated by Aerospace Technology Test and Demonstration, Education (which will see hundreds of schools and universities flying low cost, small payloads to provide students a learning tool), Satellite Deployment (which includes the launch of very small satellites), and Media and PR (through what we have predicted to be a small but influential number of flights for advertisements, documentaries, and television programming). In the growth scenario, demand in these markets doubles or triples. In the constrained scenario, demand is about half or less of baseline levels.

Two markets are not forecasted to drive launches. SRVs can provide a platform for Remote Sensing activities, but do not offer a competitive advantage over competing satellites, aircraft, and unmanned aerial vehicles (UAVs). Finally, in coming decades, SRVs could evolve into hypersonic airliners to support a market for Point-to-Point Transportation. However, this technology will not be available in the time horizon of this forecast.

DEMAND BY USER

Individuals

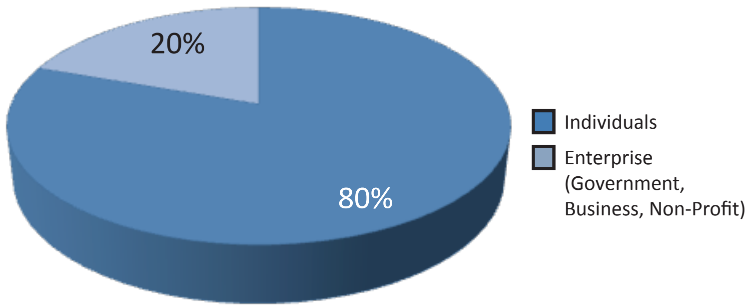


Figure 40. Enterprise Demand and Individual Demand in Baseline Case

The majority of SRV demand comes from individuals (see Figure 40); the SRV market is a consumer market. Consequently, the capability and viability of SRV ventures will be heavily influenced by individual decision makers.

Unlike enterprise users who typically have lead times for decision making measured in years (reflecting annual budgeting processes and government program timelines), individuals can make purchasing decisions quickly. This market is likely to be sensitive to perceptions of risk, and how expectations and shared experiences of SRV flights disseminate.

The behavior of consumers in the future remains uncertain. Marketing and visibility resulting from the approach of flight operations, or successful and publicized flight experiences, could significantly – and rapidly – increase demand. Alternatively, those that have purchased tickets already may represent an early adopter population with different motivations and risk disposition from the broader market. At least some portion of tickets sold to date are refundable or deposits rather than full payments, creating a possibility that not all ticket holders will convert to passengers.

Enterprises

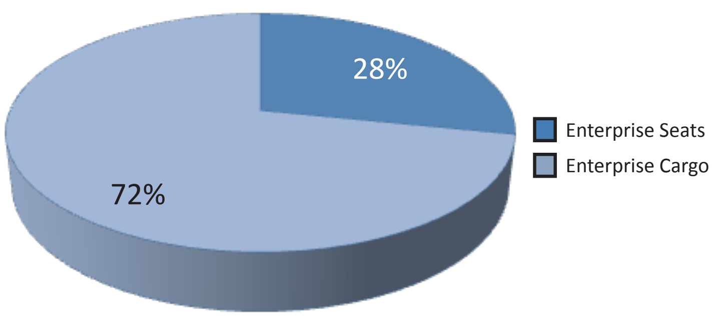


Figure 41. Enterprise Demand by Type of Payload

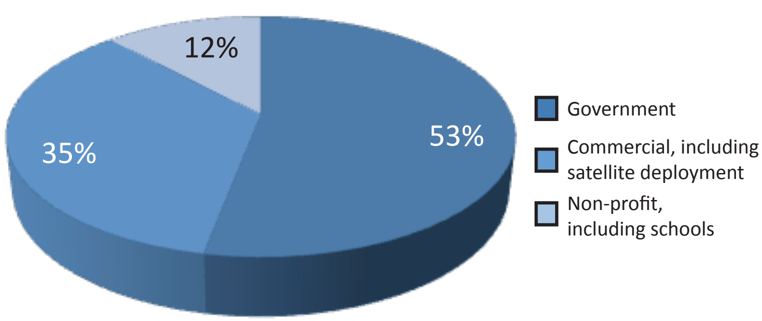


Figure 42. Enterprise Demand by Type of User

Enterprise users include government, commercial, non-profits, and school and university SRV users, and represents about a fifth of total forecasted SRV demand. Most enterprise demand is for cargo, rather than seats (see Figure 41). About half of enterprise demand is from government agencies, followed by commercial entities (more than one-third), with schools and non-profits accounting for the remainder (see Figure 42). Over 40% of government demand is NASA. (Note that this means that our forecast projects that NASA represents less than 5% of total SRV demand.) About 10% of enterprise demand is from non-US agencies, mainly in the Research and Technology Test and Demonstration markets. Finally, about one-third of enterprise demand is from commercial entities – about 30% Research, with the rest from Media and PR, Commercial Human Spaceflight, and very small satellite launches.

REVENUE

Our forecast roughly translates a total of $600 million in demand over 10 years in the baseline case. The growth scenario totals $1.6 billion, and the constrained scenario totals $300 million.

There are important caveats to these estimates. They do not reflect all related expenditures associated with demand (such as, for example, budgets for developing experiments hardware and paying researchers, or revenues from spaceport activities for family and friends of those flying). They also do not represent predicted SRV flight revenues, but rather the potential revenue associated with SRV demand. The interplay of supply with demand is unaccounted for. For example, there is near-term demand for satellite launches at SRV prices and reflective of SRV capabilities, but no SRVs capable of launching satellites are anticipated until 2017.

Actual revenues will depend on when vehicles become operational, the pace of operations overall, the relative flight rates of providers, ancillary sources of revenue, and future price levels. If, in Year 1, reservations occurred at roughly the rate at which they have recently been announced (150 in 2011 and 185 in 2012, and a total of 925 since 2003), sales to fulfill our demand forecast in the baseline would grow at about 18% annually. In the growth scenario, sales would increase at about 40% each year. The constrained scenario would grow at about 4%. Announced historical reservations, compared to this possible trend of future reservations, are shown in Figure 43.

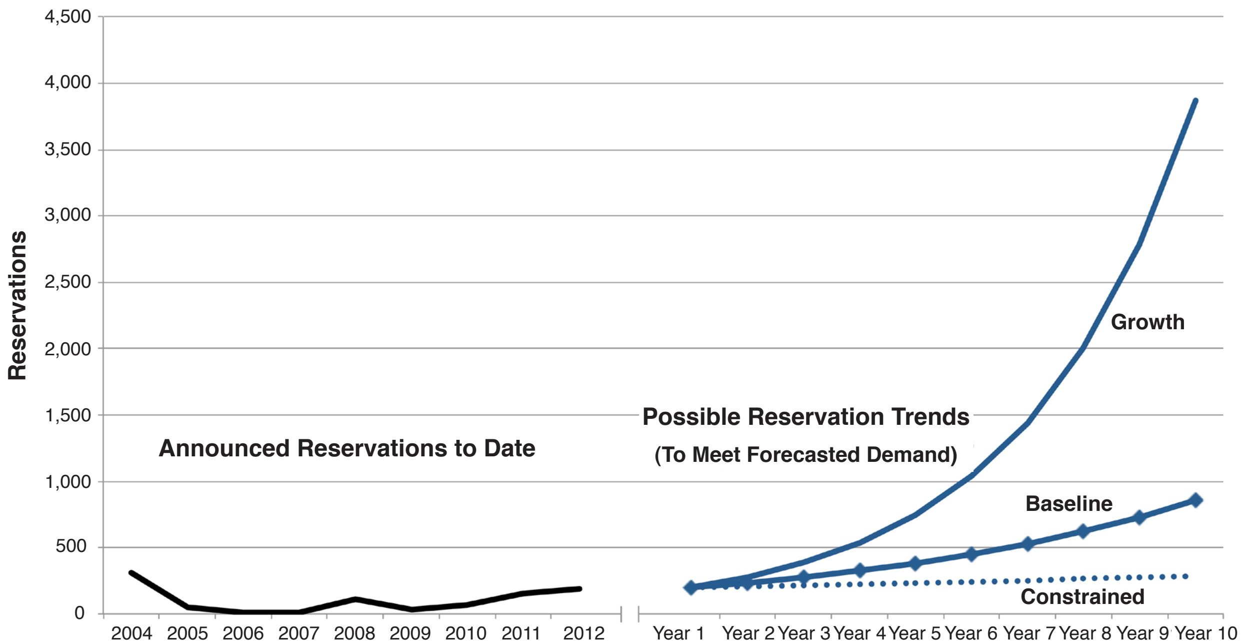


Figure 43. Possible Reservations Trend to Meet Forecasted Demand

MAJOR UNCERTAINTIES

The forecast predicts outcomes related to experiences that, for the most part, do not yet exist. If levels of SRV capability and performance vary from what is expected based on today's information, demand will change from predicted levels.

Forecast results are particularly sensitive to assumptions regarding future consumer behavior. The forecast assumes passengers fly once only, that a potential passenger has a 1/25 probability of flying in a given year (so 40% of interested passengers today will fly within the next 10 years), and that most (95%) passengers have net assets exceeding $5 million. Relaxing or strengthening any of these assumptions changes demand significantly.

Another sensitivity involves research outcomes. Research success and identification of a clear, related commercial application that requires sustained, ongoing SRV use could increase funding beyond the exploratory levels predicted.

The forecast reflects expectations about future government interest in SRVs. If SRV capabilities vary from current expectations, these levels of activity could be either higher or lower. Further, if NASA decision dynamics change, SRVs could be used for astronaut training, to replace sounding rockets to a greater degree, or for microgravity research integrated with ISS activities. The forecast also predicts that more than 50 international governments will begin to fund SRV research. National restrictions on access to SRVs could potentially limit funding from these governments. Alternatively, rapid uptake and greater activity from these nations could result in higher demand than predicted.

As an indicator of the revenue associated with estimated demand, we translated our forecast from seat/cargo equivalents at a rate of $123,000 per seat/cargo equivalent. This estimate reflects announced seat prices across vehicles in active development, extrapolated to all vehicles (including cargo-only vehicles) based on vehicle capacity. It is a rough estimate. No cargo prices (other than satellite deployment costs on an XCOR Lynx Mark III) have been announced, though some providers have stated informally that cargo costs align with seat costs for their vehicles. The mix of vehicles in operation will affect both demand and revenue. Vehicles are priced differently and have different capabilities.

CONCLUSION

Demand for suborbital flights is sustained and appears sufficient to support multiple providers. Total baseline demand over 10 years exceeds $600 million in SRV flight revenue, supporting daily flight activity. The baseline reflects predictable demand based on current trends and consumer interest. In the growth scenario, reflecting increased marketing, demonstrated research successes, increasing awareness, and greater consumer uptake, multiple flights per day generate $1.6 billion in revenue over 10 years. In a constrained scenario, where consumer and enterprise spending drop relative to today’s trends, multiple weekly flights generate about $300 million over 10 years. Further potential could be realized through price reductions and unpredictable achievements such as major research discoveries, the identification of new commercial applications, the emergence of global brand value, and new government (especially military) uses for SRVs. Figure 44 presents a summary of the 10-year SRV demand forecast.

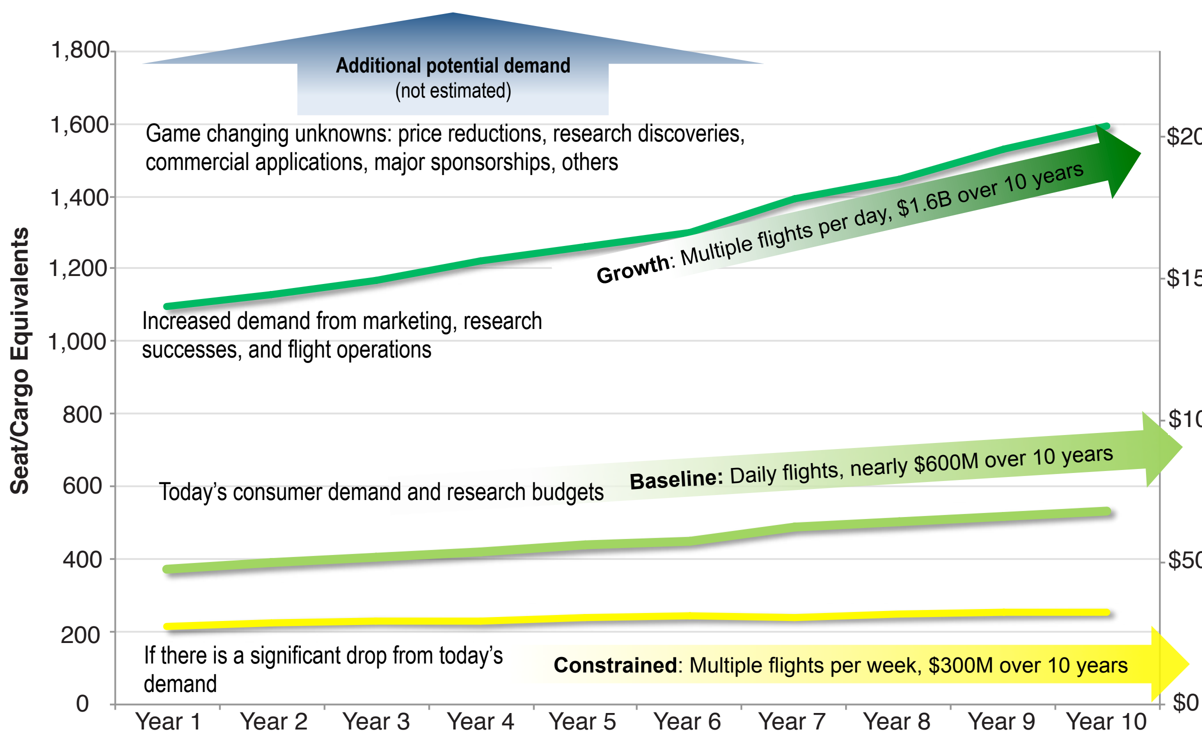
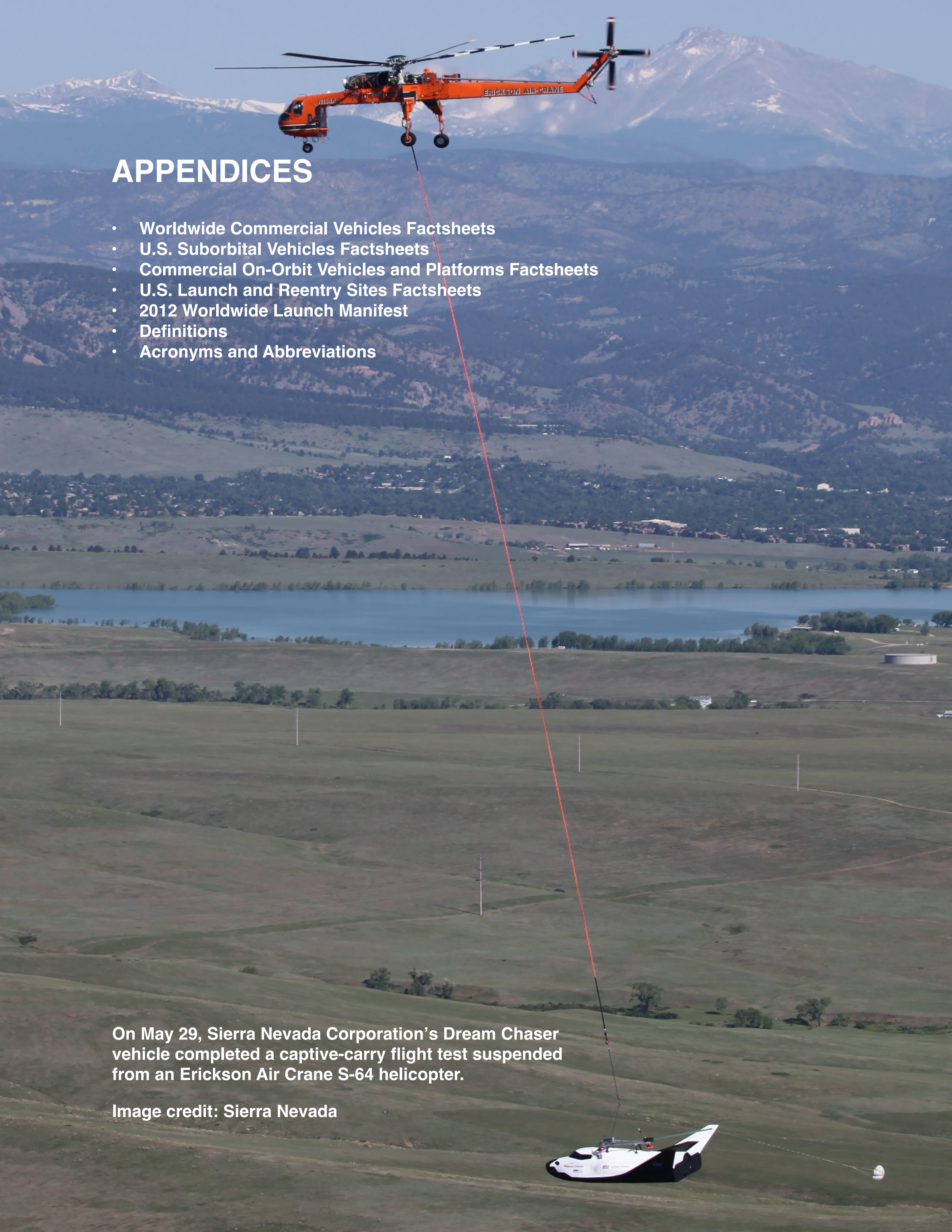


Figure 44. 10-year SRV Demand Forecast



APPENDICES

- Worldwide Commercial Vehicles Factsheets
- U.S. Suborbital Vehicles Factsheets
- Commercial On-Orbit Vehicles and Platforms Factsheets
- U.S. Launch and Reentry Sites Factsheets
- 2012 Worldwide Launch Manifest
- Definitions
- Acronyms and Abbreviations

On May 29, Sierra Nevada Corporation's Dream Chaser vehicle completed a captive-carry flight test suspended from an Erickson Air Crane S-64 helicopter.

