Federal Aviation Administration

Quarterly Launch Report
2nd Quarter 2009

Featuring Launch Results from the 1st Quarter and
Forecasts for the 2nd and 3rd Quarter 2009

Special Report: Economic Benefits of the Development of Spaceport Infrastructure

Introduction

The *Second Quarter 2009 Quarterly Launch Report* features launch results from the first quarter of 2009 (January - March 2009) and forecasts for the second quarter of 2009 (April - June 2009) and the third quarter of 2009 (July - September 2009). This report contains information on worldwide commercial, civil, and military orbital and commercial suborbital space launch events. Projected launches have been identified from open sources, including industry contacts, company manifests, periodicals, and government sources. Projected launches are subject to change.

This report highlights commercial launch activities, classifying commercial launches as one or both of the following:

- Internationally-competed launch events (i.e., launch opportunities considered available in principle to competitors in the international launch services market);

- Any launches licensed by the Office of Commercial Space Transportation of the Federal Aviation Administration (FAA) under 49 United States Code Subtitle IX, Chapter 701 (formerly the Commercial Space Launch Act).

The FAA is changing to a half-year schedule for publishing the Launch Report. The next Launch Report will be published in October 2009.

Contents

Cover photo courtesy of United Launch Alliance (ULA) and Carleton Bailie Copyright © 2009. A ULA Delta IV Heavy vehicle lifts off from Cape Canaveral Air Force Station (CCAFS) on January 17, 2009. The mission, which carried the U.S. National Reconnaissance Office (NRO) payload NRO L-26, was the first orbital launch of 2009.

First Quarter 2009 Highlights

Virgin Galactic, Spaceport America finalize lease agreement

In early January, Virgin Galactic formally agreed to a 20-year lease as anchor tenant of Spaceport America, New Mexico's commercial spaceport. Under the agreement, Virgin Galactic will pay $1 million a year for the first five years of the lease, and after that a fee based on the amortization of the remaining cost of the spaceport's facilities. One of the provisions of the lease also requires Virgin Galactic to establish its world headquarters in the state. Virgin Galactic agreed in principle to operate from Spaceport America in 2005, but did not formalize the lease until January 2009. The agreement, along with the FAA launch site operator's license announced in December 2008, clears the way for the release of state money set aside for the spaceport.

Northrop Grumman merges space and aviation units

Also in January, Northrop Grumman announced a corporate reorganization that merged its space division with one that builds aircraft. As part of the reorganization the Space Technology division was combined with the Integrated Systems division, which is responsible for a number of manned and unmanned aircraft programs, to create a new Aerospace Systems division. The changes, intended to reduce costs and better align the company with its customers, took effect immediately.

EADS completes acquisition of Surrey Space Technology Ltd.

On January 13, the European Aeronautic Defence and Space Company (EADS) completed its acquisition of British smallsat developer Surrey Satellite Technology Ltd. (SSTL). Under the acquisition, SSTL remains an independent company focused on smallsats, but receives the financial backing of EADS, Europe's largest aerospace company.

Swedish Space Corporation to buy Universal Space Network

On January 21, the Swedish Space Corporation (SSC) announced its acquisition of Universal Space Network (USN), a US company that operates ground stations for spacecraft command and control. The two companies had cooperated since 1999 in operating PrioraNet, a combined global network of ground stations for satellite operations, and SSC already had a 12-percent stake in the company. Under the terms of the deal, USN will operate as a US-based subsidiary of SSC.

Eutelsat W2M satellite fails

In late January, Eutelsat announced that its satellite, Eutelsat W2M, had suffered a "major anomaly" in its power subsystem while in orbit awaiting activation. The satellite, launched in December 2008, had been set to replace the existing Eutelsat W2 geosynchronous (GEO) communications satellite. Due to the anomaly, Eutelsat considers the Eutelsat W2M satellite non-operational. A new satellite, Eutelsat W3B, is planned to replace Eutelsat W2 in mid-2010.

First Quarter 2009 Highlights

Iridium and Russian satellites collide in orbit

On February 10, an Iridium commercial communications satellite and the defunct Russian military satellite Kosmos 2251 collided in low Earth orbit (LEO). The collision, which took place about 790 kilometers (490 miles) above Siberia, created a debris cloud that has since been monitored to guard against potential damage to the International Space Station (ISS) and other spacecraft. Iridium has activated a spare already in orbit to replace the satellite that was destroyed.

NASA and ESA agree on missions to Jupiter moons

In February, the U.S. and European space agencies agreed on joint development of the Europa Jupiter System, a multibillion-dollar mission to Jupiter's moons. Under the agreement, NASA will build a spacecraft to study the icy moon Europa, while ESA will build a spacecraft to orbit Ganymede, Jupiter's largest moon. The two spacecraft are planned to launch in 2020 and arrive in 2026 for at least a three-year mission.

Orbiting Carbon Observatory launch fails

On February 24, a Taurus XL vehicle carrying the Orbiting Carbon Observatory (OCO) failed during launch when the rocket's payload fairing stage failed to separate properly. Instead of reaching orbit, the OCO spacecraft landed in the southern Pacific Ocean near Antarctica. The OCO payload, built by Orbital Sciences Corporation, was designed to monitor carbon dioxide in the atmosphere in order to track greenhouse gases.

New administration proposes $18.7-billion NASA budget

On February 26, the new Obama Administration outlined its proposed fiscal year (FY) 2010 budget for NASA. The plan would devote $18.7 billion to NASA in FY2010, almost a billion more than the $17.8 billion allocated under the current omnibus appropriations bill under consideration by Congress. Key aspects of the outlined budget included ongoing development of spacecraft capable of returning humans to the Moon by 2020, as well as increased Earth sciences research. NASA also received an additional $1 billion in funding under the February federal stimulus bill.

NASA awards launch contracts to ULA

In March, NASA awarded the United Launch Alliance contracts to launch four scientific missions between 2011 and 2014: the Radiation Belt Storm Probes, the Magnetospheric Multiscale missions, and the TDRS-K and TDRS-L satellites.

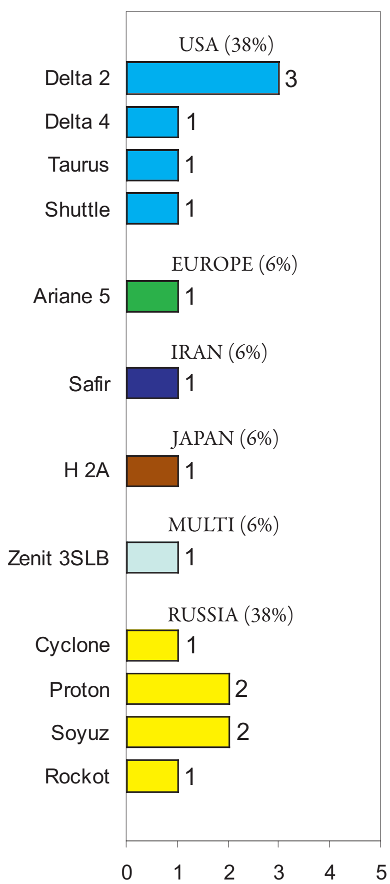
Space tourist makes return visit to ISS

On March 26, a Soyuz rocket launched the Soyuz ISS 19 mission, carrying two Russian crew members bound for the ISS along with commercial space tourist Charles Simonyi. The flight made Simonyi the first orbital space tourist to return to the ISS: his first trip was in April 2007. Simonyi returned to the Earth on April 7 along with two departing ISS crew members.