Image credit: Sierra Nevada

Antares

Orbital Sciences Corp.

Antares 120

Antares 130

Antares 121

Antares 131

Antares 122

Antares 132

Orbital Sciences Corporation plans to launch the Antares, a medium-class vehicle, for commercial clients in 2013. Antares is a two-stage vehicle designed to launch government and commercial satellites to low Earth orbit, Cygnus cargo modules to the International Space Station, and missions requiring Earth escape trajectories. The Antares is also available under the NASA Launch Services (NLS) II contract for future science missions.

The vehicle is launched from the Mid-Atlantic Regional Spaceport (MARS), located on Virginia's Wallops Island.

Launch Service Provider Orbital Sciences Corp.
Company Headquarters USA
Manufacturer Orbital Sciences Corp.

Mass, kg (lb) 530,000 (1,168,450)
Length, m (ft) 40.5 (132.9)
Diameter, m (ft) 3.9 (12.8)

Year of First Launch 2013
Launch Site MARS (Pad 0-A)

LEO Capacity, kg (lb) 4,550-5,700 (10,031-12,566)
SSO Capacity, kg (lb) 3,350-4,500 (7,385-9,921)

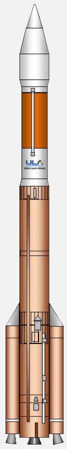
Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	9.9 (32.5)	3.9 (12.8)

	1st Stage	2nd Stage	3rd Stage Option	3rd Stage Option
Stage designation	N/A	Castor-30B	STAR-48V	Bi-Propellant Third Stage
Length, m (ft)	25 (82)	6 (19.7)	2 (6.6)	1.8 (5.9)
Diameter, m (ft)	3.9 (12.8)	3.9 (12.8)	1.2 (3.9)	1.7 (5.6)
Manufacturer	Yuzhnoye	ATK	ATK	Orbital
Propellant	LOX/Kerosene	Solid	Solid	N_2O_4/UDMH
Propellant mass, kg (lb)	240,000 (529,109)	12,837 (28,300)	2,010 (4,431)	--
Total thrust, kN (lbf)	3,265 (734,001)	293.4 (65,959)	77.8 (17,490)	--
Engine(s)	2 x AJ26-62	--	--	--
Engine manufacturer	Aerojet	--	--	Orbital
Engine thrust, kN (lbf)	1,632 (366,888)	293.4 (65,959)	77.8 (17,490)	--

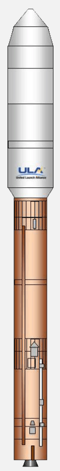
ATLAS V

United Launch Alliance

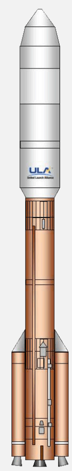
Atlas V
401/402
411/412



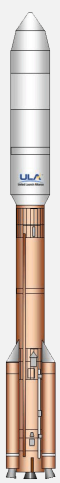
Atlas V
422/421
431/432



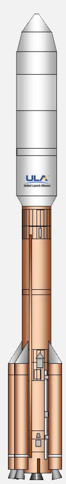
Atlas V
501/502
511/512



Atlas V
521/522
531/532



Atlas V
541/542



Atlas V
551/552

The Atlas V family is a product of the U.S. Air Force's Evolved Expendable Launch Vehicle Program (EELV), begun in 1995. Lockheed Martin develops the Atlas V, United Launch Alliance (ULA) markets the vehicle to U.S. Government customers, and Lockheed Martin Commercial Launch Services (LMCLS) markets it to commercial clients worldwide. The vehicles can launch payloads to any desired orbit.
The Atlas V family debuted in 2002 with the successful launch of an Atlas V 401 from Cape Canaveral Air Force Station (CCAFS).

Launch Service Provider
United Launch Alliance
LMCLS

Company Headquarters
USA

Manufacturer
United Launch Alliance

Mass, kg (lb)
401: 333,731 (734,208)
551: 568,878 (1,251,532)

Length, m (ft)
60.6-75.5 (198.7-247.5)

Diameter, m (ft)
3.8 (12.5)

Year of First Launch
2002

Number of launches
34

Reliability
100%

Launch Sites
CCAFS (SLC-41)
VAFB (SLC-3E)

GTO Capacity, kg (lb)
4,750-8,900 (10,472-19,621)

LEO Capacity, kg (lb)
9,370-18,510 (20,657-40,510)

SSO Capacity, kg (lb)
7,724-15,179 (17,029-33,464)

Fairing	Length, m (ft)	Diameter, m (ft)
Large Payload Fairing	12 (39.4)	4.2 (13.8)
Extended Payload Fairing	12.9 (42.3)	4.2 (13.8)
Extra Extended Payload Fairing	13.8 (45.3)	4.2 (13.8)

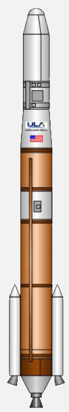
	1st Stage	SRB*	2nd Stage Option	2nd Stage Option
Stage designation	Common Core Booster	Solid Rocket Boosters	Single Engine Centaur	Dual Engine Centaur
Length, m (ft)	32.5 (106.6)	20 (65.6)	12.7 (41.7)	12.7 (41.7)
Diameter, m (ft)	3.8 (12.5)	1.6 (5.2)	3.1 (10.2)	3.1 (10.2)
Manufacturer	ULA	Aerojet	ULA	ULA
Propellant	LOX/Kerosene	Solid	LOX/LH_2	LOX/LH_2
Propellant mass, kg (lb)	284,089 (626,309)	46,697 (102,949)	20,830 (45,922)	20,830 (45,922)
Total thrust, kN (lbf)	3,827 (860,309)	1,688 (379,550)	99.2 (22,300)	198.4 (44,600)
Engine(s)	1 x RD-180	-	1 x RL10A-4-2	2 x RL10A-4-2
Engine manufacturer	RD AMROSS	-	PWR	PWR
Engine thrust, kN (lbf)	3,827 (860,309)	1,688 (379,550)	99.2 (22,300)	99.2 (22,300)

*Figures are for each booster.

Delta IV

United Launch Alliance

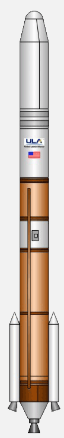
Delta IV Medium



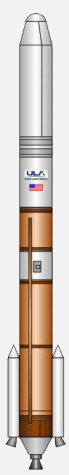
Delta IV Medium+ (4,2)

The Delta IV family is a product of the U.S. Air Force's Evolved Expendable Launch Vehicle Program (EELV), begun in 1995. Boeing develops the Delta IV, United Launch Alliance (ULA) markets the vehicle to U.S. Government customers, and Boeing Launch Services markets it to commercial clients worldwide. The Delta IV can launch payloads to any desired orbit. The Delta IV family debuted in 2002 with the successful launch of a Delta IV Medium+(4,2) from Cape Canaveral Air Force Station (CCAFS).

Launch Service Provider United Launch Alliance Boeing Launch Services
Company Headquarters USA
Manufacturer United Launch Alliance
Mass, kg (lb) D-IVM: 249,500 (549,559) D-IVH: 733,000 (1,615,416)
Length, m (ft) 62.8-71.6 (206-234.9)
Diameter, m (ft) 5 (16.4)
Year of First Launch 2002
Number of Launches 21
Reliability 100%
Launch Sites CCAFS (SLC-37) VAFB (SLC-6)
GTO Capacity, kg (lb) 4,300-14,420 (9,480-31,791)
LEO Capacity, kg (lb) 9,150-22,560 (20,172-49,736)
SSO Capacity, kg (lb) 7,500-21,000 (16,535-46,300)

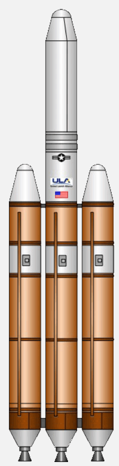


Delta IV Medium+ (5,2)



Delta IV Medium+ (5,4)

Fairing	Length, m (ft)	Diameter, m (ft)
11.7-Meter Fairing	11.7 (38.5)	4 (16.4)
14.3-Meter Fairing	14.3 (47)	5 (16.4)
19.1-Meter Fairing	19.1 (62.7)	5 (16.4)
Metallic Fairing	19.8 (65)	5 (16.4)



Delta IV Heavy

	1st Stage	SRB*	2nd Stage Option	2nd Stage Option
Stage designation	Common Booster Core	GEM-60	4-Meter Cryogenic Upper Stage	5-Meter Cryogenic Upper Stage
Length, m (ft)	46.7 (153.2)	15. 8 (52)	10.4 (34)	12.2 (40)
Diameter, m (ft)	5 (16.4)	1.6 (5.3)	4 (13.1)	5 (16.4)
Manufacturer	ULA	ATK	ULA	ULA
Propellant	LOX/LH_2	Solid	LOX/LH_2	LOX/LH_2
Propellant mass, kg (lb)	199,640 (439,735)	59,520 (130,944)	20,410 (45,000)	27,200 (60,000)
Total thrust, kN (lbf)	2,891 (650,000)	1,245.5 (280,000)	110 (24,750)	110 (24,750)
Engine(s)	1 x RS-68A	--	1 x RL10B-2	1 x RL10B-2
Engine manufacturer	PWR	--	PWR	PWR
Engine thrust, kN (lbf)	2,891 (650,000)	1,245.5 (280,000)	110 (24,750)	110 (24,750)

Figures are for each booster.

Falcon 9

SpaceX

Falcon 9 v1.1

Space Exploration Technologies (SpaceX), founded in 2002, first launched its Falcon 9 in 2010 from Cape Canaveral Air Force Station (CCAFS). The vehicle is designed to deliver government and commercial payloads to low Earth orbit, geosynchronous transfer orbit, and Earth escape trajectories. It is also used to transport the Dragon spacecraft to orbit, the ISS, and other destinations, and in 2015 will begin transporting a Dragon crew spacecraft. SpaceX was awarded two launches under the Air Force's Orbital/Suborbital Program-3 (OSP-3).

The first generation vehicle has recently been referred to as the Falcon 9 v1.0 to reflect the 2013 introduction of an upgraded Falcon 9 v1.1.

Launch Service Provider	SpaceX
Company Headquarters	USA
Manufacturer	SpaceX

Length, m (ft)	68.4 (224.4)
Diameter, m (ft)	3.6 (12)

Year of First Launch	2010
Number of Launches	4
Reliability	100%
Launch Sites	CCAFS (SLC-40) VAFB (SLC-4E)

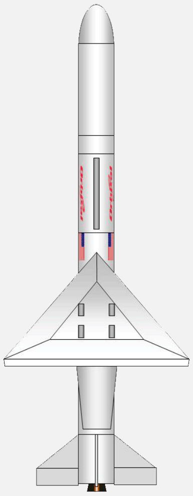
GTO Capacity, kg (lb)	4,850 (10,692)
LEO Capacity, kg (lb)	13,150 (28,991)

Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	13.2 (43.3)	5.2 (17)

	1st Stage	2nd Stage
Length, m (ft)	41.5 (136.2) (engine section + first-stage tanks)	9.6 (31.4)
Diameter, m (ft)	3.6 (12)	3.6 (12)
Manufacturer	SpaceX	SpaceX
Propellant	LOX/Kerosene (RP-1)	LOX/Kerosene (RP-1)
Propellant mass, kg (lb)	~411,000 (~906,010)	~73,400 (~161,819)
Total thrust, kN (lbf)	5,872 (1,320,000)	733 (165,000)
Engine(s)	9 x Merlin 1C	1 x Merlin 1C
Engine manufacturer	SpaceX	SpaceX
Engine thrust, kN (lbf)	653.8 (147,000) per engine at sea level	716.2 (161,000) per engine at sea level

Pegasus XL

Orbital Sciences Corp.



Pegasus XL

Orbital Sciences Corporation offers the Pegasus XL as a means to launch small satellites to low Earth orbits (LEO). The vehicle is derived from the first generation Standard Pegasus first launched in 1990. It is normally composed of three solid propellant stages manufactured by ATK, but it may also include an Orbital-built Hydrazine Auxiliary Propulsion System (HAPS) as a fourth stage. The vehicle is air-launched from a Lockheed-built L-1011 aircraft.

The Pegasus XL has flown 27 consecutive successful missions since 1996.

LEO capacity figures are for the Pegasus XL without a HAPS fourth stage from Cape Canaveral Air Force Station (CCAFS). Sun-synchronous orbit (SSO) figures are for the same vehicle configuration launched from Vandenberg Air Force Base (VAFB).

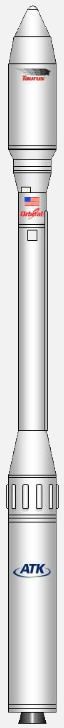
Launch Service Provider	Orbital Sciences Corp.
Company Headquarters	USA
Manufacturer	Orbital Sciences Corp.
Mass, kg (lb)	23,130 (50,993)
Length, m (ft)	16.9 (55.4)
Diameter, m (ft)	1.3 (4.2)
Year of First Launch	1994
Number of Launches	31
Reliability	94%
Launch Sites	Canary Islands, CCAFS, Kwajalein, VAFB, WFF
LEO Capacity, kg (lb)	450 (992)
SSO Capacity, kg (lb)	325 (717)

Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	2.1 (6.9)	1.2 (3.9)

	1st Stage	2nd Stage	3rd Stage	4th Stage
Stage designation	Orion-50SXL	Orion-50XL	Orion-38	HAPS
Length, m (ft)	1 (3.3)	3.1 (10.2)	1.3 (4.3)	0.7 (2.3)
Diameter, m (ft)	1.3 (4.2)	1.3 (4.2)	1 (3.3)	1 (3.3)
Manufacturer	ATK	ATK	ATK	Orbital
Propellant	Solid	Solid	Solid	Hydrazine
Propellant mass, kg (lb)	15,014 (33,105)	3,925 (8,655)	770 (1,697)	73 (161)
Total thrust, kN (lbf)	726 (163,247)	196 (44,171)	36 (8,062)	0.6 (135)
Engine(s)	--	--	--	3 x Rocket Engine Assemblies
Engine manufacturer	--	--	--	Orbital
Engine thrust, kN (lbf)	726 (163,247)	196 (44,171)	36 (8,062)	0.2 (45)

TAURUS

Orbital Sciences Corp.



Taurus 3210

Orbital Sciences Corporation offers the four-stage small-class vehicle, Taurus, as an option for satellite customers. The Taurus, essentially a ground-launched version of the Pegasus, was developed under the sponsorship of the Defense Advanced Research Projects Agency. Several variations of the Taurus are available, allowing Orbital to mix and match different stages and fairings to address customer needs.

The Taurus launches from SLC-376E at Vandenberg Air Force Base (VAFB), though it may also launch from SLC-46 at Cape Canaveral Air Force Station (CCAFS). It can also launch from Pad 0-B at Virginia's Mid-Atlantic Regional Spaceport.