Vehicle Use

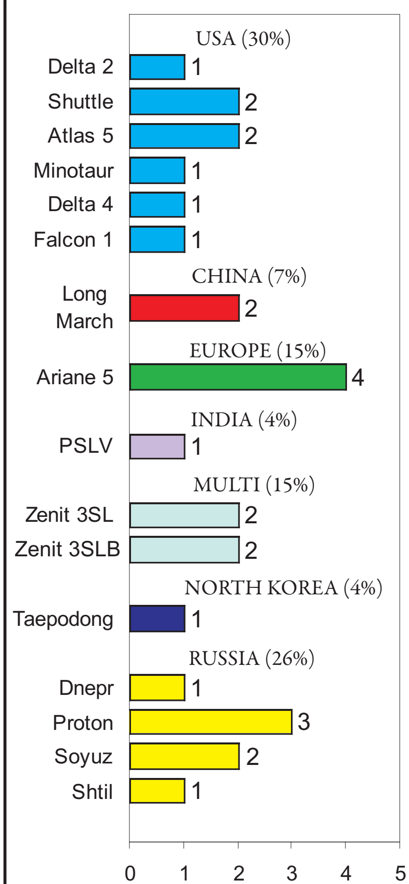
(January 2009 – September 2009)

Figure 1: First Quarter 2009 Total Launch Vehicle Use



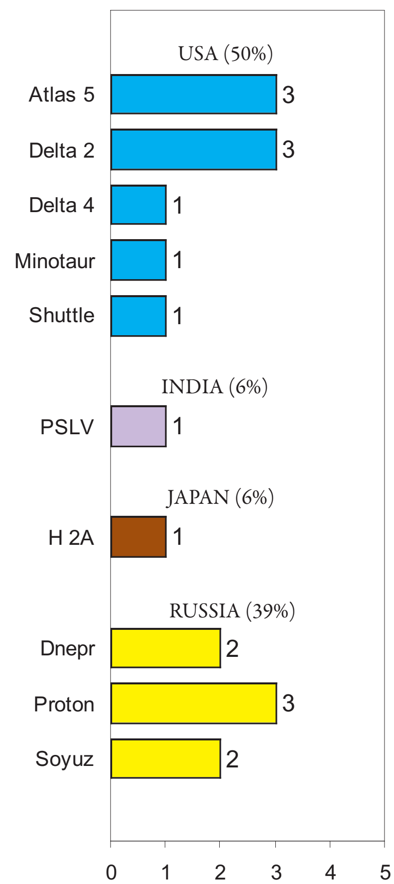
Total = 16

Figure 2: Second Quarter 2009 Total Projected Launch Vehicle Use



Total = 27

Figure 3: Third Quarter 2009 Total Projected Launch Vehicle Use



Total = 18

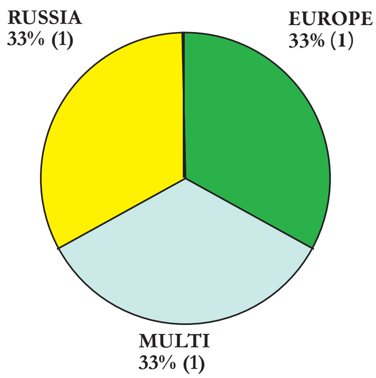
Figures 1-3 show the total number of orbital and commercial suborbital launches of each launch vehicle and the resulting market share that occurred in the first quarter of 2009. They also project this information for the second quarter of 2009 and third quarter of 2009. The launches are grouped by the country in which the primary vehicle manufacturer is based. Exceptions to this grouping are launches performed by Sea Launch, which are designated as multinational.

Note: Percentages for these and subsequent figures may not add up to 100 percent due to rounding of individual values.

Commercial Launch Events by Country

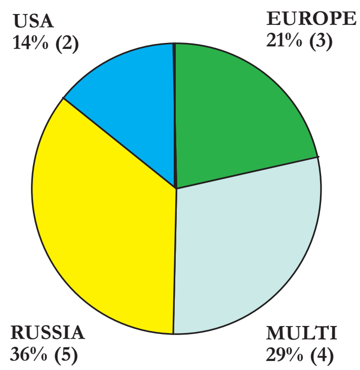
(January 2009 – September 2009)

Figure 4: First Quarter 2009 Commercial Launch Events by Country



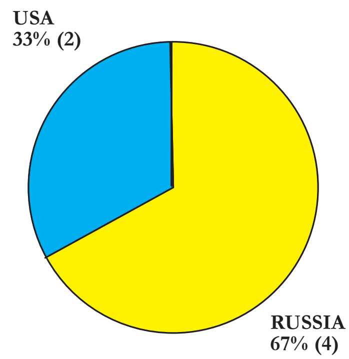
Total = 3

Figure 5: Second Quarter 2009 Projected Commercial Launch Events by Country



Total = 14

Figure 6: Third Quarter 2009 Projected Commercial Launch Events by Country



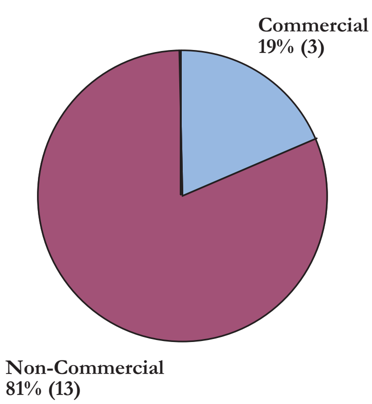
Total = 6

Figures 4-6 show all commercial orbital and suborbital launch events that occurred in the first quarter of 2009 and that are projected for the second quarter of 2009 and third quarter of 2009.

Commercial vs. Non-Commercial Launch Events

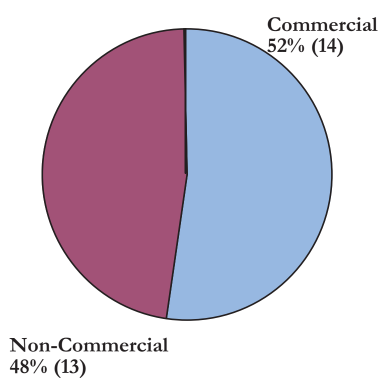
(January 2009 – September 2009)

Figure 7: First Quarter 2009 Commercial vs. Non-Commercial Launch Events



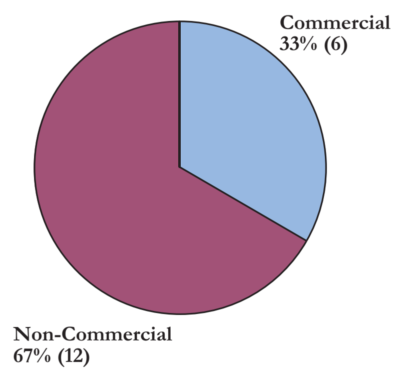
Total = 16

Figure 8: Second Quarter 2009 Projected Commercial vs. Non-Commercial Launch Events



Total = 27

Figure 9: Third Quarter 2009 Projected Commercial vs. Non-Commercial Launch Events

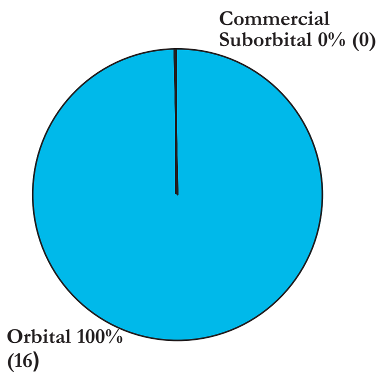


Total = 18

Figures 7-9 show commercial vs. non-commercial orbital and suborbital launch events that occurred in the first quarter of 2009 and that are projected for the second quarter of 2009 and third quarter of 2009.

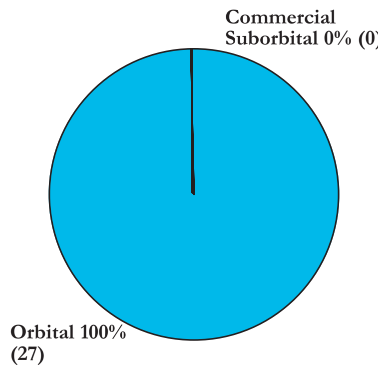
Orbital vs. Commercial Suborbital Launch Events
(January 2009 – September 2009)

Figure 10: First Quarter 2009 Commercial Suborbital vs. Orbital Launch Events



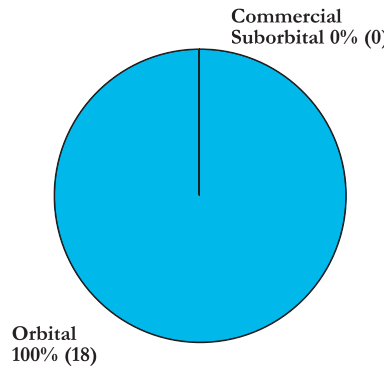
Total = 16

Figure 11: Second Quarter 2009 Projected Commercial Suborbital vs. Orbital Launch Events



Total = 27

Figure 12: Third Quarter 2009 Projected Commercial Suborbital vs. Orbital Launch Events

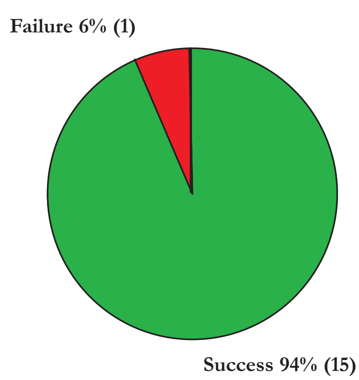


Total = 18

Figures 10-12 show orbital vs. FAA-licensed commercial suborbital launch events (or their international equivalents) that occurred in the first quarter of 2009 and that are projected for the second quarter of 2009 and third quarter of 2009.

Launch Successes vs. Failures
(January 2009 – March 2009)

Figure 13: First Quarter 2009 Launch Successes vs. Failures



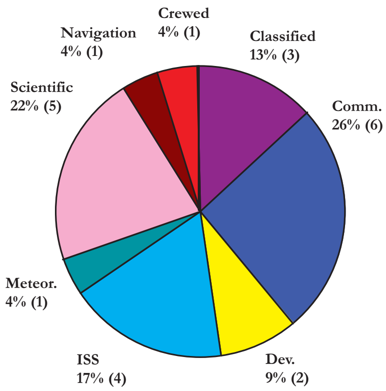
Total = 16

Figure 13 shows orbital and commercial suborbital launch successes vs. failures for the period from January 2009 to March 2009. Partially-successful orbital launch events are those where the launch vehicle fails to deploy its payload to the appropriate orbit, but the payload is able to reach a useable orbit via its own propulsion systems. Cases in which the payload does not reach a useable orbit or would use all of its fuel to do so are considered failures.

Payload Use (Orbital Launches Only)

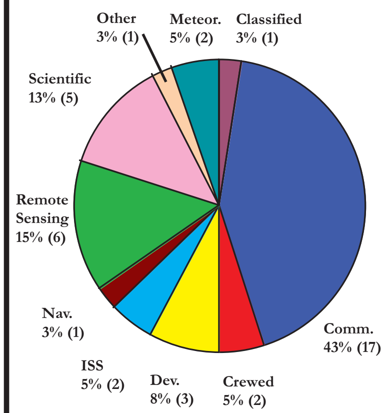
(January 2009 – September 2009)

Figure 14: First Quarter 2009 Payload Use



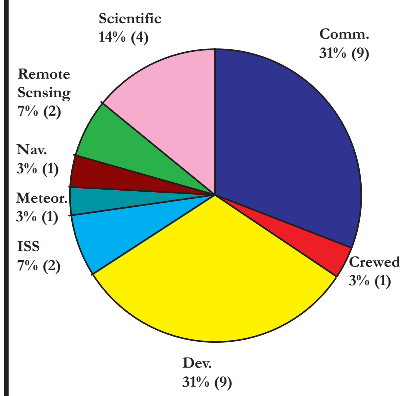
Total = 23

Figure 15: Second Quarter 2009 Projected Payload Use



Total = 40

Figure 16: Third Quarter 2009 Projected Payload Use



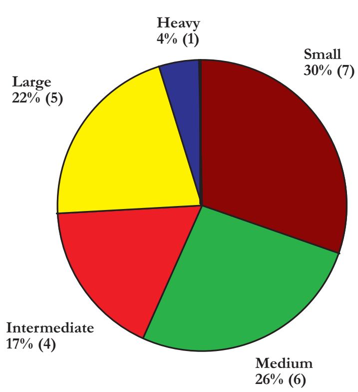
Total = 29

Figures 14-16 show total payload use (commercial and government), actual for the first quarter of 2009 and projected for the second quarter of 2009 and third quarter of 2009. The total number of payloads launched may not equal the total number of launches due to multiple manifesting, i.e., the launching of more than one payload by a single launch vehicle.

Payload Mass Class (Orbital Launches Only)

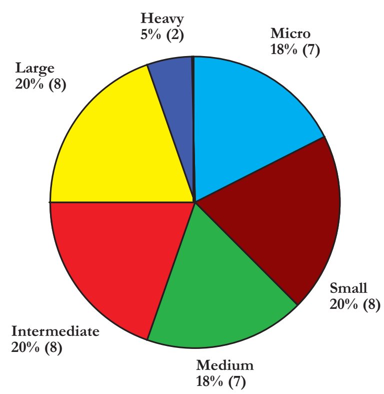
(January 2009 – September 2009)

Figure 17: First Quarter 2009 Payload Mass Mass Class



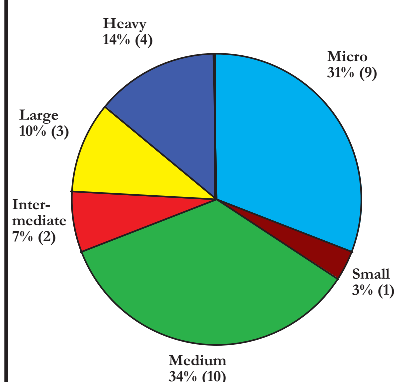
Total = 23

Figure 18: Second Quarter 2009 Projected Payload Mass Class



Total = 40

Figure 19: Third Quarter 2009 Projected Payload Mass Class

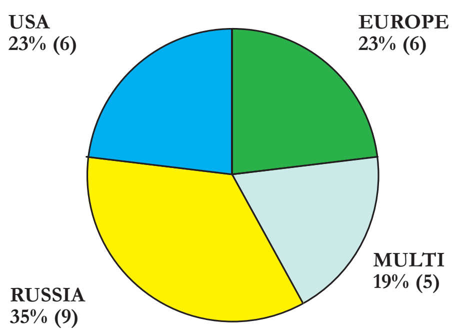


Total = 29

Figures 17-19 show total payloads by mass class (commercial and government), actual for the first quarter of 2009 and projected for the second quarter of 2009 and third quarter of 2009. The total number of payloads launched may not equal the total number of launches due to multiple manifesting, i.e., the launching of more than one payload by a single launch vehicle. Payload mass classes are defined as Micro: 0 to 91 kilograms (0 to 200 lbs.); Small: 92 to 907 kilograms (201 to 2,000 lbs.); Medium: 908 to 2,268 kilograms (2,001 to 5,000 lbs.); Intermediate: 2,269 to 4,536 kilograms (5,001 to 10,000 lbs.); Large: 4,537 to 9,072 kilograms (10,001 to 20,000 lbs.); and Heavy: over 9,072 kilograms (20,000 lbs.).