Launch Service Provider	Orbital Sciences Corp.
Company Headquarters	USA
Manufacturer	Orbital Sciences Corp.
Mass, kg (lb)	70,000 (154,324)
Length, m (ft)	24.6 (80.7)
Diameter, m (ft)	2.4 (7.9)
Year of First Launch	1994
Number of Launches	9
Reliability	67%
Launch Sites	CCAFS (SLC-46) MARS (Pad 0-B) VAFB (SLC-376E)
LEO Capacity, kg (lb)	1,160 (2,552)
SSO Capacity, kg (lb)	1,600 (3,520)

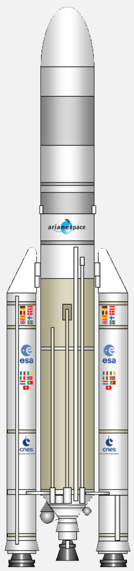
Fairing	Length, m (ft)	Diameter, m (ft)
2.3-Meter Fairing	1.6 (5.2)	2.3 (7.5)
1.6-Meter Fairing	2.2 (7.2)	1.6 (5.2)

Taurus 2110, 3110, 3113

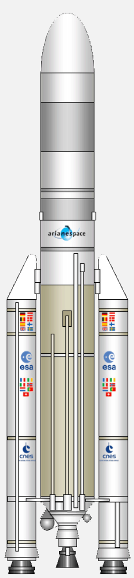
	1st Stage	2nd Stage	3rd Stage	4th Stage Option	4th Stage Option
Stage designation	Castor-120	Orion-50SGXL	Orion-50XL	Orion-38	STAR-37
Length, m (ft)	9.1 (29.9)	8.9 (29.2)	3.1 (10.2)	1.3 (4.3)	2.3 (7.5)
Diameter, m (ft)	2.4 (7.9)	1.3 (4.3)	1.3 (4.3)	1 (3.3)	0.7 (2.3)
Manufacturer	ATK	ATK	ATK	ATK	ATK
Propellant	Solid	Solid	Solid	Solid	Solid
Propellant mass, kg (lb)	48,960 (107,939)	15,023 (33,120)	3,925 (8,655)	770 (1,697)	1,066
Total thrust, kN (lbf)	1,904 (428,120)	704 (157,729)	196 (44,171)	36 (8,062)	47.3 (10,625)
Engine thrust, kN (lbf)	1,904 (428,120)	704 (157,729)	196 (44,171)	36 (8,062)	47.3 (10,625)

Ariane 5

Arianespace



Ariane 5 ECA



Ariane 5 ES

The Ariane 5, technically the Ariane 5 ECA, is the workhorse of France-based Arianespace, a European launch consortium. With direct technical heritage to the Ariane 4 series, the Ariane 5 ECA is optimized for dual-launches of geostationary communication satellites. Arianespace also operates the Ariane 5 ES version with a storable propellant upper stage engine used to launch the Automated Transfer Vehicles (ATV) to the International Space Station (ISS) and very large satellites like Envisat.

Arianespace oversees the procurement, quality control, and launch operations of the Ariane 5. The Ariane 5 has had 67 launches, including 4 failures and 2 partial failures, all from the ELA-3 launch complex at the Guiana Space Center in French Guiana.

Launch Service Provider	Arianespace
Company Headquarters	France
Manufacturer	Arianespace
Mass, kg (lb)	777,000 (1,712,992)
Length, m (ft)	46-52 (151-171)
Diameter, m (ft)	5.4 (17.7)
Year of First Launch	2002
Number of Launches	39 (ECA version)
Reliability	97%
Launch Site	Guiana Space Center (ELA-3)
GTO Capacity, kg (lb)	9,500 (20,944)
LEO Capacity, kg (lb)	21,000 (46,297)
SSO Capacity, kg (lb)	10,000 (22,046)

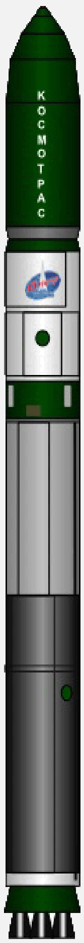
Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	17 (55.8)	5.4 (17.7)

	1st Stage	SRB*	2nd Stage
Stage designation	EPC	EAP	ESC-A
Length, m (ft)	30.5 (100.1)	31.6 (103.7)	4.7 (15.4)
Diameter, m (ft)	5.4 (17.7)	3.1 (10.2)	5.4 (17.7)
Manufacturer	EADS Astrium	Europropulsion	EADS Astrium
Propellant	LOX/LH_2	Solid	LOX/LH_2
Propellant mass, kg (lb)	170,000 (374,786)	240,000 (529,109)	14,900 (32,849)
Total thrust, kN (lbf)	960 (215,817)	7,000 (1,573,663)	67 (15,062)
Engine(s)	1 x Vulcain 2	--	1 x HM7B
Engine manufacturer	Snecma	--	Snecma
Engine thrust, kN (lbf)	960 (215,817)	7,000 (1,573,663)	67 (15,062)

**Figures are for each booster.*

DNEPR

ISC Kosmotras



Dnepr

The Dnepr, introduced in 1999, is developed from surplus Soviet R-36 (SS-18) intercontinental ballistic missiles (ICBM). About 150 missiles were made available for conversion into launch vehicles. The missiles, with components built during the Soviet era, are refurbished by PA Yuzhmash located in Ukraine. The three-stage, liquid-fueled vehicle is designed to address medium-class payloads or clusters of small- and micro-class satellites. It is marketed by the Russian-based company ISC Kosmotras.

The Dnepr is launched from Pad 109 and Pad 95 at the Baikonur Kosmodrome in Kazakhstan and the Dombarovsky missile base in Western Russia.

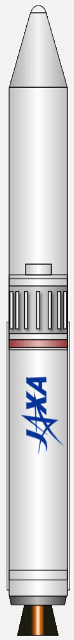
Launch Service Provider	ISC Kosmotras
Company Headquarters	Russia
Manufacturer	Yuzhnoye Design Office
Mass, kg (lb)	260,546 (574,406)
Length, m (ft)	34.3 (112.5)
Diameter, m (ft)	3 (9.8)
Year of First Launch	1999
Number of Launches	17
Reliability	94%
Launch Sites	Baikonur (LC-109, LC-95) Dombarovsky (LC-13)
LEO Capacity, kg (lb)	3,700 (8,157)
SSO Capacity, kg (lb)	2,300 (5,071)

Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	5.3 (17.4)	3 (9.8)
Extended Fairing	6.1 (20)	3 (9.8)

	1st Stage	2nd Stage	3rd Stage
Stage designation	1st Stage	2nd Stage	3rd Stage
Length, m (ft)	22 (72.2)	6 (19.7)	1.5 (4.9)
Diameter, m (ft)	3 (9.8)	3 (9.8)	3 (9.8)
Manufacturer	Yuzhnoye	Yuzhnoye	Yuzhnoye
Propellant	N_2O_4/UDMH	N_2O_4/UDMH	N_2O_4/UDMH
Propellant mass, kg (lb)	147,900 (326,064)	36,740 (80,998)	1,910 (4,211)
Total thrust, kN (lbf)	4,520 (1,016,136)	755 (169,731)	18.6 (4,181)
Engine(s)	1 x RD-264	1 x RD-0255	1 x RD-869
Engine manufacturer	OKB-456 (NPO Energomash)	OKB-154 (KB Khimavtomatika)	OKB-586 (Yuzhnoye)
Engine thrust, kN (lbf)	4,520 (1,016,136)	755 (169,731)	18.6 (4,181)

EPSILON

Japan Aerospace Exploration Agency



Epsilon

The Epsilon is a vehicle under development by IHI for the Japan Aerospace Exploration Agency (JAXA), derived from the Nissan-built M-V discontinued in 2006. The vehicle will be used to send small payloads to low Earth orbits and polar orbits. The first launch of Epsilon is expected to take place during 2013.

The Epsilon comes in both a Standard Configuration and an Optional Configuration. The Optional Configuration features an additional compact Post Boost Stage integrated with the third stage for sun-synchronous orbits (SSO).

The vehicle will launch from Uchinoura Space Center, formerly called Kagoshima Space Center.

Launch Service Provider	JAXA
Company Headquarters	Japan
Manufacturer	IHI

Mass, kg (lb)	90,800 (200,180)
Length, m (ft)	24.4 (80.1)
Diameter, m (ft)	2.5 (8.2)

Year of First Launch	2013
Launch Site	Uchinoura Space Center

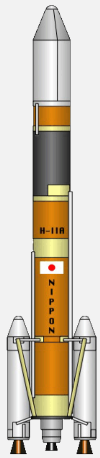
LEO Capacity, kg (lb)	700-1,200 (1,543-2,646)
SSO Capacity, kg (lb)	450 (992)

Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	10 (32.8)	2.5 (8.2)

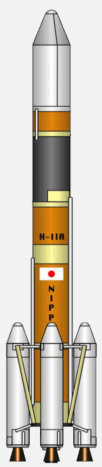
	1st Stage	2nd Stage	3rd Stage	4th Stage
Stage designation	SRB-A3	M-34c	KM-V2b	Post Boost Stage
Length, m (ft)	15.1 (49.5)	5 (16.4)	3 (9.8)	0.5 (1.6)
Diameter, m (ft)	2.5 (8.2)	2.5 (8.2)	2.5 (8.2)	2 (6.6)
Manufacturer	Nissan	Nissan	Nissan	Nissan
Propellant	Solid	Solid	Solid	Hydrazine
Propellant mass, kg (lb)	66,000 (145,505)	10,800 (23,800)	2,500 (5,512)	100 (220)
Total thrust, kN (lbf)	1,580 (355,198)	377.2 (84,798)	81.3 (18,277)	< 1 (225)
Engine(s)	--	--	--	3 units
Engine manufacturer	--	--	--	Nissan
Engine thrust, kN (lbf)	1,580 (355,198)	377.2 (84,798)	81.3 (18,277)	< 0.33 (74)

H-IIA/B

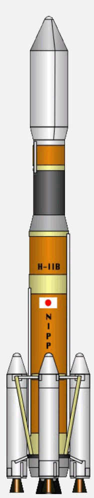
Japan Aerospace Exploration Agency



H-IIA
202



H-IIA
204



H-IIB

The two-stage H-IIA and H-IIB were jointly developed by the Japanese Exploration Agency (JAXA) and Mitsubishi Heavy Industries, Ltd. (MHI), as Japan's primary launch vehicles. There are currently two versions of the H-IIA and one version of the H-IIB available. The H-IIA (with two or four solid boosters) is used to launch a variety of satellites to low Earth orbit, geosynchronous transfer orbits, and beyond. The H-IIB (with four upgraded solid boosters) is currently used to launch the H-II Transfer Vehicle (HTV) to the International Space Station, and has recently been offered as an option for commercial satellite customers.

The H-II vehicle family can trace its lineage through the H-I, the N-1, and ultimately the U.S. Thor intermediate range ballistic missile.

Launch Service Provider
H-IIA Launch Services

Company Headquarters
Japan

Manufacturer
Mitsubishi Heavy Industries

Mass, kg (lb)
289,000-530,000
(637,136-1,168,450)

Length, m (ft)
53-57 (173.9-187))

Diameter, m (ft)
4 (13.1)

Year of First Launch
2001

Number of Launches
21

Reliability
95%

Launch Site
Tanegashima

GTO Capacity, kg (lb)
4,000-6,000 (8,818-13,228)

LEO Capacity, kg (lb)
10,000-16,500 (22,046-36,376)

SSO Capacity, kg (lb)
3,600-10,000 (7,937-22,046)

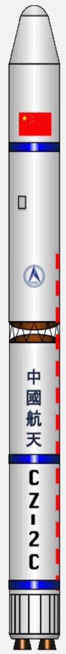
Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	12 (39)	4.1 (13.5)

	1st Stage	Solid Booster (H-IIA)*	Solid Booster (H-IIB)*	2nd Stage
Stage designation	1st Stage	SRB-A	SRB-A3	2nd Stage
Length, m (ft)	37 (121.4)	15 (49.2)	15.1 (49.5)	11 (36.1)
Diameter, m (ft)	4 (13.1)	2.5 (8.2)	2.5 (8.2)	4 (13.1)
Manufacturer	MHI	Nissan	Nissan	MHI
Propellant	LOX/LH_2	Solid	Solid	LOX/LH_2
Propellant mass, kg (lb)	101,000 (222,667))	60,500 (133,380)	66,000 (145,505)	17,000 (37,479)
Total thrust, kN (lbf)	1,098 (246,840)	2,260 (508,068)	1,580 (355,198)	137 (30,799)
Engine(s)	LE-7A	--	--	LE-5B
Engine manufacturer	MHI	--	--	MHI
Engine thrust, kN (lbf)	1,098 (246,840)	2,260 (508,068)	1,580 (355,198)	137 (30,799)

**Figures are for each booster.*

LONG MARCH 2

China Great Wall Industry Corporation



Long March 2C

Long March 2D

The Long March 2 is a small-class vehicle designed to primarily address missions to low Earth orbit. The vehicle is built by the Shanghai Academy of Spaceflight Technology (SAST) and marketed by China Great Wall Industry Corporation (CGWIC). Both organizations are subsidiaries of the China Aerospace Science and Technology Corporation (CASC).

The Long March 2D, used mainly for sun-synchronous orbit (SSO) missions, consists of two stages and launches only from Jiuquan Satellite Launch Center (JSLC). The Long March 2C features a solid motor upper stage and launches from JSLC, Taiyuan Satellite Launch Center (TSLC), and Xichang Satellite Launch Center (XSLC).

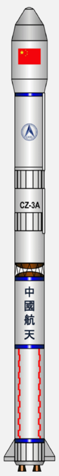
Launch Service Provider	CGWIC
Company Headquarters	China
Manufacturer	SAST
Mass, kg (lb)	233,000 (513,677)
Length, m (ft)	41-42 (134.5-137.8)
Diameter, m (ft)	3.4 (11.2)
Year of First Launch	LM-2C: 1975, LM-2D: 1992
Number of Launches	LM-2C: 32, LM-2D: 11
Reliability	LM-2C: 100%, LM-2D: 100%
Launch Sites	Jiuquan Taiyuan Xichang
GTO Capacity, kg (lb)	1,250 (2,756)
LEO Capacity, kg (lb)	3,850 (8,488)
SSO Capacity, kg (lb)	1,300-1,900 (2,866-4,189)

Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	7 (22.9)	3.4 (11.2)

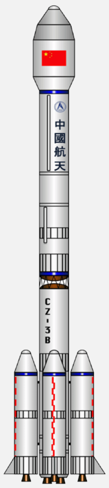
	1st Stage (LM-2C)	1st Stage (LM-2D)	2nd Stage (LM-2C)	2nd Stage (LM-2D)	3rd Stage (LM-2C)
Stage designation	1st Stage	1st Stage	2nd Stage	2nd Stage	2804
Length, m (ft)	25.7 (84.3)	27.9 (91.5)	7.8 (25.6)	10.9 (35.8)	1.5 (4.9)
Diameter, m (ft)	3.4 (11.2)	3.4 (11.2)	3.4 (11.2)	3.4 (11.2)	2.7 (8.9)
Manufacturer	SAST	SAST	SAST	SAST	SAST
Propellant	N_2O_4/UDMH	N_2O_4/UDMH	N_2O_4/UDMH	N_2O_4/UDMH	Solid
Propellant mass, kg (lb)	162,706 (358,705)	182,000 (401,241)	54,667 (120,520)	52,700 (116,184)	125 (275.6)
Total thrust, kN (lbf)	2,961.6 (665,794)	2,961.6 (665,794)	741.3 (166,651)	742 (166,808)	10.8 (2,428)
Engine(s)	4 x YF-21C	4 x YF-21C	1 x YF-24E	1 x YF-24C	--
Engine manufacturer	CALT	CALT	CALT	CALT	--
Engine thrust, kN (lbf)	740.4 (166,449)	740.4 (166,449)	741.3 (166,651)	742 (166,808)	10.8 (2,428)

Long March 3A

China Great Wall Industry Corporation



Long March 3A



Long March 3B

China Great Wall Industry Corporation (CGWIC) markets the Long March 3A vehicle family for customers seeking launches of satellites to geosynchronous orbit. It is derived from the discontinued Long March 3 and is the basis for the Long March 3B, enhanced 3BE, and C versions. The Long March 3B features four liquid boosters and the 3C features two. All variants launch from Xichang Satellite Launch Center (XSLC).

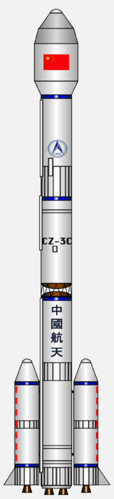
The China Academy of Launch Vehicles (CALT) develops and manufactures the Long March 3A vehicles. The Long March 3A can trace its lineage to the DF-5 ICBM first deployed in 1981.