Commercial Launch Trends (Orbital Launches Only)
(April 2008 – March 2009)

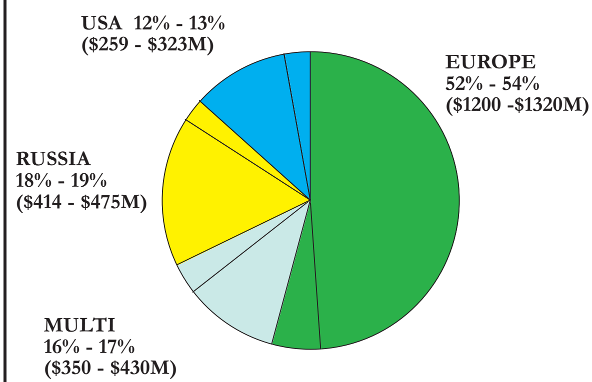
Figure 20: Commercial Launch Events, Last 12 Months



Total = 26

Figure 20 shows commercial orbital launch events for the period from April 2008 to March 2009 by country.

Figure 21: Estimated Commercial Launch Revenue, Last 12 Months

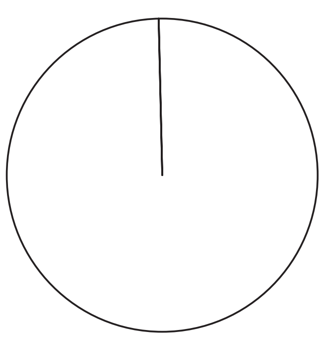


Total = $2,223 - $2,548M

Figure 21 shows estimated commercial launch revenue for orbital launches for the period from April 2008 to March 2009 by country.

Commercial Launch Trends (Suborbital Launches and Experimental Permits)
(April 2008 – March 2009)

Figure 22: FAA-Licensed Commercial Suborbital Launch Events (or Their International Equivalents), Last 12 Months



Total = 0

Figure 22 shows FAA-licensed commercial suborbital launch events (or their international equivalents) for the period from April 2008 to March 2009 by country.

Figure 23: FAA Experimental Permit Flights, Last 12 Months

Flight Date	Operator	Vehicle	Launch Site
10/26/2008	Armadillo Aerospace	Pixel	Las Cruces International Airport, NM
10/25/2008	Armadillo Aerospace	MOD-1	Las Cruces International Airport, NM
10/25/2008	Armadillo Aerospace	MOD-1	Las Cruces International Airport, NM
10/25/2008	Armadillo Aerospace	MOD-1	Las Cruces International Airport, NM
10/25/2008	TrueZer0	Ignignokt	Las Cruces International Airport, NM

Figure 23 shows suborbital flights conducted under FAA experimental permits for the period from April 2008 to March 2009 by country.

Commercial Launch History
(January 2004 – December 2008)

Figure 24: Commercial Launch Events by Country, Last Five Years

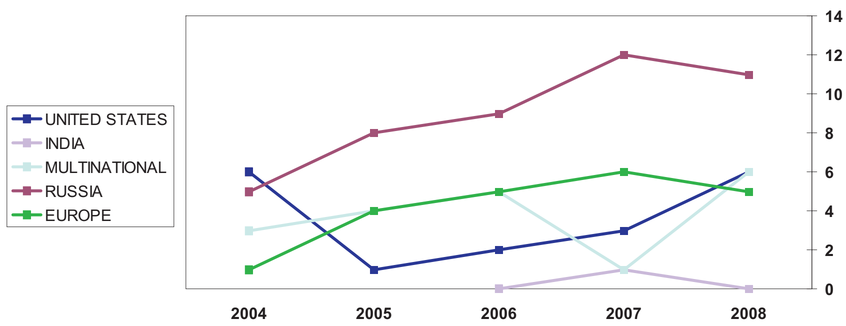


Figure 24 shows commercial launch events by country for the last five full calendar years.

Figure 25: Estimated Commercial Launch Revenue (in $ millions) by Country, Last Five Years

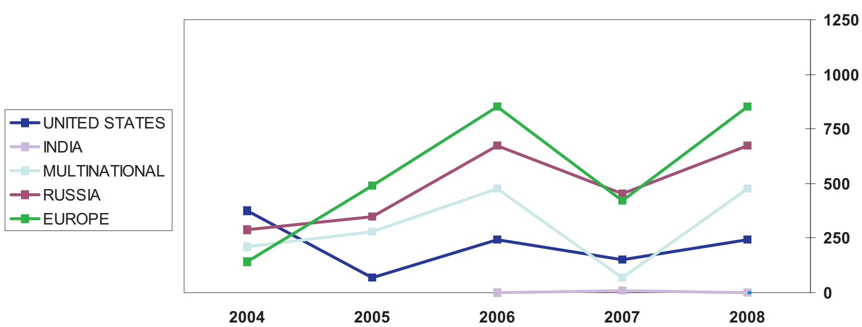


Figure 25 shows estimated commercial launch revenue by country for the last five full calendar years.

Economic Benefits of Spaceport Infrastructure

Introduction

A number of companies, both established and entrepreneurial, are currently working to develop vehicles capable of significantly reducing the cost of accessing space. The success of these vehicles and the ventures developing them will likely increase the type and volume of applications conducted in space; many of these will likely represent novel business opportunities. These private emerging space companies may hold significant potential for long-term growth within the space industry.

One of several obstacles to the eventual success of these ventures, however, is the relative lack of ground-based infrastructure to meet these vehicles' needs. A number of spaceports, both those currently operating as well as those under construction, are working to adapt their facilities for the regular operation of orbital or suborbital private space vehicles.

The progress of these spaceports in constructing their facilities to the needs of the private space industry will likely have a significant impact on the rate of development as well as the safety of operations conducted by the private space industry. The economic benefits of spaceport infrastructure development are dependent on both the types of infrastructure planned and the markets that users of that infrastructure will address.

This report attempts to outline new infrastructure that is currently being sought by emerging private spaceports, take a snapshot of the markets that the emerging private spaceflight industry will service from these facilities, and detail the types of economic benefits that could be expected from pursuing these infrastructure projects. While the private space industry is still at the very earliest stages of development, the economic benefits that could be gained by encouraging the industry's development may be substantial.

Spaceport Infrastructure and Estimating Economic Benefits

The economic benefits of funding infrastructure improvements to spaceports can be divided into immediate impacts and long-term impacts. The immediate impacts are almost always related to the construction of the facility. The jobs created are primarily in construction and related sectors. The long-term impact of these types of improvements is tied to operations: either the commencement of activities at the facility or an anticipated increase of activity at the spaceport.

The chief problem with estimating the long-term economic impact of improvements to spaceports is the nascent nature of the emerging private spaceflight industry. While it is widely anticipated that this sector of the aerospace industry holds some of the greatest potential for long-term growth, it remains one of the least understood sectors in the industry. This is in large part due to the lack of studies on the potential size of emerging markets, such as suborbital science and space tourism, conducted to date.

For this reason, the estimates contained in this report need to be couched within the confines of currently available information. While the immediate economic impact of these improvements can be reasonably well estimated, the scale and timeline of the longer-term growth that these improvements will enable is much harder to define. Producing hard metrics of potential economic impact requires additional study of the industry as it has evolved significantly in the last several years.

However, there have already been success stories related to infrastructure commitments: the decision by Virgin Galactic to operate out of Spaceport America was based in large part on the commitment by New Mexico to not only build the facility, but also to develop it specifically for the kind of operations that Virgin Galactic anticipates conducting once their vehicle becomes operational.

Taking these factors into account, this report tries to take an objective look at the kinds of activities that would likely be supported by new spaceport infrastructure as well as at the specific infrastructure itself.

Methodology

Infrastructure Costs and Impacts

This report attempts to capture the range of projects currently in need of funding at the spaceports having the greatest likelihood of hosting privately-developed space access vehicles. However, it does not attempt to define solid metrics of economic growth as a direct result of these infrastructure improvements. This is primarily because there are a number of critical factors in addition to infrastructure that will impact such metrics and the scope of this report does not permit exploring all of these factors to create a detailed numeric forecast. Rather, the intent of this report is to define required infrastructure, address the potential of that infrastructure, and try to make reasonable estimates about what kinds of economic benefits could be expected from executing such projects.

These limitations are in large part due to the relative lack of available data in this area. Those cases where hard numbers detailing economic benefits (anticipated jobs created or economic activity expected) are used were developed with very few data sets (limited information gathered from the spaceports themselves). In these cases, data coming from different facilities was similar enough to make the authors comfortable in including it.

Examination of Potential Markets

This report also explores the primary market areas these vehicles will likely serve. This is a necessary step both in terms of understanding the economic benefits of spaceports and spaceport operations as well as gaining a clearer picture of the growth potential of the industry. However, this report does not take an in-depth look at the potential for these markets, nor does it provide detailed quantitative data as to their potential.

Selection of Spaceports

There are a number of spaceports across the country, with varying customer bases and types of vehicles they support. The "Spaceports" chapter of the *2009 U.S. Commercial Space Transportation Developments and Concepts: Vehicles, Technologies, and Spaceports* report includes summaries of existing and planned spaceports in the United States.

For the purposes of this report, the chief criterion for determining which spaceports to include was the potential for growth and therefore future economic benefit. This potential is almost exclusively rooted in the commercial launch industry, particularly the emerging private space industry. This includes both emerging privately-funded suborbital vehicles as well as low-cost orbital vehicles that will likely enable new in-space applications by lowering the cost of accessing space. The focus therefore is upon those facilities that have positioned themselves to accommodate and enable these emerging commercial capabilities.

The facilities examined in this report are:

- California: The Mojave Air and Space Port
- Florida: Cecil Field and Spaceport Florida
- New Mexico: Spaceport America
- Oklahoma: The Oklahoma Spaceport
- Virginia: The Mid-Atlantic Regional Spaceport (MARS)

Types of Spaceport Infrastructure

There are many types of infrastructure that can have significant impact upon the operations and economic benefits of a spaceport. Other types of infrastructure are critical to conducting certain types of operations. Examples of improvements that have been identified as significantly beneficial by the spaceports within this report include:

- Launch Pads
- Vehicle and payload processing facilities
- Office space
- Hangars
- Runways
- Spacecraft fueling facilities
- Spacecraft apron facilities
- Space tourist handling facilities
- Radar arrays
- Space tourist preparation and training facilities
- Utility improvements.

Some of the facilities considered here have many of these types of infrastructure already in place and are seeking to expand their existing capabilities, while others are looking to develop all the required infrastructure. These types of improvements have differing levels of impact as well as differing levels of potential long-term impact. The chart below details several kinds of infrastructure projects and their estimated costs. The data is a compilation of information collected from the spaceports included in this study.

Infrastructure Type	Estimated Cost	Related to:
Hangar	$15-40M	Ground Servicing
Runway	$40-50M+	Flight Ops
Launch Pad	~$30M	Flight Ops
Radar Array	$14-60M+	Flight Ops

Tourist Prep Center	~$4M	Payload Processing
Payload Processing Center	~$10M	Payload Processing
Spacecraft Fueling Facilities	~$4M	Ground Servicing

It is critical to note that many factors go into estimates of project size and potential impact. These factors include the location of the infrastructure project, the ability of the spaceport overall to attract customers, and the growth of the industry, all of which affect both the near- and long-term impact of these kinds of projects. It is also important to understand that many of the infrastructure projects cited in the chart are really enabling projects. In many cases actual operations would not be feasible at some facilities in the absence of these improvements. Without a runway, for example, Spaceport America will never be able to serve its anchor tenant, Virgin Galactic.

There are also wide discrepancies in the scale and scope of projects requested at multiple facilities. Vehicle hangars illustrate this point clearly. The cost of constructing a hangar is determined by its size and function. A hangar for a handful of suborbital vehicles can cost less than $10 million to construct and its immediate economic impact would only include a few dozen people. In contrast, a hangar for an orbital vehicle would likely be significantly larger and need to include additional facilities for vehicle handling. Such a facility could cost several tens of millions of dollars, and perhaps as much as $100 million. An additional type of infrastructure that some facilities propose is hardware that increases safety. Examples of this kind of hardware include radar arrays and crash rescue units. These types of facilities generally employ no more than a few tens of people after construction, but can significantly increase the ability of the spaceport to operate safely. Finally, the infrastructure improvements defined above are only those that spaceports are requesting in addition to already-funded projects.

Supporting Markets

To understand the types of infrastructure needed at today's spaceports, it is also critical to understand the kinds of markets that the emerging suborbital vehicles anticipate serving. The general market areas that private suborbital vehicles would likely service are: space tourism, suborbital science, remote sensing, hardware testing, and national security. This list is not meant to be exhaustive, but rather a snapshot of those markets that are clearly emerging today as initial industry drivers. Estimating the size, impact, and potential of each of these market areas as they affect spaceports, vehicles, or the overall economy is extremely difficult, primarily due to the challenges of predicting the impact of any new technology. In addition, there exist only a very limited number of studies examining the details of each of these markets. To date, the only comprehensive study that has been completed in any of these areas as it relates directly to suborbital vehicles is Futron's *Space Tourism Market Study* (revised 2006), which quantified the most directly understandable of these markets, space tourism. Even this study is out of date, though, as it anticipates that suborbital tourism on private spacecraft would have already started by now. Moreover, there remain today uncertainties about the space tourism experience that could appreciably affect the size of the market. While it is possible to make some very general assertions about these market areas, there remains a significant need for further market studies.

Space Tourism

One of the most promising—and definitely the most publicized—emerging markets for spacecraft and spaceports is space tourism. Space tourists, or spaceflight participants as defined by regulation, are anticipated to number in the hundreds shortly after vehicles currently under construction begin flying and in the thousands as early operations mature into more regular flight schedules. They will require flight training, medical support, ground support and other basic amenities, and lodging. Some of these needs will be met by spaceports and some by the surrounding community, but the economic impact of relatively wealthy individuals taking exciting once-in-a-lifetime trips from our nation's spaceports holds the potential to be quite substantial.

Suborbital Science

A lesser-known emerging market for private suborbital spacecraft is suborbital science. This is an area that has often been raised as a significant future market, although to date has not been thoroughly studied. However, NASA has allocated $400,000 this year to study the potential of this kind of activity. Higher funding levels may be expected in the future as the suborbital vehicles currently under development reach testing and eventual operational status. The scientific fields that have already expressed significant interest include microgravity life sciences, microgravity physical sciences, aeromedical science, heliophysics, Earth sciences, astronomy, and planetary sciences. Depending upon the type and frequency of flights conducted for these diverse scientific fields, this kind of flight operation could become quite large.