Launch Service Provider CGWIC
Company Headquarters China
Manufacturer CALT

Mass, kg (lb) 242,000-456,000 (533,519-1,005,308)
Length, m (ft) 52.5-57 (172-187)
Diameter, m (ft) 3.4 (11)

Year of First Launch LM-3A: 1994, LM-3B: 1996, LM-3C: 2008
Number of Launches LM-3A: 23, LM-3B: 21, LM-3C: 10
Reliability LM-3A: 100%, LM-3B: 83%, LM-3C: 100%
Launch Site Xichang

GTO Capacity, kg (lb) 2,600-5,500 (5,732-12,125)



Long March 3C

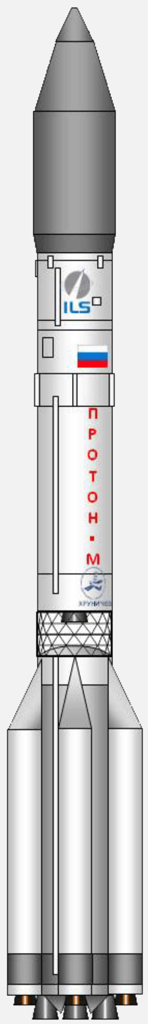
Fairing	Length, m (ft)	Diameter, m (ft)
Fairing Option A	8.9 (29)	3.4 (11.2)
Fairing Option B	8.9 (29)	3.7 (12)
Fairing Option C	8.9 (29)	4 (13)
Fairing Option D	8.9 (29)	4.2 (13.8)

	1st Stage (LM-3A)	1st Stage (LM-3BE)	Booster (LM-3B/C)*	Booster (LM-3BE)*	2nd Stage (LM-3A)	2nd Stage (LM-3B/BE)	3rd Stage (ALL)
Stage designation	1st Stage	1st Stage	Booster	Booster	2nd Stage	2nd Stage	3rd Stage
Length, m (ft)	23.3 (76.4)	24.8 (81.4)	15.3 (50.2)	16.1 (52.8)	11.3 (37.1)	12.9 (42.3)	12.4 (40.7)
Diameter, m (ft)	3.4 (11.2)	3.4 (11.2)	2.3 (7.5)	2.3 (7.5)	3.4 (11.2)	3.4 (11.2)	3 (9.8)
Manufacturer	CALT	CALT	CALT	CALT	CALT	CALT	CALT
Propellant	N_2O_4/ UDMH	N_2O_4/ UDMH	N_2O_4/ UDMH	N_2O_4/ UDMH	N_2O_4/ UDMH	N_2O_4/ UDMH	LOX/LH_2
Propellant mass, kg (lb)	171,800 (378,754)	186,200 (410,501)	37,700 (83,114)	41,100 (90,610)	32,600 (71,871)	49,400 (108,908)	18,200 (40,124)
Total thrust, kN (lbf)	2,961.6 (665,794)	2,961.6 (665,794)	740.4 (166,449)	740.4 (166,449)	742 (166,808)	742 (166,808)	167.2 (37,588)
Engine(s)	4 x YF-21C	4 x YF-21C	1 x YF-25	1 x YF-25	1 x YF-24E	1 x YF-24E	1 x YF-75
Engine manufacturer	CALT	CALT	CALT	CALT	CALT	CALT	CALT
Engine thrust, kN (lbf)	740.4 (166,449)	740.4 (166,449)	740.4 (166,449)	740.4 (166,449)	742 (166,808)	742 (166,808)	167.2 (37,588)

Figures are for each booster.

Proton M

International Launch Services



Proton M

The Proton M is provided by International Launch Services (ILS) as a launch option for government and commercial operators of satellites in geosynchronous orbit. It is typically not used for missions to low Earth orbit.

The Proton M is built by the Khrunichev State Research and Production Space Center. The Proton vehicle traces its lineage to the UR500 system developed by Vladimir Chelomei's OKB-52 design bureau in 1965. The vehicle was originally intended to send cosmonauts to the Moon until Soviet leadership selected Sergei Korolov's N-1 vehicle instead. The Proton M launched the Soviet Union's Almaz (Salyut) and Mir space stations, and two modules to the International Space Station.

Launch Service Provider	International Launch Services
Company Headquarters	USA
Manufacturer	Khrunichev
Mass, kg (lb)	712,800 (1,571,400)
Length, m (ft)	53 (173.9)
Diameter, m (ft)	7.4 (24.3)
Year of First Launch	2001
Number of Launches	69
Reliability	90%
Launch Site	Baikonur (LC-8 and LC-200)
GTO Capacity, kg (lb)	6,920 (15,256)
LEO Capacity, kg (lb)	23,000 (50,706)

Fairing	Length, m (ft)	Diameter, m (ft)
PLF-BR-13305 Fairing	13.3 (43.6)	4.4 (14.4)
PLF-BR-15255 Fairing	15.3 (50.2)	4.4 (14.4)

	1st Stage	2nd Stage	3rd Stage	4th Stage
Stage designation	1st Stage	2nd Stage	3rd Stage	Breeze-M
Length, m (ft)	21.2 (69.6)	17.1 (56.1)	4.1 (13.5)	2.7 (8.9)
Diameter, m (ft)	7.4 (24.3)	4.1 (13.5)	4.1 (13.5)	4 (13)
Manufacturer	Khrunichev	Khrunichev	Khrunichev	Khrunichev
Propellant	N_2O_4/UDMH	N_2O_4/UDMH	N_2O_4/UDMH	N_2O_4/UDMH
Propellant mass, kg (lb)	428,300 (944,239)	157,300 (346,787)	46,562 (102,651)	19,800 (43,651)
Total thrust, kN (lbf)	10,000 (2,248,089)	2,400 (539,541)	583 (131,063)	19.2 (4,411)
Engine(s)	6 x RD-276	3 x RD-0210	1 x RD-0213	1 x 14D30
Engine manufacturer	NPO Energomash	KB Khimavtomatika	KB Khimavtomatika	DB Khimmash
Engine thrust, kN (lbf)	1,667 (374,682)	800 (179,847)	583 (131,063)	19.6 (4,411)

Rockot

Eurockot

Rockot

The three-stage Rockot is developed using missile components. The missile used as the basis for the commercially available vehicle is the UR100N (SS-19) intercontinental ballistic missile built by Soviet-era OKB-52. Production and launch of the Rockot is managed by Eurockot Launch Services GmbH, a joint company between Russia's Khrunichev State Research and Production Space Center and EADS Astrium.

Since its inaugural launch in 1990, the vehicle has launched 20 times, with 2 failures. The first three launches were from Pads LC-131 and LC-175 at Baikonur Kosmodrome. All launches since 1999 have taken place from LC-133 at Plesetsk Kosmodrome.

Launch Service Provider	Eurockot
Company Headquarters	Germany
Manufacturer	Khrunichev

Mass, kg (lb)	107,000 (235,895)
Length, m (ft)	29.2 (95.8)
Diameter, m (ft)	2.5 (8.2)

Year of First Launch	2000
Number of Launches	17
Reliability	88%
Launch Site	Plesetsk (LC-133)

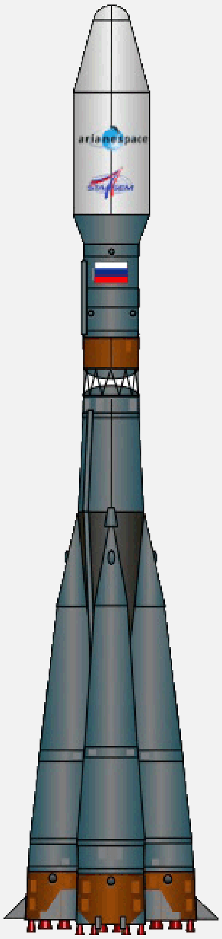
LEO Capacity, kg (lb)	1,820-2,150 (4,012-4,740)
SSO Capacity, kg (lb)	1,180-1,600 (2,601-3,527)

Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	2.6 (8.5)	2.5 (8.2)

	1st Stage	2nd Stage	3rd Stage
Stage designation	1st Stage	2nd Stage	Breeze-KM
Length, m (ft)	17.2 (56.4)	3.9 (12.8)	2.5 (8.2)
Diameter, m (ft)	2.5 (8.2)	2.5 (8.2)	2.5 (8.2)
Manufacturer	OKB-52 (Khrunichev)	OKB-52 (Khrunichev)	Khrunichev
Propellant	N_2O_4/UDMH	N_2O_4/UDMH	N_2O_4/UDMH
Propellant mass, kg (lb)	71,455 (157,531)	10,710 (23,612)	4,975 (10,968)
Total thrust, kN (lbf)	1,870 (420,393)	240 (53,954)	19.6 (4,406)
Engine(s)	3 x RD-0233 1 x RD-0234	1 x RD-235	1 x S5.98M
Engine manufacturer	OKB-154 (KB Khimavtomatika)	OKB-154 (KB Khimavtomatika)	Khrunichev
Engine thrust, kN (lbf)	520 (116,901)	240 (53,954)	19.6 (4,406)

Soyuz 2

Arianespace Starsem



Soyuz 2

The Soyuz 2 is used to launch satellites to virtually any orbit from three different launch sites. It can trace its lineage to the R-7 intercontinental ballistic missile designed by Sergei Korolov and his OKB-1 design bureau in the mid-1950s. The Soyuz received its current name when it was selected to launch crewed Soyuz spacecraft in 1966. Since that year, the R-7-derived vehicles have launched almost 1,800 times. There have been seven versions of the Soyuz, culminating with the Soyuz 2 (Soyuz ST) currently providing commercial service. The older Soyuz FG version continues to launch Progress and Soyuz missions to the ISS. The Soyuz 2 is operated by Arianespace at the Guiana Space Center. Arianespace's sister company, Starsem, operates the Soyuz from Baikonur.

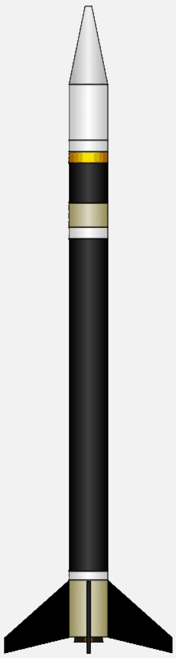
Launch Service Provider	Arianespace Starsem
Company Headquarters	France
Manufacturer	TsSKB Progress
Mass, kg (lb)	334,668 (737,817)
Length, m (ft)	46.2 (151.6)
Diameter, m (ft)	10.3 (33.8)
Year of First Launch	2004
Number of Launches	20
Reliability	100%
Launch Sites	Baikonur (LC-31 or LC-6) Guiana Space Center (ELS) Plesetsk (LC-43)
GTO Capacity, kg (lb)	3,250 (7,165)
LEO Capacity, kg (lb)	4,850 (10,692)
SSO Capacity, kg (lb)	4,400 (9,700)

Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	11.4 (37.4)	4.1 (13.5)

	1st Stage	4 x Liquid Boosters	2nd Stage	3rd Stage
Stage designation	Core Stage	Liquid Boosters	2nd Stage	Fregat
Length, m (ft)	27.1 (88.9)	19.6 (64.3)	6.7 (22)	1.5 (4.9)
Diameter, m (ft)	3 (9.8)	2.7 (8.9)	2.7 (8.9)	3.4 (11.2)
Manufacturer	TsSKB-Progress	TsSKB-Progress	TsSKB-Progress	NPO Lavotchkin
Propellant	LOX/Kerosene	LOX/Kerosene	LOX/Kerosene	N_2O_4/UDMH
Propellant mass, kg (lb)	90,100 (198,636)	39,160 (86,333)	25,400 (55,997)	6,638 (14,634)
Total thrust, kN (lbf)	838.5 (188,502)	792.5 (178,161)	297.9 (66,971)	19.9 (4,474)
Engine(s)	1 x RD-108A	1 x RD-107A	1 x RD-0124	1 x S5.92
Engine manufacturer	AO Motorostroitel	AO Motorostroitel	Voronyezh	NPO Lavotchkin
Engine thrust, kN (lbf)	838.5 (188,502)	792.5 (178,161)	297.9 (66,971)	19.9 (4,474)

SUPER STRYPI

Operational Responsive Space Office
Sandia National Labs



Super Strypi

The Department of Defense's ORS Office, with support from Sandia National Laboratories, is developing a small launch vehicle known as Super Strypi. The goal is to deliver payloads in the range of 300 kilograms (661 pounds) to LEO. This vehicle may be available commercially following test flights.

The rail-launched Super Strypi, also called SPARK, or Spaceborne Payload Assist Rocket Kauai, is scheduled to make its inaugural flight in 2013 from the Pacific Missile Range Facility (PMRF) at Barking Sands in Hawaii. The three-stage all-solid vehicle, based on the 1960s-era Strypi test missile, is being developed by a partnership that includes the University of Hawaii, Sandia Labs, NASA's Ames Research Center, and Aerojet.

Launch Service Provider	ORS Office Sandia National Laboratory
Company Headquarters	USA
Manufacturer	ORS Office Sandia National Laboratory Aerojet
Mass, kg (lb)	28,240 (62,260)
Length, m (ft)	16.8 (55)
Diameter, m (ft)	1.5 (5)
Year of First Launch	2013
Launch Site	PMRF (Pad 41)
LEO Capacity, kg (lb)	300 (441)
SSO Capacity, kg (lb)	300 (441)

Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	1.5 (5)	1.5 (5)

	1st Stage	2nd Stage	3rd Stage
Stage designation	LEO-46	LEO-7	LEO-1
Length, m (ft)	11.3 (37)	2.7 (9)	1.5 (5)
Diameter, m (ft)	1.5 (5)	1.5 (5)	1.5 (5)
Manufacturer	Aerojet	Aerojet	Aerojet
Propellant	ANB-3745 solid	ANB-3790 solid	ANB-3790 solid
Propellant mass, kg (lb)	20,582 (45,376)	3,232 (7,125)	651 (1,435)
Total thrust, kN (lbf)	729.5 (164,000)	TBA	TBA
Engine thrust, kN (lbf)	729.5 (164,000)	TBA	TBA

VEGA

Arianespace

Vega

The Vega launch vehicle is operated by Arianespace and targets payloads to polar and low Earth orbits (LEO) used by scientific and Earth observation satellites. Plans are for the Vega to mainly address LEO missions. It has the capability to send 1,500 kilograms (3,307 pounds) to 700 kilometers (435 miles).

Development of the Vega began in 2003 led by the European Space Agency with contributions from the Italian space agency, the French space agency, and Italy-based Avio.

Launch Service Provider	Arianespace
Company Headquarters	France
Manufacturer	ELV S.p.A.

Mass, kg (lb)	133,770 (294,912)
Length, m (ft)	29.9 (98.1)
Diameter, m (ft)	3 (9.8)

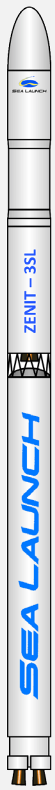
Year of First Launch	2012
Number of Launches	1
Reliability	100%
Launch Site	Guiana Space Center (ZLV)

LEO Capacity, kg (lb)	1,500 (3,307)
SSO Capacity, kg (lb)	1,100-1,740 (2,425-3,836)

Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	7.9 (25.9)	2.6 (8.5)

	1st Stage	2nd Stage	3rd Stage	4th Stage
Stage designation	P80FW	Zefiro 23	Zefiro 9	AVUM
Length, m (ft)	11.2 (36.7)	8.4 (27.6)	4.1 (13.5)	2 (6.6)
Diameter, m (ft)	3 (9.8)	1.9 (6.2)	1.9 (6.2)	2.2 (7.2)
Manufacturer	Europropulsion	Avio	Avio	Avio
Propellant	Solid	Solid	Solid	N_2O_4 (UDMH)
Propellant mass, kg (lb)	88,365 (194,811)	23,906 (52,704)	10,115 (22,300)	367 (809)
Total thrust, kN (lbf)	2,261 (508,293)	1,196 (268,871)	225 (50,582)	2.5 (562)
Engine(s)	--	--	--	1 x RD-869
Engine manufacturer	--	--	--	Yuzhnoye
Engine thrust, kN (lbf)	2,261 (508,293)	1,196 (268,871)	225 (50,582)	2.5 (562)

Zenit-3SL



Zenit-3SL

The Zenit-3SL can be traced to the 1980s when the Soviet government pursued a system that could be used as both a booster for the Energia launch vehicle and as a standalone vehicle. The first-generation Zenit-2 was introduced in 1985 and has launched 37 times. The Zenit-3SL represents a second generation vehicle. It is provided by Sea Launch, a conglomerate entity with four major component providers: RSC Energia, Yuzhnoye, Aker Solutions, and Boeing.

The Zenit-3SLB is a modernized version of the earlier generation of the two-stage Zenit featuring a Block-DM third stage, but marketed by Land Launch, a subsidiary of Sea Launch. Land Launch also includes the Zenit-2SLB, which is essentially the same as the Zenit-3SLB but without a third stage.

Launch Service Provider
Sea Launch AG

Company Headquarters
Switzerland

Manufacturer
Yuzhnoye/Yuzhmash

Mass, kg (lb)
470,000 (1,036,173)

Length, m (ft)
59 (193.6)

Diameter, m (ft)
3.9 (12.8)

Year of First Launch
1999

Number of Launches
39

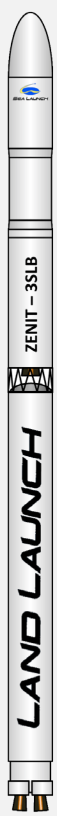
Reliability
92%

Launch Site
Pacific Ocean/*Odyssey*

Fairing	Length, m (ft)	Diameter, m (ft)
Standard Fairing	11.39 (37.4)	4.15 (13.6)

GTO Capacity, kg (lb)
6,160 (13,580)

	1st Stage	2nd Stage	3rd Stage
Stage designation	1st Stage	2nd Stage	Block DM-SL
Length, m (ft)	32.9 (108)	10.4 (34)	4.9 (16.1)
Diameter, m (ft)	3.9 (12.8)	3.9 (12.8)	3.7 (12.1)
Manufacturer	Yuzhnoye/Yuzhmash	Yuzhnoye/Yuzhmash	RSC Energia
Propellant	LOX/Kerosene	LOX/Kerosene	LOX/Kerosene
Propellant mass, kg (lb)	322,280 (710,505)	81,740 (180,205)	15,850 (34,943)
Total thrust, kN (lbf)	7,256 (1,631,421)	992 (223,026)	79.5 (17,864)
Engine(s)	1 x RD-171M	1 x RD-120 1 x RD-8	1 x 11D58M
Engine manufacturer	NPO Energomash	Yuzhmash	RSC Energia
Engine thrust, kN (lbf)	7,256 (1,631,421)	912 (205,026) 80 (18,000)	79.5 (17,864)



Zenit-3SLB

Hyperion

Armadillo Aerospace

Hyperion

Armadillo Aerospace is developing two SRVs, the Suborbital Transport Inertially Guided (STIG) (not crewed) and Hyperion (crewed).

Armadillo Aerospace's crewed vehicle will carry two passengers to an altitude of 100 kilometers (62 miles). Over 200 reservations for Hyperion have been made through Space Adventures. The current advertised cost is $102,000 per seat. The vehicle is not piloted, and is fully autonomous.

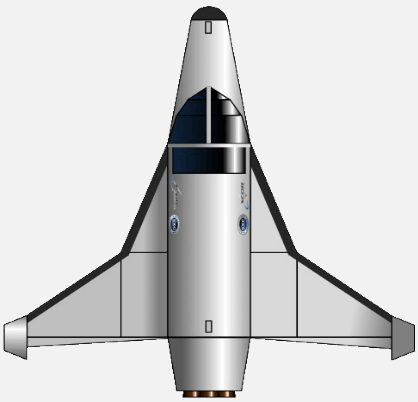
Operator Armadillo Aerospace
Company Headquarters USA
Manufacturer Armadillo Aerospace
Launch Site Spaceport America

Engine manufacturer Armadillo Aerospace

Vehicle Type Vertical takeoff, vertical landing
Year Launch Operations Begin 2014
Seats Participants: 2
Price $102,000 per seat
Cargo Capacity, kg (lb) 200 (441)
Apogee, km (mi) 100 (62)
Time in Microgravity 3 to 5 minutes

Lynx

XCOR Aerospace



Lynx

XCOR Aerospace is developing the Lynx suborbital reusable vehicle, which builds on XCOR's previously demonstrated rocket aircraft, the EZ-Rocket and X-Racer. XCOR is developing the Lynx vehicle through a phased approach with a Mark I test vehicle to be tested in 2013 and a Mark II operational vehicle expected to start service in 2014. The more capable Mark III vehicle will include a dorsal pod for larger suborbital payloads, space telescopes, or for launching small satellites.

The Lynx vehicles will initially fly from the Mojave Air and Space Port; however, they can operate from any licensed spaceport with a 2,400-meter (8,000-foot) runway.

Operator XCOR Aerospace
Company Headquarters USA
Manufacturer XCOR Aerospace
Launch Site Mojave Air and Space Port Midland International Airport

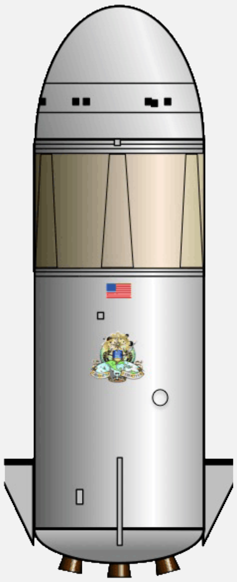
Mass, kg (lb) ~5,000 (11,023)
Length, m (ft) 10 (33)
Wingspan, m (ft) 7.3 (24)

Vehicle Type Horizontal takeoff, horizontal landing
Year Launch Operations Begin 2013
Seats Pilot: 1 Participant: 1
Price $95,000 per seat

	Lynx Mark I	Lynx Mark II	Lynx Mark III
Introduction year	2013	2014	2015-2016
Length, m (ft)	10 (33)	10 (33)	10 (33)
Wingspan, m (ft)	7.3 (24)	7.3 (24)	7.3 (24)
Mass, kg (lb)	4,850 (10,692)	5,000 (11,023)	TBD
Cargo capacity, kg (lb)	120 (265)	120 (265)	770 (1,698)
Apogee, km (mi)	61 (38)	100+ (62+)	100+ (62+)
Time in microgravity	~1 minute	~3 minutes	~3 minutes
Flight duration	25-30 minutes	25-30 minutes	25-30 minutes
Propellant	LOX/Kerosene (RP-1)	LOX/Kerosene (RP-1)	--
Total thrust, kN (lbf)	51.6 (11,600)	51.6 (11,600)	--
Engine(s)	4 x XR5K18	4 x XR5K18	--
Engine manufacturer	XCOR	XCOR	XCOR
Engine thrust, kN (lbf)	12.9 (2,900)	12.9 (2,900)	--

NEW SHEPARD

Blue Origin



New Shepard

Blue Origin, founded in 2000, is developing a vertical takeoff and vertical landing (VTVL) suborbital vehicle named the New Shepard. The system includes a Crew Capsule capable of carrying three or more astronauts plus a separate Propulsion Module. After accelerating for approximately two and a half minutes, the Propulsion Module will shut down and separate from the Crew Capsule. The Propulsion Module will perform an autonomous rocket-powered vertical landing. The Crew Capsule will land with the assistance of parachutes.

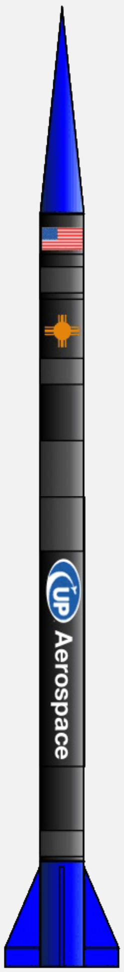
Operator	Blue Origin
Company Headquarters	USA
Manufacturer	Blue Origin
Launch Site	Van Horn, Texas

Length, m (ft)	15 (49.2)
Diameter, m (ft)	~5 (16.4)
Engine	BE-3
Engine Manufacturer	Blue Origin
Thrust, kN (lbf)	444.8 (100,000)
Propellant	LOX/LH_2

Vehicle Type	Vertical takeoff, vertical landing
Seats	Participants: 3
Apogee, km (mi)	100 (62)

SpaceLoft

UP Aerospace



SpaceLoft

UP Aerospace operates the SpaceLoft launch platform. The SpaceLoft is an operational, single-stage unguided rocket; the vehicle takes off vertically and lands via parachute. The SpaceLoft can transport up to 36 kilograms (79 pounds) of payloads to a standard mission altitude of 115 kilometers (71.5 miles). Customers can select options from among a collection of standardized payload modules that provide power and command circuitry.

Since its inaugural launch in September 2006, SpaceLoft has launched a total of six times. UP Aerospace is headquartered in Denver, Colorado, with launch facilities at Spaceport America in New Mexico.

Payload accommodations	Length, cm (in)	Diameter, cm (in)
NC-1	35.6 (14)	8.4 (3.3)
NC-2	34.3 (13.5)	15.9 (6.3)
NC-3	21.6 (8.5)	20.3 (8)
PTS4-X	8.3 (3.3)	24.8 (9.8)
PTS10-X	23.5 (9.3)	24.8 (9.8)

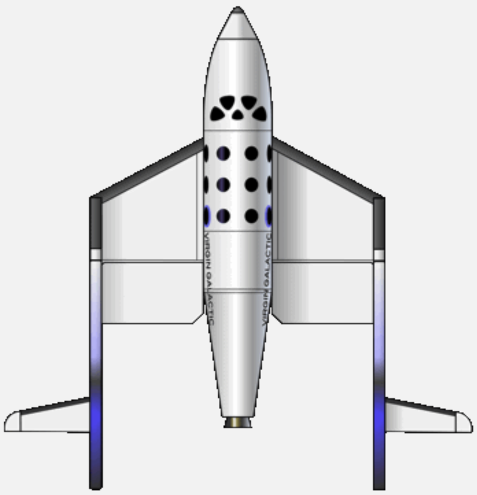
Operator	UP Aerospace
Company Headquarters	USA
Manufacturer	UP Aerospace
Launch Site	Spaceport America

Mass, kg (lb)	354 (780)
Length, m (ft)	6.1 (20)
Diameter, m (ft)	0.26 (0.85)
Engine	1 x UPA-264-C
Engine Manufacturer	Cesaroni Technologies
Thrust, kN (lbf)	36.6 (8,228)
Propellant	Solid

Vehicle Type	Vertical takeoff, parachute recovery
Year Launch Operations Began	2006
Cargo Capacity, kg (lb)	36 (79)
Apogee, km (mi)	160 (99)
Time in Microgravity	~4 minutes
Flight Duration	~13 minutes

SpaceShipTwo

Virgin Galactic



SpaceShipTwo

Virgin Galactic is developing the reusable suborbital vehicle SpaceShipTwo. Scaled Composites designed, built, and tested SpaceShipTwo. The Spaceship Company will build future production vehicles. SpaceShipTwo is twice as large, but uses the same basic technology, carbon composite construction, and design as SpaceShipOne, which won the Ansari X PRIZE in 2004 and was the world's first privately built vehicle flown into space.

The vehicle is air-launched at approximately 15,240 meters (50,000 feet) from the carrier aircraft WhiteKnightTwo. Powered by a hybrid rocket motor, SpaceShipTwo will follow a typical ballistic arc. The vehicle will use a "feathering" system for reentry, followed by a glide runway landing.

	1st Stage	2nd Stage
Stage designation	WhiteKnightTwo (Eve)	SpaceShipTwo
Length, m (ft)	24 (78.7)	18.3 (60)
Wingspan, m (ft)	42.7 (140)	8.2 (27)
Manufacturer	Scaled Composites	The Spaceship Company
Propellant	Jet A-1 (kerosene)	N_2O/HTPB solid
Total thrust, kN (lbf)	123.3 (27,706)	266.9 (60,000)
Engine(s)	4 x PW308A	1 x RocketMotorTwo
Engine manufacturer	Pratt & Whitney Rocketdyne	Sierra Nevada Corp.
Engine thrust, kN (lbf)	30.7 (6,904)	266.9 (60,000)

Operator
Virgin Galactic

Company Headquarters
USA

Manufacturer
The Spaceship Company

Launch Site
Spaceport America

Mass, kg (lb)
54,431 (120,000) est.

Length, m (ft)
24 (78.7)

Wingspan, m (ft)
42.7 (140)

Vehicle Type
Horizontal takeoff, horizontal landing

Year Launch Operations Begin
2014

Seats
Pilots: 2
Participants: 6

Price
$200,000 per seat

Cargo Capacity, kg (lb)
600 (1,323)

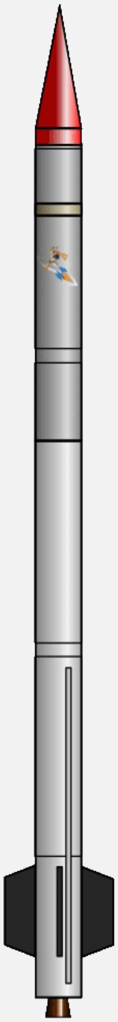
Apogee, km (mi)
110 (68.4)

Time in Microgravity
5 minutes

Flight Duration
~120 minutes

STIG-B

Armadillo Aerospace



STIG-B

Armadillo Aerospace is developing two suborbital reusable vehicles, the Suborbital Transport Inertially Guided (STIG) (not crewed) and Hyperion (crewed). The STIG family of vehicles are reusable, un-crewed, vertical takeoff, parachute recoverable suborbital vehicles. STIG-B is a larger version of the company's STIG-A vehicle and is capable of launching 50-kilogram (110-pound) payloads to an altitude of 100 kilometers (62 miles).

In October 2012, STIG-B performed the first licensed launch from Spaceport America.

Operator Armadillo Aerospace
Company Headquarters USA
Manufacturer Armadillo Aerospace
Launch Site Spaceport America

Length, m (ft) 10.6 (35)
Diameter, m (ft) 0.5 (1.6)
Engine Manufacturer Armadillo Aerospace
Propellant LOX/ethanol

Vehicle Type Vertical takeoff, parachute recovery
Year Launch Operations Began 2012
Cargo Capacity, kg (lb) 50 (110)
Apogee, km (mi) 100 (62)
Time in Microgravity ~4 minutes
Flight Duration ~20 minutes

XAERO

Masten Space Systems

Xaero

Masten currently offers the Xaero suborbital vehicle for payload flights. Xogdor will be the next vehicle and is currently in development. Masten intends to later develop a reusable suborbital production vehicle called the Extreme Altitude 1.0 (XA-1.0). Masten Space Systems is located in Mojave, California.

Xaero and Xogdor are both vertical takeoff, vertical landing (VTVL), uncrewed vehicles. Xaero is designed to reach 30-kilometer (18.6-mile) altitudes with a 10-kilogram (22-pound) payload, whereas Xogdor will be capable of reaching 100 kilometers.

The exact design and performance metrics for the XA-1.0 are still notional.

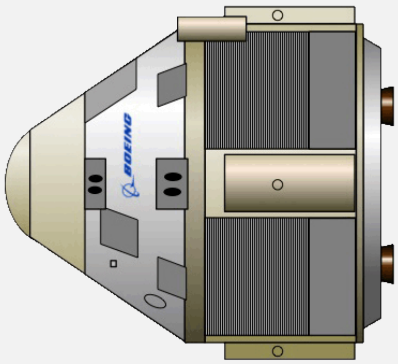
Operator	Masten Space Systems
Company Headquarters	USA
Manufacturer	Masten Space Systems
Launch Site	Mojave Air and Space Port

Length, m (ft)	3.6 (12)
Engine Manufacturer	Master Space Systems
Propellant	LOX/alcohol

Vehicle Type	Vertical takeoff, parachute recovery
Cargo Capacity, kg (lb)	10 (22)
Apogee, km (mi)	30.5 (19)
Flight Duration	5 to 6 minutes

CST-100

Boeing



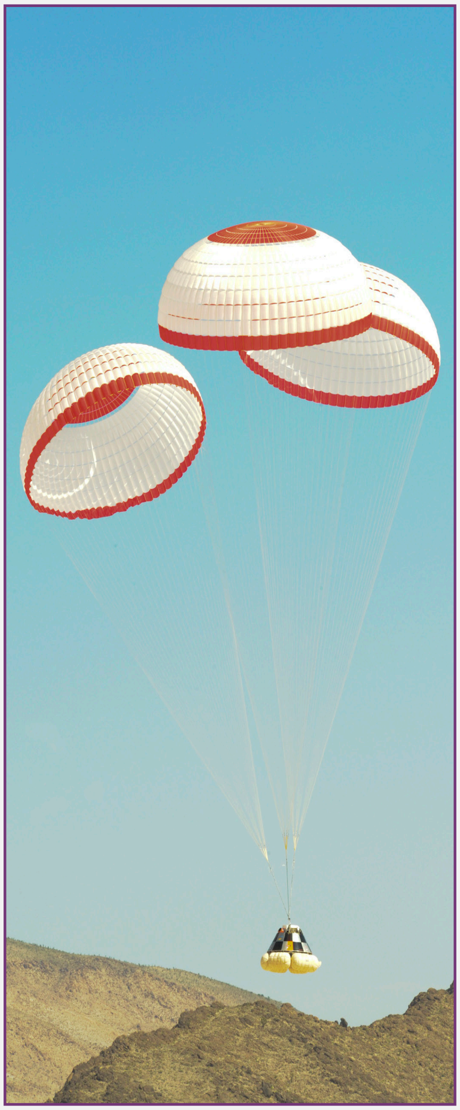
CST-100

Crew Space Transportation (CST)-100 is a reusable capsule consisting of a crew module and service module. It is designed for transportation of up to seven crew or a combination of people and cargo to and from low Earth orbit. CST-100 is designed to be reused up to 10 times and includes a launch escape system.