There will likely be a substantial need for payload processing and integration as well as pre- and post-flight support and data gathering. For some higher flight rate activities one could even envision permanent or semi-permanent facilities at spaceports supporting these flight activities.

Remote Sensing

Though generally associated with aircraft or satellites, remote sensing will likely also play a major role in the flight activities of private suborbital spacecraft. The opportunity to schedule high-altitude, high-speed overflight operations has a number of applications in both the military and civilian regimes.

Technology Demonstration and Hardware Testing

Another application for suborbital spacecraft is testing hardware under development or in the process of certification for future high altitude or space missions. The cost of ensuring that such hardware can successfully operate in space or at high altitude can be extremely high. However, there are a number of technology areas where it would be quite economical to fly prototype hardware in the space environment as opposed to performing testing and analysis operations on the ground. This could be a significant market for suborbital vehicles, but will require the support of ground facilities capable of handling the test hardware and the vehicles. This particular application would also likely require additional hangar and other support facilities to modify and assemble components and then integrate them with vehicles as appropriate.

National Security

One area that may have a significant impact on the operations of spaceports in the years to come is national security research and development (R&D) and possibly even operations. The new suborbital vehicles under development are anticipated to provide regular, repeatable operations from the spaceports addressed in this report. Nearly all of them have a significant number of dual use applications. While much of this capability and eventual operations will be developed and conducted at other facilities, it is very likely, given the proximity of many spaceports to military facilities, that significant R&D work and operations will take place from commercial spaceports in the coming years.

Economic and Other Benefits

The development of spaceport infrastructure has a variety of benefits for the spaceport, the surrounding community, and the industry that will make use of it. Beyond the immediate impact associated with its construction, the infrastructure can attract business to the spaceport, stimulate additional economic impact in the surrounding community, and also support the industry by providing it with the infrastructure needed to serve existing and emerging markets. Those benefits are described below.

Immediate Impact

The immediate impact of each of these infrastructure projects can be roughly estimated based on the economic impact of similar projects or on the estimated number of jobs required to complete the task where similar facilities have been built in the past. This is the process that has been employed to create the data in this report. Examples of these kinds of estimates include previous construction of similar launch pads, runways, or other hardware. Funding any infrastructure project has the most immediate impact by creating construction jobs around the improvement itself. In most cases these types of projects provide a few tens to a few hundred jobs for the duration of construction. In some large exceptional cases such projects can generate thousands of jobs. Generally, these jobs are located in the immediate area around or on the spaceport with a more limited impact on the regional supply and manufacturing base. The estimated near- and long-term impact (based on the number of jobs) of each piece of spaceport infrastructure is provided in the table below:

Infrastructure Type	Immediate Impact	Long Term Impact
Hangar	30-40	Varies
Runway	~50	N/A
Launch Pad	~100	200-300
Radar Array	~100	~15
Tourist Prep Center	30-40	30-40
Payload Processing Center	30-40	150-200
Spacecraft Fueling Facilities	20-25	N/A

Impact on Depressed Economic Areas

By virtue of their need for large open spaces, almost every one of the spaceports considered in this report is located in a rural and/or economically depressed area. The only exceptions are the two facilities in Florida, which take advantage of their coastal location as opposed to wide open spaces to provide for a buffer zone around the facility. While definitions of economically depressed area vary from state to state, there are definitions that are common. The best examples include HUB (Historically Underutilized Business) Zones and Enterprise Zones, which provide incentives for business and allow specific areas to be targeted for economic development, respectively. All of the facilities discussed except those in Florida are in at least one of these areas. The immediate impact of construction jobs and new infrastructure in these areas therefore is quite significant. Further, the longer-term impact of bringing aerospace jobs, which are typically high-paying jobs, to these kinds of locations can provide a tax base for improving basic services within these communities in addition to their direct economic impact.

Growth Potential

The more challenging aspect of estimating economic impact is dealing with the potential for long-term growth. In general, there are fairly conservative prospects for growth within the traditional space launch market. There is not anticipated to be a significant increase in the number of new customers nor in the number of launches. However, constructing new launch facilities by existing spaceports may lead to an increase in flight activity at that particular location. In addition, orbital vehicles developed with private money have a strong likelihood of being a growth market in this very mature market segment. Flights of these kinds of vehicles from facilities like MARS and Florida hold significant potential.

In contrast to the traditional space launch market, the amount of launch activity associated with private suborbital flight is anticipated to grow significantly over the next several years, despite its nearly nonexistent level today. However, only a small percentage of the potential markets for suborbital vehicles have been studied. This presents a major problem in trying to make assertions about the level of economic growth that can be expected from infrastructure improvements at spaceports. While the enormous potential for the emergence of private spacecraft is accepted by some, the scope, scale, and timeline of such activity is more difficult to gauge.

In the U.S. alone, there are a number of companies developing such vehicles, several of which have debuted key system components and two of which, Virgin Galactic and XCOR Aerospace, have already begun ticket sales to space flight participants (aka space tourists). The operations that these companies anticipate conducting will need to be entirely supported by the spaceports from which they operate. In terms of infrastructure this will include not only launch pads, runways, and other vehicle servicing infrastructure, but also related facilities for handling people, payloads, and other associated capabilities.

Overall Industry Growth

The promotion of the private spaceflight industry as a means of generating economic and technological growth within the US cannot be understated. This industry holds the potential of revolutionizing fields that are already touched directly by space as well as those that seem to have nothing to do with it today. At the moment the growth of the entire space industry is limited by the high costs of conducting flight operations. The success of private firms attempting to develop lower cost operations as a competitive advantage has the potential to revolutionize the entire industry. The development of the kinds of infrastructure discussed in this report will likely play a major role in developing the industry.

Specific Spaceport Requirements

The table below captures the facilities included in this report based the probability of significant growth via commercial spaceflight. As a group, these facilities can accommodate orbital and suborbital vehicles, vertical and horizontal launch, and consist of both "green field" facilities and established sites. The chart below, based on information provided in interviews with the spaceports as well as published in the *2009 U.S. Commercial Space Transportation Developments and Concepts* and other reports, details the general state and capabilities of the facilities considered in this report.

Spaceport	Launch Pad[1]	Runway [2]	Established Facility
Spaceport America	Planned [3]	Planned	No
Spaceport Florida [4]	LC36, LC46	15,000 feet [5]	Yes
Cecil Field	No	12,500 feet	Yes [6]
MARS	2 Pads	8,750 feet	Yes
Oklahoma Spaceport	No	13,500 feet	Yes
Mojave Air and Spaceport	No	12,500 feet	Yes

TABLE NOTES:
1. Vertical Facility
2. Horizontal Facility
3. For vehicles without boosters.
4. Kennedy Space Center/Cape Canaveral Air Force Station)
5. Shuttle Landing Facility
6. A decommissioned military base.

Breakdown of Infrastructure Needs by Spaceport

All of the spaceports examined in this report have specific infrastructure needs. In some cases, these needs are focused on flight operations, while in other cases they are focused on ground processing or supporting a related business activity such as training and preparing space tourists. In preparing this report, each spaceport was asked to provide a summary of infrastructure projects that were currently unfunded, but held significant potential. The lists below were compiled by each of the spaceports discussed in this report.