The CST-100 design uses proven flight components from heritage systems, such as an Apollo parachute system and Orion's airbag landing system. CST-100 will launch initially on the Atlas V launch vehicle, but the design is compatible with a variety of launch vehicles. Boeing plans to have CST-100 operational in 2016.

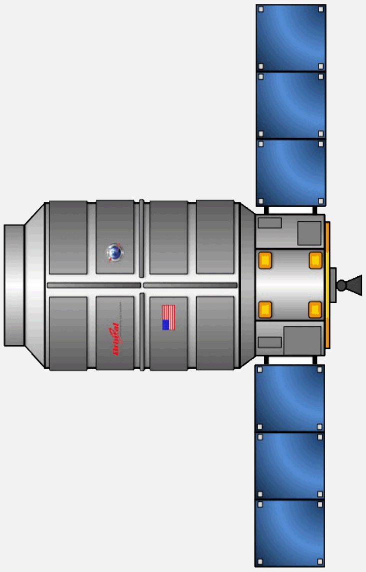
	CST-100
Vehicle type	Crewed, reusable
Crew	7
Length, m (ft)	5 (16.4)
Diameter, m (ft)	4.6 (15.1)
Propulsion	4 x thruster units (service module) 12 x thrusters (command module) 4 x RS-88 abort engines
Propellant	LOX/alcohol

Operator Boeing
Company Headquarters USA
Manufacturer Boeing
Launch Site CCAFS (SLC-41)
Launch Vehicle Atlas V
Landing Type Parachute splashdown
Year Operations Begin ~2016



CYGNUS

Orbital Sciences Corp.



Cygnus

Orbital Sciences Corporation offers the Cygnus, an advanced maneuvering spacecraft designed to transport pressurized cargo to the International Space Station. NASA selected Orbital to develop the Cygnus under the agency's Commercial Crew and Cargo Program. In addition, NASA awarded Orbital a Commercial Resupply Services contract totalling $1.9 billion to provide at least eight cargo resupply missions to the ISS.

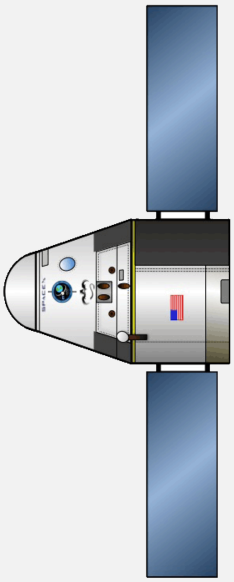
The Cygnus system consists of a service module based on Obital's LEOStar and GEOStar and a pressurized cargo module based on the multipurpose pressurized logistics module for the ISS developed by Thales Alenia Space. Once the Cygnus undocks from the ISS, it can stay in orbit for two years before it is programmed to reenter.

Operator Orbital Sciences Corp.
Company Headquarters USA
Manufacturer Orbital Sciences Corp. Thales Alenia Space
Launch Site MARS (Pad 0-A)
Launch Vehicle Antares
Landing Type Non-recoverable
Year Operations Begin 2013

	Standard Cygnus	Enhanced Cygnus
Vehicle type	Cargo, expendable	Carge, expendable
Length, m (ft)	5.7 (18.7)	6.9 (22.6)
Diameter, m (ft)	3.1 (10.2)	3.1 (10.2)
Up mass, kg (lb)	2,000 (4,409.2)	2,700 (5,952.5)
Pressurized cargo volume, m^3 (ft^3)	18.8 (663.9)	27 (953.5)
Flight duration	1 week - 2 years	1 week - 2 years
Propulsion	1 x main engine, 4 x thrusters	1 x main engine, 4 x thrusters
Propellant	N_2H_4/MON-3	N_2H_4/MON-3
Power, kW (peak)	3.5	3.5

DRAGON

SpaceX



Dragon

Dragon is a free-flying reusable spacecraft designed to take pressurized cargo, unpressurized cargo, and/or a crew of seven to and from low Earth orbit. The crewed version is almost identical to the cargo version, but includes a life support system, crew escape system, and onboard controls for the crew to take over from the flight computer when needed. SpaceX began developing Dragon internally in 2005. In 2006, the company received NASA funding for Dragon's development and operation under the COTS program. In addition, NASA awarded SpaceX a CRS contract totaling $1.6 billion to provide at least 12 cargo resupply missions to the ISS. SpaceX has also secured funding from NASA for its efforts to develop Dragon's crew capabilities, through the CCDev-2 program in 2011 and the CCiCap program in 2012. Combined, these two awards amount to $515 million.

Operator
SpaceX

Company Headquarters
USA

Manufacturer
SpaceX

Launch Site
CCAFS (SLC-40)

Launch Vehicle
Falcon 9

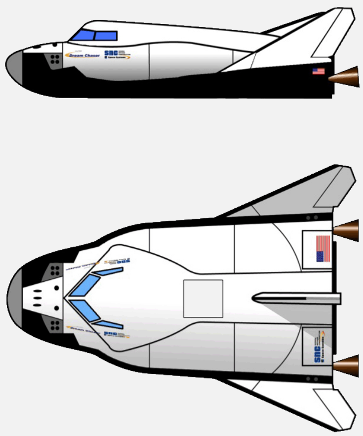
Landing Type
Parachute splashdown

Year Operations Begin
Dragon Cargo: 2012
Crew Dragon: 2015

	Dragon Cargo	Crew Dragon
Vehicle type	Cargo, reusable	Crewed, reusable
Crew	0	7
Length, m (ft)	4.4 (14.4)	4.4 (14.4)
Diameter, m (ft)	3.6 (11.8)	3.6 (11.8)
Up mass, kg (lb)	6,000 (13,228)	--
Down mass, kg (lb)	3,000 (6,614)	--
Pressurized cargo volume, m^3 (ft^3)	10 (353)	--
Unpressurized cargo volume, m^3 (ft^3)	14 (490)	--
Flight duration	1 week - 2 years	--
Propulsion	18 x Draco thrusters	18 x Draco thrusters
Propellant	NTO/MMH	NTO/MMH
Power, kW (peak)	4	--

Dream Chaser

Sierra Nevada Corp.



Dream Chaser

Dream Chaser is a reusable, piloted lifting-body spacecraft designed to fly up to seven crew and cargo to and from LEO using non-toxic propellant. Dream Chaser will launch vertically on an Atlas V launch vehicle, conduct operations in low Earth orbit, and ultimately dock to the International Space Station. Following completion of its mission, Dream Chaser will deorbit, experience a low-g reentry (<1.5 gs), and glide to a horizontal landing on a conventional runway.

The design of Dream Chaser derives from NASA's HL-20 experimental aircraft concept. The onboard propulsion system is derived from Sierra Nevada Corporation's SpaceShipOne and SpaceShipTwo hybrid rocket motor technology. Dream Chaser will complete its first glide test in early 2013.

Operator	Sierra Nevada Corp.
Company Headquarters	USA
Manufacturer	Sierra Nevada Corp.
Launch Site	CCAFS (SLC-41)
Launch Vehicle	Atlas V
Landing Type	Horizontal landing
Year Operations Begin	~2016

	Dream Chaser
Vehicle type	Crewed, reusable
Crew	7
Length, m (ft)	9 (29.5)
Wingspan, m (ft)	7 (23)
Pressurized cargo volume, m³ (ft³)	16 (565)
Flight duration	210 days
Propulsion	2 x hybrid motors
Propellant	HTBP/N_2O

California Spaceport Vandenberg Air Force Base

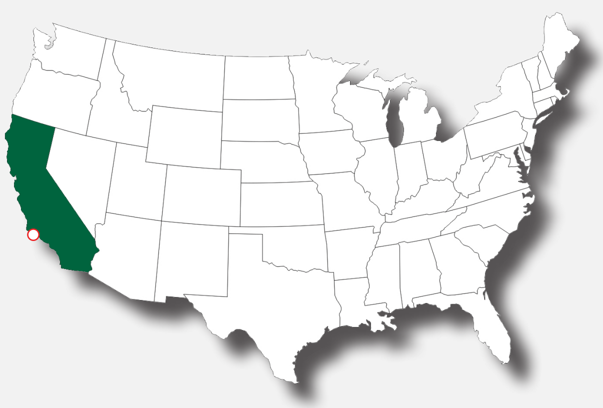
SSI

U.S. Air Force

Spaceport Systems International (SSI), established in 1993, operates California Spaceport (CSP), which is located on California's central coast. The spaceport is a commercial launch facility and satellite processing facility on Vandenberg Air Force Base (VAFB). In 1996, the FAA issued the first Commercial Space Launch Site Operator's License to the spaceport. SSI received this license one year after signing a 25-year lease with the Air Force to provide commercial launch services from a 100-acre plot on VAFB property. The lease also included a payload processing facility that was originally built for the Space Shuttle program.

VAFB is the only location in the United States where both commercial and government polar orbiting satellites are launched. The Pegasus, Taurus, Minotaur, Atlas V, and Delta IV vehicles launch polar orbiting satellites from VAFB. SpaceX plans to launch its Falcon 9 vehicle from VAFB in 2013. VAFB also launches intercontinental ballistic missiles. The base started as a U.S. Army training center, Camp Cooke, in 1941, and was officially transferred to the U.S. Air Force in 1957.

Location
California
Owner/Operator
CSP: SSI VAFB: USAF
Launch Site Type
CSP: FAA licensed VAFB: Federal (military)
Year Established
California Spaceport: 1996 VAFB: 1941
Number of Launch Events
California Spaceport: 11 VAFB: 646
Description
Active orbital and suborbital launch site and headquarters of the Air Force's 30th Space Wing that manages the Western Range. SLC-8 is a commercial launch site co-located at VAFB.
Key Facilities
CSP: SLC-8 (Minotaur) ***VAFB:*** SLC-2E/W (Delta II) SLC-3E (Atlas V) SLC-3W (Falcon 9) SLC-6 (Delta IV) SLC-576E (Taurus) 12/30 (4,572-meter runway)



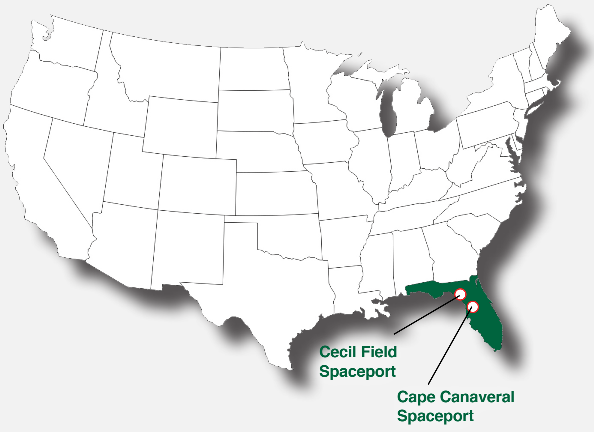
CAPE CANAVERAL SPACEPORT
CECIL FIELD SPACEPORT

Space Florida

Space Florida manages two launch sites. Cape Canaveral Spaceport (CCS) is co-located at Cape Canaveral Air Force Station. It also manages a hangar at NASA's Kennedy Space Center for suborbital reusable vehicles. Cecil Field Spaceport (CFS) is co-located at Cecil Airport near Jacksonville.

Space Florida, using a $500,000 grant from the State of Florida, is refurbishing SLC-46, which has not been used for launches since 1999. The site will support launches of Lockheed Martin's new Athena III and Orbital's Minotaur and Taurus. Space Florida is also configuring SLC-36 for suborbital launches similar to SLC-47. In May 2011, Masten Space Systems and Space Florida signed a $400,000 contract for Masten to perform vertical launches from SLC-36A. Recently completed construction includes a processing facility, launch control center, and launch pad.

Location Florida
Owner/Operator Space Florida
Launch Site Type CCS: FAA licensed CFS: FAA licensed
Year established CCS: 1999 CFS: 2010
Number of Orbital Launch Events CCS: 2
Description Cape Canaveral Spaceport supports commercial orbital and suborbital launches. Cecil Field Spaceport supports commercial suborbital activity.
Key Facilities ***CCS:*** Business Incubator SLC-36 SLC-46 (Athena, Minotaur) SLC-47 (suborbital) Exploration park Operation Storage Facility RLV Hangar Space Life Sciences Lab Sea port ***CFS:*** 9L/27R (2,439-meter runway 9R/27L (2,439-meter runway) 18L/36R (3,811-meter runway) 18R/36L (2,439-meter runway)



Cape Canaveral AFS
Kennedy Space Center

U.S. Air Force

NASA

Together, the Air Force's Cape Canaveral Air Force Station (CCAFS) and NASA's Kennedy Space Center (KSC) represent the most active orbital launch location in the United States. Commercial and government launches take place from CCAFS, while human spaceflight missions managed by NASA take place from KSC's Launch Complex 39.

Both launch sites include a large variety of payload and vehicle processing facilities, hazardous materials storage, liquid fueling systems, and access to rail, air, and sea transportation.

KSC is preparing facilities for NASA's forthcoming Space Launch System and Orion crewed capsule. It is also working with Space Florida to lease facilities for commercial use.

Location Florida
Owner/Operator CCAFS: USAF KSC: NASA
Launch Site Type CCAFS: Federal (military) KSC: Federal (civil)
Year Established CCAFS: 1948 KSC: 1962
Number of Orbital Launch Events CCAFS: 671 KSC: 151
Description Main orbital launch site for the United States since 1958. Headquarters of the Air Force's 45th Space Wing that manages the Eastern Range with support from NASA WFF. KSC has been the center of NASA's human spaceflight activity since the mid-1960s.
Key Facilities ***CCAFS***: SLC-37 (Delta IV) SLC-40 (Falcon 9) SLC-41 (Atlas V) 13/31 (3,048-meter skid strip) Sea port ***KSC:*** LC-39A LC-39B 15/33 (4,572-meter runway) Sea port

Kodiak Launch Complex

Alaska Aerospace Corporation

Location
Alaska

Owner/Operator
Alaska Aerospace Corporation

Launch Site Type
FAA licensed

Year Established
1998

Number of Orbital Launch Events
3

Description
Kodiak Launch Complex was the first commercial launch site located outside a federal facility. Launch site for military, government, and commercial telecommunications, remote sensing, and space science payloads.

Key Facilities
LP-1 (Athena)
LP-2 (missile testing)
Control and management center
Payload processing facility
Spacecraft transfer facility
Solid motor storage

Kodiak Launch Complex (KLC) is the first FAA-licensed launch site not co-located on a federally controlled launch site. Kodiak has one launch pad (LP-1) that can launch intermediate-class payloads to LEO or polar orbits. The complex also has a suborbital launch pad (LP-2) for missile testing.

In 2010, Lockheed Martin announced the revival of the Athena launch vehicle family and highlighted KLC as a launch site for the vehicles. Development of a new launch pad for the Athena III began in 2012. In October 2010, the FAA awarded $227,195 to the Alaska Aerospace Corporation as part of the Space Transportation Infrastructure Matching (STIM) Grants Program for construction of a rocket motor storage facility.

Mid-Atlantic Regional Spaceport Wallops Flight Facility

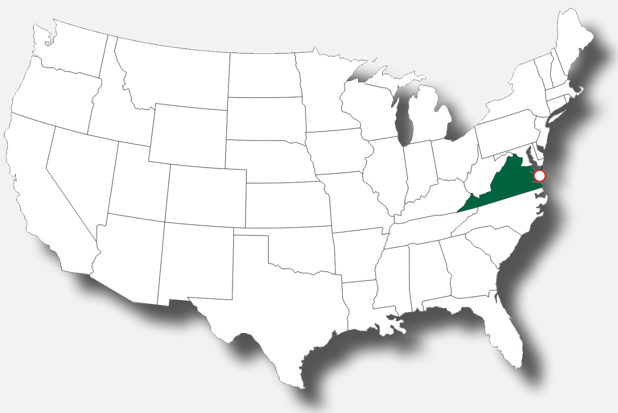
VCSFA
NASA

Location
Virginia
Owner/Operator
MARS: VCSFA WFF: NASA
Launch site type
MARS: FAA licensed WFF: Federal (civil)
Year established
MARS: 1997 WFF: 1945
Number of orbital launch events
MARS: 4 WFF: 28
Description
WFF is a federally funded research, development, and testing facility supporting vertical launch and aircraft-based launches. MARS is a commercial spaceport co-located at WFF supporting vertical and horizontal space launch activities.
Key facilities
MARS Pad 0-A Pad 0-B ***WFF*** Three launch pads Two launchers Runway for unmanned aerial systems 11 assembly and processing facilities Solid motor storage Liquid fueling facilities

The Virginia Commercial Space Flight Authority (VCSFA) was created in 1995. VCSFA began its lease at Wallops Island in 1997 and expanded the Mid-Atlantic Regional Spaceport (MARS) facilities to its present state, with two launch facilities (one mid-class and one small-class launch facility). Through agreements with NASA, VCSFA also added access to support infrastructure facilities, such as vehicle and payload processing integration facilities and instrumentation and emergency facilities. In 2011, VCSFA received an FAA $125,000 Space Transportation Infrastructure Grant for security and remote monitoring improvements at MARS.

NASA's WFF is the primary provider of NASA's science suborbital and small orbital flight programs. Annually, WFF conducts approximately 30 sounding rocket missions from this and other sites worldwide. It also conducts about 20 balloon missions per year and several hundred hours of piloted and unpiloted aircraft missions. WFF also manages the Wallops Research Range (WRR), consisting of the launch range, mobile range, and research airport.

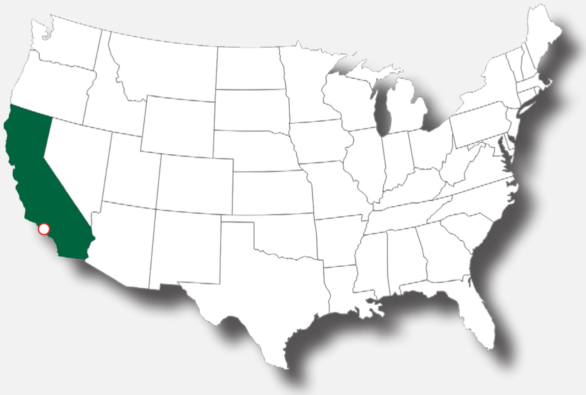
WRR has conducted more than 16,000 launches over its 65-year history and annually supports approximately 20 suborbital launches.



Mojave Air and Space Port

East Kern Airport District

Location
California
Owner/Operator
East Kern Airport District
Launch Site Type
FAA licensed
Year Established
2004
Description
Mojave Air and Space Port is a site used for flight testing, space industry development, and aircraft heavy maintenance and storage.
Key Facilities
12/30 (3,810-meter runway) 8/26 (2,148-meter runway) 4/22 (1,202-meter runway) Dedicated space vehicle areas



The Mojave Air and Space Port is an aerospace test center and spaceport operated by the East Kern Airport District in the Mojave Desert. High-performance aircraft were tested at Edwards Air Force Base in the Mojave desert.

Sixty companies operate out of Mojave, including Scaled Composites, XCOR Aerospace, Masten, and Interorbital Systems. Companies are currently designing, building, and testing small suborbital reusable vehicles on site.

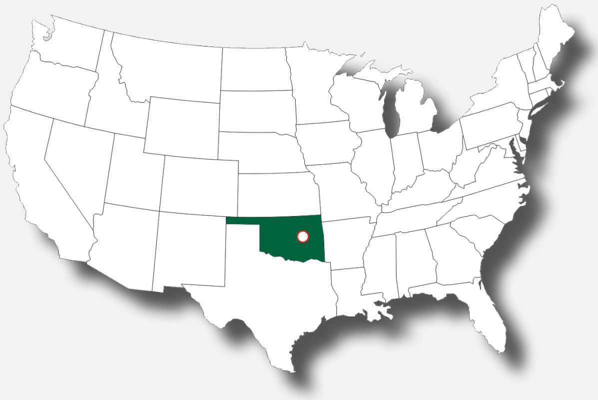
East Kern Airport District has been awarded three FAA Space Transportation Infrastructure Matching (STIM) grants since 2010, totalling $273,750 for aquisition of an emergency rescue vehicle, development of a supplemental environmental assessment, and the purchase of specialized firefighting equipment.

Oklahoma Spaceport

Oklahoma Space Industry Development Authority

Location Oklahoma
Owner/Operator OSIDA
Launch Site Type FAA licensed
Year Established 2006
Description Provides launch and support services for horizontally launched suborbital RLVs.
Key Facilities 17R/35L (4,116-meter runway) 17L/35R (1,583-meter runway)

Oklahoma Spaceport is managed by the Oklahoma Space Industry Development Authority (OSIDA). The site is located near the community of Burns Flat. It is part of what is also known as the Clinton-Sherman Industrial Airpark.

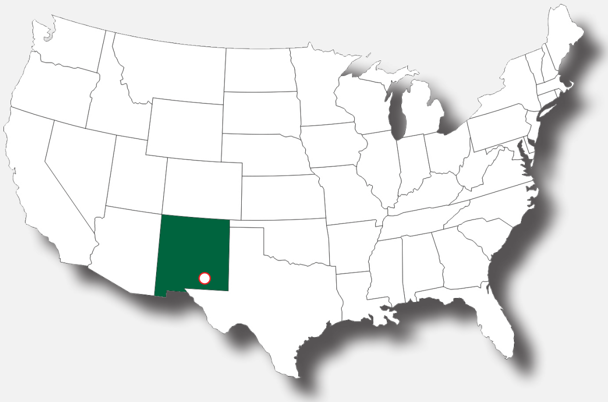


In March 2010, using $380,000 in FAA grants, OSIDA installed precision approach path indicator systems for the spaceport's two runways and replaced the old rotating airport beacon. OSIDA will install runway and taxi way signage and runway end identifier lights, using a $600,000 FAA grant received in August 2011. OSIDA plans to build a spaceport operations control center along with new perimeter fencing and security gates completely enclosing the facility.

Spaceport America

New Mexico Spaceport Authority

Location New Mexico
Owner/Operator NMSA
Launch Site Type FAA licensed
Year Established 2008
Description Spaceport America is a commercial spaceport that supports vertical and horizontal space launch activity.
Key Facilities Main terminal building Hangar Visitor center (in development) UP Aerospace launch pad 16/34 (3,048-meter runway)



Spaceport America is the world's first purpose-built, commercial spaceport. The site is located in Sierra County, near the city of Truth or Consequences, New Mexico.

Virgin Galactic, the anchor tenant, signed a 20-year lease agreement immediately after issuance of the license. The main terminal hangar is capable of housing two WhiteKnightTwo aircraft and five Virgin Galactic SpaceShipTwo spacecraft.

In September 2010, the FAA awarded the New Mexico Spaceport Authority (NMSA) $43,000 to provide an Automated Weather Observing System, as part of the FAA's Space Transportation Infrastructure Matching Grants Program. NMSA was also awarded an FAA grant worth nearly $250,000 in August 2011, for constructing a rollback integration building that can be used to prepare space vehicles for vertical launches. The spaceport is entirely financed by the taxpayers of New Mexico, with an estimated cost of $209 million.

The spaceport's first FAA-licensed launch occurred in October 2012.

2012 WORLDWIDE ORBITAL LAUNCH EVENTS

Date		Vehicle	Site		Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l Price	L	M
9-Jan-12		Long March 4B	Taiyuan		Ziyuan 3	SSO	China State Bureau of Surveying & Mapping	CAST	Remote Sensing		S	S
				*	Vesselsat 2	LEO	ORBCOMM	LuxSpace Sarl (OHB)	Communications			S
13-Jan-12		Long March 3A	Xichang		Feng Yun 2F	GEO	China State Meteorological Administration	Shanghai Institute of Satellite Engineering	Meteorological		S	S
20-Jan-12		Delta IV Medium +(5, 4)	CCAFS		WGS 4	GEO	U.S. Air Force	Boeing	Communications		S	S
25-Jan-12		Soyuz	Baikonur		Progress M-14M (ISS 46P)	LEO	Roscosmos	RSC Energia	ISS		S	S
3-Feb-12		Safir 2	Semnan Providence		Navid-e Elm-o Sanat	LEO	Government of Iran	Sharif University of Technology	Remote Sensing		S	S
13-Feb-12		Vega	Kourou		LARES	LEO	Italian Space Agency	CGS S.p.A.	Scientific		S	S
					PW-Sat 1	LEO	Warsaw Polytech	Warsaw Polytech	Development			S
					XaTcobeo	LEO	University of Vigo	University of Vigo	Development			S
					Robusta	LEO	University of Montepellier II	University of Montepellier II	Development			S
					e-St@r	LEO	Polytechnic University of Turin	Polytechnic University of Turin	Development			S
					Goliat	LEO	University of Bucharest	University of Bucharest	Remote Sensing			S
					ALMASAT	LEO	University of Bologna	University of Bologna	Development			S
					MaSat 1	LEO	Budapest University of Technology and Economics	Budapest University of Technology and Economics	Development			S
					Unicubesat GG	LEO	University of Rome	University of Rome	Scientific			S
14-Feb-12	V	Proton M	Baikonur	*	SES 4	GEO	SES World Skies	Space Systems/Loral	Communications	$85M	S	S
24-Feb-12		Atlas V 551	CCAFS		MUOS 1	GEO	U.S. Navy	Lockheed Martin Corp.	Communications		S	S
24-Feb-12		Long March 3C	Xichang		Beidou 2-G5	GEO	People's Liberation Army	Dongfanghong Satellite Co.	Navigation		S	S
23-Mar-12		Ariane 5 ES-ATV	Kourou		ATV 3	LEO	European Space Agency	European Space Agency	ISS		S	S
25-Mar-12	V	Proton M	Baikonur	*	Intelsat 22	GEO	Intelsat	Boeing Satellite Systems	Communications	$85M	S	S
30-Mar-12		Proton K	Baikonur		Cosmos 2479	GEO	Russian Space Forces	NPO Lavotchkin	Early Warning		S	S
31-Mar-12	V	Long March 3B	Xichang	*	APSTAR 7	GEO	APT Satellite Co., Ltd.	Thales Alenia Space	Communications	$70M	S	S
3-Apr-12		Delta IV Medium-Plus (5, 2)	Vandenberg AFB		NRO L-25	SSO	NRO	Classified	Classified		S	S
12-Apr-12		Unha 3	Musudan-ri		Kwangmyongsong 3	LEO	Democratic People's Republic of Korea	Institute for Electronic War	Remote Sensing		F	F
20-Apr-12		Soyuz	Baikonur		Progress M-15M (ISS 47P)	LEO	Roscosmos	RSC Energia	ISS		S	S
23-Apr-12	V	Proton M	Baikonur	*	Yahsat 1B	GEO	Yah Satellite Communications Co.	EADS Astrium	Communications	$85M	S	S
26-Apr-12		PSLV XL	Satish Dhawan		Risat 1	SSO	ISRO	ISRO	Remote Sensing		S	S
29-Apr-12		Long March 3B	Xichang		Beidou 2C-M3	MEO	People's Liberation Army	CAST	Navigation		S	S
					Beidou 2C-M4	MEO	People's Liberation Army	CAST	Navigation			S
4-May-12		Atlas V 531	CCAFS		Advanced EHF 2	GEO	U.S. Department of Defense	Lockheed Martin Corp.	Communications		S	S
6-May-12		Long March 2D	Jiuquan		Tian Hui 1B	SSO	China National Space Administration	Dongfanghong Satellite Co.	Remote Sensing		S	S
10-May-12		Long March 4B	Taiyuan		Yaogan 14	SSO	People's Liberation Army	Shanghai Academy of Space Technology	Remote Sensing		S	S
					Tiantuo 1	SSO	People's Liberation Army	National University of Defense Technology	Scientific			S

Date			Vehicle	Site		Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l Price	L	M
15-May-12	√		Ariane 5 ECA	Kourou	*	JCSAT 13	GEO	Sky Perfect JSAT Group	Lockheed Martin Corp.	Communications	$220M	S	S
						Vinasat 2	GEO	Vietnam Telecom International	Lockheed Martin Corp.	Communications			S
15-May-12			Soyuz	Baikonur		Soyuz TMA-04M (ISS 30S)	LEO	Roscosmos	RSC Energia	Crewed		S	S
17-May-12			Soyuz U	Plesetsk		Cosmos 2480	LEO	Russian Space Forces	RSC Energia	Intelligence		S	S
17-May-12	√		Proton M	Baikonur	*	Nimiq 6	GEO	Telesat Canada	Space Systems/Loral	Communications	$85M	S	S
17-May-12			H IIA	Tanegashima		GCOM W1	SSO	JAXA	NEC Corp.	Scientific		S	S
						Arirang 3	SSO	KARI	KARI	Remote Sensing			S
						SDS 4	SSO	JAXA	JAXA	Development			S
						Horyu 2	SSO	Kyushu Institute of Technology	Kyushu Institute of Technology	Communications			S
22-May-12	√	+	Falcon 9	CCAFS	*	Dragon COTS Demo 2/3	LEO	SpaceX	SpaceX	Development	$54M	S	S
23-May-12			Safir 2	Semnan Providence		Fajr	LEO	Iranian Ministry of Defense	Iranian Ministry of Defense	Development		F	F
26-May-12			Long March 3B	Xichang		Chinasat 2A	GEO	People's Liberation Army	CAST	Communications		S	S
29-May-12			Long March 4C	Taiyuan		Yaogan 15	SSO	People's Liberation Army	Shanghai Academy of Space Technology	Remote Sensing		S	S
1-Jun-12	√	+	Zenit 3SL	Sea Launch Platform	*	Intelsat 19	GEO	Intelsat	Space Systems/Loral	Communications	$100M	S	S
13-Jun-12			Pegasus XL	Kwajalein Island		NuSTAR	LEO	NASA/JPL	Orbital Sciences Corp.	Scientific		S	S
16-Jun-12			Long March 2F	Jiuquan		Shenzhou 9 Descent Module	LEO	China Aerospace Corp.	CAST	Crewed		S	S
						Shenzhou 9 Orbital Module	LEO	China Aerospace Corp.	CAST	Development			S
20-Jun-12			Atlas V 401	Vandenberg AFB		NRO L-38	GEO	NRO	Boeing	Communications		S	S
29-Jun-12			Delta IV Heavy	CCAFS		NRO L-15	GEO	NRO	Unknown	Intelligence		S	S
5-Jul-12	√		Ariane 5 ECA	Kourou	*	Echostar XVII	GEO	Hughes Network Systems	Space Systems/Loral	Communications	$220M	S	S
						MSG 3	GEO	Eumetsat	Thales Alenia Space	Meteorological			S
9-Jul-12	√		Proton M	Baikonur	*	SES 5	GEO	SES World Skies	Space Systems/Loral	Communications	$85M	S	S
15-Jul-12			Soyuz	Baikonur		Soyuz TMA-05M (ISS 31S)	LEO	Roscosmos	RSC Energia	Crewed		S	S
21-Jul-12			H IIB	Tanegashima		HTV 3	LEO	JAXA	Mitsubishi Heavy Industries Ltd.	ISS		S	S
						F-1	LEO	Fspace Laboratory, FTP Tech Research	Fspace Laboratory, FTP Tech Research	Remote Sensing			S
						We-Wish	LEO	Meisei Electric Co. Ltd.	Meisei Electric Co. Ltd.	Development			S
						FitSat-1	LEO	Fukuoka Institute of Technology	Fukuoka Institute of Technology	Development			S
						TechEdSat	LEO	NASA Ames Research Center	NASA Ames Research Center	Communications			S
						RAIKO	LEO	Wakayama University	Wakayama University	Development			S
22-Jul-12			Soyuz	Baikonur		Kanopus B1	SSO	Roscosmos	VNIIEM	Remote Sensing		S	S
						Zond PP	SSO	Roscosmos	NPO Lavotchkin	Scientific			S
						ExactView 1	SSO	exactEARTH	COM DEV International	Remote Sensing			S
						TET-1	SSO	DLR	Kayser-Threde GmbH	Development			S
						Belka 2	SSO	National Academy of Sciences of Belarus	VNIIEM	Remote Sensing			S
25-Jul-12			Long March 3C	Xichang		Tianlian-1C	GEO	CAST	CAST	Communications		S	S
28-Jul-12			Rockot	Plesetsk		Cosmos 2481	LEO	Russian Space Forces	Reshetnev Co.	Communications		S	S
						Gonets M-03	LEO	SMOLSAT	Reshetnev Co.	Communications			S
						Gonets M-04	LEO	SMOLSAT	Reshetnev Co.	Communications			S
						MIR (Yubileyniy 2)	LEO	Reshetnev Co.	Reshetnev Co.	Communications			S