Space Florida

Space Florida is responsible for both Spaceport Florida as well as an emerging facility, Cecil Field. Given this range of responsibility Space Florida's infrastructure needs encompass the requirements of both facilities:

Spaceport Florida

1. Launch Complex 36
2. Thermal vacuum chamber
3. Exploration Park research and lab complex
4. Launch Complex 46 launch tower refurbishments
5. Shuttle Landing Facility/RLV Hangar
6. Launch Complex 40

Cecil Field

1. Spacecraft hangar & assembly facility
2. Spacecraft apron facility
3. Spacecraft fueling station facility

Mid-Atlantic Regional Spaceport (MARS)

1. Payload processing and encapsulation facility that can accommodate spacecraft with hazardous components or fuels onboard for heavy class launch
2. Personal spaceflight training, certification, and operations facility

Mojave Air and Space Port

1. On-site HAZMAT capable crash rescue unit

Oklahoma Spaceport

1. Phased array radar for clearing local airspace

Spaceport America

1. Runway
2. Crosswind runway relocation/burial of power line (required for crosswind runway)
3. Taxiway
4. Environmental Impact Study (EIS)/Cultural resource mitigation
5. Sierra Electric substation/transmission lines or onsite self-generation
6. Aircraft Rescue and Firefighting (ARFF) facility
7. Water distribution system
8. Wastewater treatment plant
9. Security and parking facilities
10. Purchase of additional land surrounding spaceport
11. Vertical launch infrastructure, including additional pads, hangar, mission control, roads, and utilities
12. Broadband/telecommunications
13. Internal road development
14. Southern road paving and realignment
15. Onsite electrical distribution
16. Communications/systems/security
17. Vertical launch improvements
18. Site-enabling works
19. Terminal and hangar facility
20. Fuel storage
21. Fencing
22. Welcome and education centers
23. Astronaut training facilities and wellness center
24. Rail improvements (passenger, spurs, terminals)

Success Stories

There are already examples of how official commitments on infrastructure spending have resulted in commitments from private spaceflight companies and economic development within their respective region. For Spaceport America, the construction of the terminal/vehicle processing facility, runways, and other structures is an eminently quantifiable project: approximately $200 million and four years of work. This investment is expected to create 400-600 jobs immediately. The New Mexico Commercial Spaceport Economic Impact Study, prepared for the state of New Mexico by the Futron Corporation in late 2005, estimated that the construction work alone would generate an economic impact of over $510 million for the state. While this impact is considerable, it is relatively small in comparison to the potential of the overall project. The same study also estimated that Spaceport America may generate as much as $550 million annually in economic impact for the state once regular operations are established.

Similar levels of impact are anticipated in Virginia where preparations are now underway at MARS to modify the facility to enable flights of Orbital Sciences Corporation's Taurus II launch vehicle for satellite launches as well as cargo delivery to the International Space Station (ISS).

In both of these cases, the impact of a commitment to construct required infrastructure on the part of the state government led to substantial commitments in turn by industry to conduct business from a local spaceport. This kind of activity represents the kind of return on investment that spaceports can generate when they can deliver the appropriate infrastructure to companies seeking a location for flight operations.

Conclusions

Developing spaceport infrastructure, like any other kind of transportation infrastructure—highways, railroads, airports, etc.—has an obvious near-term economic impact on the region where the infrastructure is located and the industries involved in developing it. As this report indicates, the economic benefits of expanding and enhancing the capabilities of existing and emerging commercial spaceports can have an economic benefit on the order of hundreds of millions of dollars for the communities where these facilities are located, should these improvements be funded. Such development can provide an immediate economic boost for areas that are often rural and/or depressed.

The long-term benefit to such infrastructure development, though, is less precise. There are a number of companies actively developing orbital and suborbital vehicles. These companies are pursing markets ranging from space tourism to scientific research and national security applications. However, beyond space tourism, the size of these potential markets has not been quantified. Additional study is needed of these potential markets, as well as the specific infrastructure requirements of each spaceport, to make a more definitive estimate of the long-term economic impact these infrastructure improvements can provide.

However, even such studies may not be able to provide a complete picture of the economic benefits these spaceport infrastructure improvements may provide. The vehicles currently under development that would use these facilities may usher in a new era of lower-cost space access, a potentially disruptive technology along the lines of the airplane, personal computer, and the Internet. This could enable markets currently not envisioned that, over the long haul, may be much larger than any currently-conceived market. What is clear is that the economic benefits to improving commercial spaceports in the U.S. will extend to the spaceports, their communities, the commercial space transportation industry, and the country in general long after the last bulldozer and last crane leave the work sites.

1Q 2009 Orbital and Suborbital Launch Events

Date		Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price Estimate	L	M
1/17/2009		Delta 4 Heavy	Cape Canaveral Air Force Station (CCAFS)		NRO L-26	National Reconnaissance Office (NRO)	Classified	$225 - $275M	S	S
1/23/2009		H 2A 202	Tanegashima		GOSAT	Japan Aerospace Exploration Agency (JAXA)	Scientific	$90 - $110M	S	S
					SDS-1	JAXA	Development			S
1/30/2009		Cyclone 3	Plesetsk		Coronas Photon	Russian Federal Space Agency (Roscosmos)	Scientific	$20 - $30M	S	S
2/2/2009		Safir	Semnan Province		Omid	Iran Aerospace Organization	Development	TBD	S	S
2/6/2009		Delta 2 7320	Vandenberg Air Force Base (VAFB)		NOAA N Prime	National Oceanic and Atmospheric Administration (NOAA)	Meteorological	$60 - $70M	S	S
2/10/2009		Soyuz	Baikonur		Progress ISS 32P	Roscosmos	Internationational Space Station (ISS)	$60 - $70M	S	S
2/11/2009		Proton M	Baikonur	*	Express AM44	Russian Satelite Communications Company (RSCC)	Communications	$90 - $100M	S	S
				*	Express MD 1	RSCC	Communications			S
2/12/2009	√	Ariane 5 ECA	Kourou	*	Hot Bird 10	Eutelsat	Communications	$200 - $220M	S	S
				*	NSS 9	SES New Skies	Communications			S
					SPIRALE 1	French Délégation Générale pour l'Armement (DGA)	Classified			S
					SPIRALE 2	DGA	Classified			S
2/24/2009		Taurus XL	VAFB		Orbiting Carbon Observatory	National Aeronautics and Space Administration (NASA)	Scientific	$25 - $47M	F	F
2/26/2009	√	Zenit 3SLB	Baikonur	*	Telstar 11N	Loral Skynet	Communications	$55 - $65M	S	S
2/28/2009		Proton K	Baikonur		Raduga-1	Russian Ministry of Defense (MoD)	Communications	$80 - $90M	S	S
3/6/2009		Delta 2 7925-10	CCAFS		Kepler	NASA	Scientific	$60 - $70M	S	S
3/15/2009		Shuttle Discovery	Kennedy Space Center (KSC)		MPLM 4	NASA	ISS	N/A	S	S
					ISS 15A	NASA	ISS			S
					STS 119	NASA	Crewed			S
3/17/2009	√	Rockot	Plesetsk		GOCE	European Space Agency (ESA)	Scientific	$10 - $15M	S	S
3/24/2009		Delta 2 7925	CCAFS		Navstar GPS 2RM-7	United States Air Force (USAF)	Navigation	$60 - $70M	S	S
3/26/2009		Soyuz	Baikonur		Soyuz ISS 19	Roscosmos	ISS	$60 - $70M	S	S

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+ Denotes FAA-licensed launch.

* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity

Notes: All prices are estimates, and vary for every commercial launch. Government mission prices may be higher than commercial prices.
Ariane 5 payloads are usually multiple manifested, but the pairing of satellites scheduled for each launch is sometimes undisclosed for proprietary reasons until shortly before the launch date.

2Q 2009 Projected Orbital and Suborbital Launch Events

Date			Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price Estimate
4/3/2009	√		Proton M	Baikonur	*	Eutelsat W2A	Eutelsat	Communications	$90 - $100M
4/3/2009			Atlas 5 421	CCAFS		WGS 2	United States Department of Defense (DoD)	Communications	$110M - $140M
4/5/2009			Taepodong 2	Musudan-ri		Kwangmyongsong-2	North Korean MoD	Communications	TBD
4/15/2009			Long March 3C	Xichang		Compass G2	Chinese National Space Agency (CNSA)	Navigation	$60 - $80M
4/20/2009			PSLV	Sriharikota		Risat 2	Indian Space Research Organization (ISRO)	Remote Sensing	$20 - $30M
						Anusat	ISRO	Communications	
4/20/2009	√	+	Zenit 3SL	Odyssey Launch Platform		Sicral 1B	Italian MoD	Communications	$80 - $100M
4/22/2009		+	Long March 2C	Taiyuan		Yaogan 6	CNSA	Remote Sensing	$20 - $25M
5/5/2009			Delta 2 7920	VAFB		STSS-ATRR	United States Missile Defense Agency (MDA)	Classified	$60M - $70M
5/5/2009			Minotaur	Wallops Flight Facility		TacSat 3	USAF	Development	$10M - $15M
						GeneSat 2	NASA	Scientific	
						PharmaSat 1	NASA	Scientific	
5/7/2009			Soyuz	Baikonur		Progress ISS 33P	Roscosmos	ISS	$60 - $70M
5/11/2009			Shuttle Atlantis	KSC		Hubble Servicing Mission 4	NASA	Other	N/A
						STS 125	NASA	Crewed	
5/14/2009	√		Proton M	Baikonur	*	Protostar II	Protostar Ltd.	Communications	$90 - $100M
5/14/2009			Ariane 5 ECA	Kourou		Herschel Space Observatory	ESA	Scientific	$200 - $220M
						Planck Surveyor	ESA	Scientific	
5/27/2009			Soyuz	Baikonur		ISS 19S	Roscosmos	ISS	$60 - $70M

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2Q 2009 Projected Orbital and Suborbital Launch Events (Continued)

Date			Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price Estimate
6/2/2009			Atlas 5 401	CCAFS		Lunar Reconnaissance Orbiter	NASA	Remote Sensing	$110 - $140M
						LCROSS	NASA	Scientific	
6/13/2009			Shuttle Endeavour	KSC		STS 127	NASA	Crewed	N/A
6/29/2009	√		Proton M	Baikonur	*	Sirius FM-5	Sirius Satellite Radio	Communications	$90 - $100M
6/2009	√		Dnepr 1	Baikonur		DubaiSat-1	Emirates Institution for Advanced Science and Technology	Remote Sensing	$10 - $15M
					*	AprizeStar 3	Aprize Satellite	Communications	
					*	AprizeStar 4	Aprize Satellite	Communications	
						DEIMOS	Deimos Imaging	Remote Sensing	
						Nanosat 1B	Spanish Instituto Nacional de Técnica Aeroespacial (INTA)	Communications	
						UK DMC 2	British National Space Centre (BNSC)	Remote Sensing	
6/2009	√		Shtil 2.1	Baikonur	*	Sirius	VNII Elektromekhaniki	Meteorological	$1 - $2M
						Sumbandila	University of Stellenbosch	Development	
6/2009	√		Ariane 5 ECA	Kourou	*	TerreStar 1	TerreStar Networks	Communications	$200M - $220M
6/2009	√	+	Delta 4 Medium-Plus (4,2)	CCAFS		GOES O	NOAA	Meteorological	$100 - $180M
6/2009	√		Zenit 3SLB	Baikonur	*	Measat 3A	MEASAT	Communications	$55 - $65M
2Q/2009	√	+	Falcon 1	Kwajalein Island		RazakSAT	Malaysia National Space Agency	Development	$7 - $9M
2Q/2009	√		Ariane 5 ECA	Kourou	*	Thor 6	Telenor AS	Communications	$200M - $220M
					*	Amazonas 2	Hispasat	Communications	
2Q/2009	√		Zenit 3SLB	Odyssey Launch Platform	*	Intelsat 15	Intelsat	Communications	$55 - $65M
2Q/2009	√	+	Zenit 3SL	Odyssey Launch Platform	*	Eutelsat W7	Eutelsat	Communications	$80 - $100M
2Q/2009	√		Ariane 5 ECA	Kourou	*	JCSAT 12	JSAT	Communications	$200M - $220M

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3Q 2009 Projected Orbital and Suborbital Launch Events

Date			Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price Estimate
7/24/2009			Soyuz	Baikonur		Progress ISS 34P	Roscosmos	ISS	$60 - $70M
7/29/2009			Delta 2 7920	CCAFS		STSS Demo 1	USAF	Development	$60 - $70M
						STSS Demo 2	USAF	Development	
7/30/2009			Atlas 5 531	CCAFS		Advanced EHF 1	USAF	Communications	$110 - $140M
7/2009			Atlas 5 401	VAFB		DMSP 5D-3-F18	DoD	Meteorological	$110 - $140M
8/6/2009			Shuttle Discovery	KSC		STS 128	NASA	Crewed	N/A
8/15/2009			Soyuz	Baikonur		Mini Research Module 2	Roscosmos	Scientific	$60 - $70M
8/21/2009			Delta 2 7925	CCAFS		Navstar GPS 2RM-8	USAF	Navigation	$60 - $70M
9/1/2009			H 2A TBA	Tanegashima		HTV	JAXA	ISS	$90 - $110M
9/2009	√	+	Delta 2 7920	VAFB	*	WorldView 2	DigitalGlobe	Remote Sensing	$60 - $70M
9/2009			Minotaur 4	VAFB		TacSat 4	USAF	Development	$15 - $20M
3Q/2009	√		Dnepr 1	Baikonur		AKS 1	CNES	Development	$10 - $15M
						AKS 2	CNES	Development	
						ALMASat 1	University of Bologna	Development	
						AtmoCube	University of Trieste	Scientific	
						Funsat	University of Florida	Development	
						KatySat 1	Stanford University	Development	
						KiwiSat	AMSAT	Communications	
						Mea Huaka'l	University of Hawaii	Scientific	
						UCISat 1	University of California Irvine	Development	
3Q/2009			Proton M	Baikonur	*	Yamal 301	Gazkom Joint Stock Company	Communications	$90 - $100M
					*	Yamal 302	Gazkom Joint Stock Company	Communications	
3Q/2009			Delta 4 Medium-Plus (5,4)	CCAFS		WGS 3	DoD	Communications	$100 - $180M
3Q/2009	√		Proton M	Baikonur	*	MSV 1	Mobile Satellite Ventures	Communications	$90 - $100M
					*	Asiasat 5	Asiasat	Communications	
3Q/2009			PSLV	Satish Dhawan Space Center		Astrosat	ISRO	Scientific	$20 -$30M
3Q/2009	√	+	Atlas 5 431	CCAFS	*	Intelsat 14	Intelsat	Communications	$110 - $140M
3Q/2009	√		Dnepr 1	Baikonur	*	TanDEM X	Infoterra	Remote Sensing	$10 - $15M
3Q/2009	√	+	Proton M	Baikonur	*	DirecTV 12	DIRECTV	Communications	$90 - $100M

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