Date			Vehicle	Site		Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l Price	L	M
1-Aug-12			Soyuz	Baikonur		Progress M-16M (ISS 48P)	LEO	Roscosmos	RSC Energia	ISS		S	S
						SFERA-53	LEO	Roscosmos	Unknown	Development			S
2-Aug-12	√		Ariane 5 ECA	Kourou	*	HYLAS 2	GEO	Avanti Screenmedia Group	Orbital Sciences Corp.	Communications	$220M	S	S
					*	Intelsat 20	GEO	Intelsat	Space Systems/Loral	Communications			S
6-Aug-12			Proton M	Baikonur	*	Telkom 3	GEO	Telkom Indonesia	Reshetnev Co.	Communications	$85M	F	F
						Express MD2	GEO	Russian Satellite Communication Co.	Khrunichev State Research & Production Space Center	Communications			F
18-Aug-12	√	+	Zenit 3SL	Sea Launch Platform	*	Intelsat 21	GEO	Intelsat	Boeing Satellite Systems	Communications	$85M	S	S
30-Aug-12			Atlas V 401	CCAFS		Van Allen Probe A	ELI	NASA	APL	Scientific		S	S
						Van Allen Probe B	ELI	NASA	APL	Scientific			S
9-Sep-12			PSLV CA	Satish Dhawan	*	SPOT 6	SSO	SPOT Image	EADS Astrium	Remote Sensing		S	S
						mResins	SSO	ISRO	ISRO	Test			S
						Proiteres	SSO	Osaka Institute of Technology	Osaka Institute of Technology	Development			S
13-Sep-12			Atlas V 401	Vandenberg AFB		NRO L-36/NOSS 3-6A	LEO	NRO	Lockheed Martin Corp.	Intelligence		S	S
						NRO L-36/NOSS 3-6B	LEO	NRO	Lockheed Martin Corp.	Intelligence			S
						CXBN	LEO	Morehead State University	Morehead State University	Scientific			S
						AENEAS	LEO	U.S. Air Force	University of Southern California Space Research Center	Development			S
						CISSWE	LEO	University of Colorado	University of Colorado	Scientific			S
						CP 5	LEO	Cal Poly Aerospace Engineering	Cal Poly Aerospace Engineering	Development			S
						CINEMA 1	LEO	University of California, Berkeley	University of California, Berkeley	Scientific			S
						SMDC-ONE 2.1 (ABLE)	LEO	U.S. Army Space & Missile Defense Command	MILTECH	Development			S
						SMDC-ONE 2.2 (BAKER)	LEO	U.S. Army Space & Missile Defense Command	MILTECH	Development			S
						STARE A	LEO	Lawrence Livermore National Laboratory	Lawrence Livermore National Laboratory	Development			S
						AeroCube 4A	LEO	Aerospace Corp.	Aerospace Corp.	Development			S
						AeroCube 4B	LEO	Aerospace Corp.	Aerospace Corp.	Development			S
						AeroCube 4C	LEO	Aerospace Corp.	Aerospace Corp.	Development			S
						OUTSAT	LEO	NASA	NASA	Development			S
17-Sep-12			Soyuz 2 1A	Baikonur		MetOp B	SSO	Eumetsat	EADS Astrium	Meteorological		S	S
18-Sep-12			Long March 3B	Xichang		Beidou 2C-M5	MEO	People's Liberation Army	CAST	Navigation		S	S
						Beidou 2C-M6	MEO	People's Liberation Army	CAST	Navigation			S
22-Sep-12			Safir 2	Semnan Providence		Unknown	LEO	Iran	Iran	Unknown		F	F
28-Sep-12	√		Ariane 5 ECA	Kourou	*	Astra 2F	GEO	SES Astra	EADS Astrium	Communications	$220M	S	S
						GSAT 10	GEO	ISRO	ISRO	Communications			S
29-Sep-12			Long March 2D	Xichang		VRSS 1	SSO	Venezuelan Ministry of Science and Technology	China Great Wall Industry Corp.	Remote Sensing		S	S
4-Oct-12			Delta IV Medium+ (4,2)	CCAFS		Navstar GPS 2F-03	MEO	U.S. Air Force	Boeing	Navigation		S	S
7-Oct-12	√	+	Falcon 9	CCAFS	*	Dragon ISS 1D	LEO	SpaceX	SpaceX	ISS	$54M	S	S
					*	ORBCOMM OG2-01	LEO	ORBCOMM	Microsat Systems	Communications			F
12-Oct-12			Soyuz 2 1B	Kourou		Galileo 3	MEO	European Space Agency	EADS Astrium	Navigation		S	S
						Galileo 4	MEO	European Space Agency	EADS Astrium	Navigation			S

Date			Vehicle	Site		Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l Price	L	M
14-Oct-12	√		Proton M	Baikonur	*	Intelsat 23	GEO	Intelsat	Orbital Sciences Corp.	Communications	$85M	S	S
14-Oct-12			Long March 2C	Taiyuan		Shijian 9A	SSO	People's Liberation Army	Shanghai Academy of Space Technology	Development		S	S
						Shijian 9B	SSO	People's Liberation Army	Shanghai Academy of Space Technology	Development			S
23-Oct-12			Soyuz	Baikonur		Soyuz TMA-06M (ISS 32S)	LEO	Roscosmos	RSC Energia	Crewed		S	S
25-Oct-12			Long March 3C	Xichang		Beidou 2-G6	GEO	People's Liberation Army	Dongfanghong Satellite Co.	Navigation		S	S
31-Oct-12			Soyuz	Baikonur		Progress M-17M (ISS 49P)	LEO	Roscosmos	RSC Energia	ISS		S	S
2-Nov-12			Proton M	Baikonur		Luch 5B	GEO	Roscosmos	Reshetnev Co.	Communications	$85M	S	S
					*	Yamal 300K	GEO	Gazprom Space Systems	Reshetnev Co.	Communications			S
10-Nov-12	√		Ariane 5 ECA	Kourou	*	Star One C3	GEO	Star One	Orbital Sciences Corp.	Communications	$220M	S	S
					*	Eutelsat 21B	GEO	Eutelsat	Thales Alenia Space	Communications			S
14-Nov-12			Soyuz 2 1A	Plesetsk		Meridian 6	LEO	Russian Space Forces	Reshetnev Company	Communications		S	S
19-Nov-12			Long March 2C	Taiyuan		Huan Jing 1C	SSO	China National Space Administration	CAST	Remote Sensing		S	S
						Fengniao 1A	SSO	China National Space Administration	CAST	Development			S
						Fengniao 1B	SSO	China National Space Administration	Dongfanghong Satellite Co.	Development			S
						Xinyan-1	LEO	China National Space Administration	Dongfanghong Satellite Co.	Development			S
20-Nov-12	√		Proton M	Baikonur	*	Echostar XVI	GEO	Echostar Communications Corp.	Space Systems/Loral	Communications	$85M	S	S
25-Nov-12			Long March 4C	Jiuquan		Yaogan 16 Main	LEO	People's Liberation Army	CAST	Remote Sensing		S	S
						Yaogan 16 Subsat 1	LEO	People's Liberation Army	CAST	Remote Sensing			S
						Yaogan 16 Subsat 2	LEO	People's Liberation Army	CAST	Remote Sensing			S
27-Nov-12			Long March 3B	Xichang	*	APSTAR 7B (Chinasat 12)	GEO	APT Satellite Co., Ltd.	Thales Alenia Space	Communications		S	S
1-Dec-12			Soyuz 2	Kourou		Pleiades 1B (Pleiades HR 2)	SSO	CNES	Astrium Satellite Ltd.	Remote Sensing		S	S
3-Dec-12	√	+	Zenit 3SL	Sea Launch Platform	*	Eutelsat 70B	GEO	Eutelsat	EADS Astrium	Communications	$100M	S	S
8-Dec-12			Proton M	Baikonur	*	Yamal 402	GEO	Gazprom Space Systems	Thales Alenia Space	Communications	$85M	P	P
11-Dec-12			Atlas V 501	CCAFS		X-37B/OTV 3	LEO	U.S. Air Force	Boeing	Test		S	S
12-Dec-12			Unha 3	Musudan-ri		Kwangmyongsong 3-2	SSO	Democratic People's Republic of Korea	Institute for Electronic War	Remote Sensing		S	S
18-Dec-12	√		Long March 2D	Jiuquan		Gökturk 2	SSO	Turkish Military	TUBITAK-UZAY	Intelligence	$20M	S	S
19-Dec-12			Soyuz	Baikonur		Soyuz TMA-07M (ISS 33S)	LEO	Roscosmos	RSC Energia	Crewed		S	S
19-Dec-12	√		Ariane 5 ECA	Kourou		MexSat 3	GEO	Government of Mexico	Boeing	Communications	$220M	S	S
						SkyNet 5D	GEO	U.K. Ministry of Defense	Astrium Satellite Ltd.	Communications			S

√ Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed, or privately financed launch activity. For multiple manifested launches, certain secondary payloads whose launches were commercially procured may also constitute a commercial launch.
+ Denotes FAA-licensed launch.
* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.
L and M refer to the outcome of the Launch and Mission: S=Success, P=Partial Success, F=Failure.

Notes: All prices are estimates.
All launch dates are based on local time at the launch site.

DEFINITIONS

Commercial Suborbital or Orbital Launch

A commercial suborbital or orbital launch has one or more of these characteristics:

- The launch is licensed by FAA AST.
- The primary payload's launch contract was internationally competed (see definition of internationally competed below). A primary payload is generally defined as the payload with the greatest mass on a launch vehicle for a given launch.
- The launch is privately financed without government support.

Launch Failure

A launch failure happens when the payload does not reach a usable orbit (an orbit where some portion of the mission can be salvaged) or is destroyed as the result of a launch vehicle malfunction.

Internationally Competed

An internationally competed launch contract is one in which the launch opportunity was available in principle to any capable launch service provider. Such a launch is considered commercial.

Commercial Payload

A commercial payload has one or both of these characteristics:

- The payload is operated by a private company.
- The payload is funded by the government, but provides satellite service partially or totally through a private or semi-private company. This distinction is usually applied to certain telecommunications satellites whose transponders are partially or totally leased to a variety of organizations, some or all of which generate revenues. Examples include Russia's Express and Ekran series of spacecraft.

All other payloads are classified as non-commercial (government civil, government military, or non-profit).

Orbits

A spacecraft in geostationary Earth orbit (GSO) is synchronized with the Earth's rotation, orbiting once every 24 hours, and appears to an observer on the ground to be stationary in the sky. Geosynchronous (GEO) is a broader category used for any circular orbit at an altitude of 35,852 kilometers (22,277 miles) with a low inclination (i.e., near or on the equator).

Non-geosynchronous orbit (NGSO) satellites are those in orbits other than GEO. They are located in low Earth orbit (LEO, lowest achievable orbit to about 2,400 kilometers, or 1,491 miles), medium Earth orbit (MEO, 2,400 kilometers to GEO), SSO (Sun Synchronous Orbit), and all other orbits or trajectories. ELI ("elliptical") describes a highly elliptical orbit (such as those used for Russian Molniya satellites), and EXT ("external") describes trajectories beyond GEO (such as interplanetary trajectories).

Vehicle Mass Class

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.

ACRONYMS AND ABBREVIATIONS

ACS	Alcântara Cyclone Space
AEHF	Advanced Extreme High Frequency (EHF)
APT	APT Satellite Holdings Limited
ATK	Alliant TechSystems
ATV	Automated Transfer Vehicle
AVUM	Attitude and Vernier Upper Module
AWOS	Automated Weather Observing System
BEAM	Bigelow Expandable Activity Module
BLS	Boeing Launch Services
BTS	Bi-Propellant Third Stage
CALT	China Academy of Launch Vehicle Technology
CASC	China Aerospace Science and Technology Corporation
CBC	Common Booster Core
CCAFS	Cape Canaveral Air Force Station
CCB	Common Core Booster
CCDev	Commercial Crew Development
CCiCap	Commercial Crew Integrated Capability
CEO	Chief Executive Officer
CGWIC	China Great Wall Industry Corporation
CLF	Commercial Launch Facility
COE-CST	Center of Excellence for Commercial Space Transportation
COMSTAC	Commercial Space Transportation Advisory Committee
COO	Chief Operations Officer
COTS	Commercial Orbital Transportation Services
CPC	Certification Product Contract
CPM	Common Propulsion Modules
CRS	Commercial Resupply Services
CSLAA	Commercial Space Launch Amendments Act
CST-100	Crew Space Transportation (CST)-100
CTS	Crew Transportation System
DARPA	Defense Advanced Research Projects Agency
DoD	Department of Defense
EADS	European Aeronautic Defence and Space Company N.V.
EAR	Export Administration Regulations
EELV	Evolved Expendable Launch Vehicle Program
EFT	Exploration Flight Test
EIS	Environmental Impact Study
ELI	Elliptical Orbit
ESA	European Space Agency
EXT	External Orbit
FAA	Federal Aviation Administration
FAA AST	Federal Aviation Administration's Office of Commercial Space Transportation
FAR	Friends of Amateur Rocketry
FCC	Federal Communications Commission
FY	Fiscal Year
GEO	Geosynchronous Orbit
GMW	GeoMetWatch

GPS	Global Positioning System
GSO	Geostationary Earth Orbit
GTO	Geosynchronous Transfer Orbit
HALS	High Altitude Launch Service
HAPS	Hydrazine Auxiliary Propulsion System
HTHL	Horizontal takeoff Horizontal Landing
HTV	H-II Transfer Vehicle
HYLAS	Highly Adaptable Satellite
ICBM	Intercontinental Ballistic Missile
ILS	International Launch Services
IOS	Interorbital Systems
ISC Kosmotras	International Space Company Kosmotras
ISPCS	International Symposium for Personal and Commercial Spaceflight
ISS	International Space Station
ITAR	International Traffic in Arms Regulations
ITU	International Telecommunication Union
JAA	Jacksonville Aviation Authority
JAXA	Japan Aerospace Exploration Agency
JCSAT	Japan Communications Satellite
KOMPSAT	Korea Multi-Purpose Satellite
KSC	Kennedy Space Center
KSLV	Korean Space Launch Vehicle
LARES	Laser Relativity Satellite
LEO	Low Earth Orbit
LH2	Liquid Hydrogen
LLC	Limited Liability Company
LLS	Launch License
LMCLS	Lockheed Martin Commercial Launch Services
LOX	Liquid Oxygen
LRLO	Launch Operator License
LSO	Launch License Order
LSP	NASA Launch Services Program
MARS	Mid-Atlantic Regional Spaceport
Masten	Masten Space Systems
MEO	Medium Earth Orbit
MHI	Mitsubishi Heavy Industries
MPCV	Multi-Purpose Crew Vehicle
MSG	Meteosat Second Generation
MUOS	Mobile User Objective System
NASA	National Aeronautic and Space Administration
NASTAR	National Aerospace Training and Research (NASTAR) Center
NDAA	National Defense Authorization Act
NESDIS	National Environmental Satellite, Data, and Information Service
NGSO	Non-Geosynchronous Orbit
NLS	NASA Launch Services
NLV	Nanosat Launch Vehicle
NMSA	New Mexico Spaceport Authority

NOAA	National Oceanic and Atmospheric Administration
NPO Lavotchkin	Lavotchkin Research and Production Association, Russia
NPRM	Notice of Proposed Rulemaking
NRO	National Reconnaissance Office
Orbital	Orbital Sciences Corporation
ORS	Operationally Responsive Space
OSD	Office of the Secretary of Defense
OSIDA	Oklahoma Space Industry Development Authority
PCM	Pressurized Cargo Module
PMRF	Pacific Missile Range Facility
PWR	Pratt & Whitney Rocketdyne
RBS	Reusable Booster System
RBSP	Radiation Belt Storm Probes
RCS	Reaction Control System
RKK Energia	S.P. Korolev Rocket and Space Corporation Energia
RLS	Reentry License
RRV	Reusable Return Vehicle
SAA	Space Act Agreement
Sandia	Sandia National Laboratories
SAR	Small Aperture Radar
SAST	Shanghai Academy of Spaceflight Technology
SBIR	Small Business Innovation Research
SES	Société Européenne des Satellites
SLF	Space Shuttle Launch Facility
SLS	Space launch System
SNC	Sierra Nevada Corporation
SNL	Sandia National Laboratories
SpaceX	Space Exploration Technologies
SPARK	Spaceborne Payload Assist Rocket - Kauai
SRB	Solid Rocket Booster
SRV	Suborbital Reusable Vehicle
SSI	Spaceport Systems International
SSO	Sun-Synchronous Orbit
STIM Grants	Space Transportation Infrastructure Matching Grants
STTR	Small Business Technology Transfer
SXC	Space Expedition Corporation
TBA	To Be Announced
TBD	To Be Determined
UAE	United Arab Emirates
UCISAT	University of California, Irvine Satellite
ULA	United launch Alliance
USAF	United States Air Force
USML	U.S. Munitions List
VAFB	Vandenberg Air Force Base
VASIMR	Variable Specific Impulse Magnetoplasma Rocket
VCSFA	Virginia Commercial Space Flight Authority
VTVL	Vertical Takeoff Vertical Landing
WFF	Wallops Flight Facility
XA-1.0	Extreme Altitude 1.0
XCOR	XCOR Aerospace, Inc.

On February 24, 2012, a United Launch Alliance Atlas V 551 launched the MUOS 1 communications satellite into GEO.

Image credit: Lockheed Martin