



**Federal Aviation  
Administration**

# **Commercial Space Transportation: 2009 Year In Review**



**January 2010**



## **About the Office of Commercial Space Transportation**

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) licenses and regulates U.S. commercial space launch and reentry activity, as well as the operation of non-federal launch and reentry sites, as authorized by Executive Order 12465 and Title 49 United States Code, Subtitle IX, Chapter 701 (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 web site at <http://ast.faa.gov>.

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### **NOTICE**

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## INTRODUCTION

The *Commercial Space Transportation: 2009 Year in Review* summarizes U.S. and international launch activities for calendar year 2009 and provides a historical look at the past five years of commercial launch activity.

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) licensed five commercial orbital launches in 2009, compared to the eleven licensed launches in 2008. Of the five orbital licensed launches, four used U.S.-built vehicles. One launch was on a United Launch Alliance (ULA) Delta II operated by Boeing Launch Services, one was on a ULA Delta IV, while another one was a ULA Atlas V operated by Lockheed Martin. One launch was by the privately-developed SpaceX Falcon 1 rocket. The remaining launch was carried out by the multinational Sea Launch Zenit-3SL.

The definitions used in the *Commercial Space Transportation: 2009 Year in Review* can be found in Appendix II at the end of the document.

Overall, 24 commercial orbital launches occurred worldwide in 2009, representing 31 percent of the 78 total launches for the year. This marked a decrease over 2008, which saw 28 commercial orbital launches worldwide.

Russia conducted 10 commercial launch campaigns in 2009, bringing its international commercial launch market share to 42 percent for the year, an increase from 2008. There were five FAA/AST-licensed orbital launches, accounting for 21 percent of the worldwide commercial launch market in 2009 while Europe attained a 21 percent market share, conducting five commercial Ariane 5 launches. The multinational Land Launch consortium performed three commercial launches and China performed one.

Of the 78 worldwide orbital launches, there were three launch failures, all of which were non-commercial launches. The first failure of the year was the February 24th loss of a Taurus XL. Following that were the April 5th failure of the North Korean Taepodong 2 and the August 25th failure of the South Korean KSLV-1.

There were no low-altitude flights conducted under FAA experimental permits in 2009.

## 2009 FAA-LICENSED ORBITAL LAUNCH SUMMARY

Recent trends in annual FAA-licensed orbital launches show that after a robust launch schedule in 2008, the number of FAA-licensed launches decreased by more than half, from 11 in 2008 to only five in 2009. GEO launches constituted three of these five. In general, the majority of FAA-licensed flights have typically been GEO launches. This was also true in 2005, 2006, and 2008. After a Sea Launch failure in early 2007, there were no further launches of the Zenit-3SL that year and the majority of licensed flights were made by Delta II rockets to LEO, carrying remote sensing satellites. With the successful return of the Zenit-3SL rocket on January 15, 2008, Sea Launch went on to complete five successful launches. However, in June 2009, Sea Launch filed for Chapter 11 bankruptcy protection and put its operations on hold for the rest of the year while it commenced a restructuring process. As a result, only one Sea Launch Zenit-3SL was launched in 2009. The five FAA-licensed launches for 2009 are summarized in Table 1.

Date	Vehicle	Payload	Orbit	Launch Outcome
20-Apr-09	Zenit-3SL	Sicral 1B	GEO	Success
27-Jun-09	Delta IV Medium-Plus (4,2)	GOES 0	GEO	Success
13-Jul-09	Falcon 1	RazakSAT	LEO	Success
08-Oct-09	Delta II 7920	WorldView 2	LEO	Success
23-Nov-09	Atlas V 431	Intelsat 14	GEO	Success

Table 1. 2009 FAA-Licensed Orbital Launch Events

Four of the licensed launches took place from U.S. ranges. The Delta II launch took place from Vandenberg Air Force Base (VAFB) in California and successfully placed a remote sensing payload into LEO. The Delta IV launch took place from Cape Canaveral and successfully placed its communications satellite

payload into GEO. The Atlas V launch took place from Cape Canaveral and successfully placed its communications satellite payload into GEO. The Falcon 1 launch took place from SpaceX's Kwajalein pad and successfully placed its remote sensing payload into LEO.

One Zenit-3SL launch from the Sea Launch Odyssey platform occurred during 2009. This single launch successfully placed its communication satellite payload into GEO.

The five FAA-licensed launches included the following characteristics:

- Two of the launches were conducted for commercial clients (DigitalGlobe and Intelsat), while one was for the U.S. National Oceanic and Atmospheric Administration (NOAA), one was for the Malaysian government, and the final launch was for the Italian government.
- The five launches were worth an estimated US \$498 million.<sup>1</sup>

<sup>1</sup> Revenues for both U.S. and foreign commercial launches are based on open source information and estimates by FAA/AST. They are only approximations. Actual revenue received for a single launch may be spread over several years.

The number of FAA-licensed orbital launches in 2009 was significantly lower than 2008. Since 2005, launch rates have fluctuated (see Figure 1) but the last year saw increased launch prices mitigate the decline in revenues. A trend similar to that for annual launches is evident for estimated FAA-licensed commercial orbital launch revenues from 2005 to 2009 (see Figure 2).

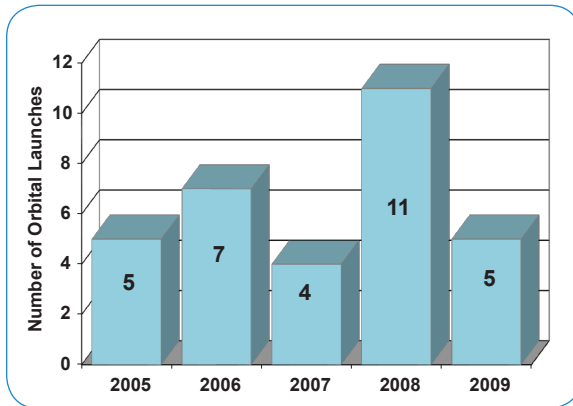


Figure 1. FAA-Licensed Orbital Launch Events, 2005–2009

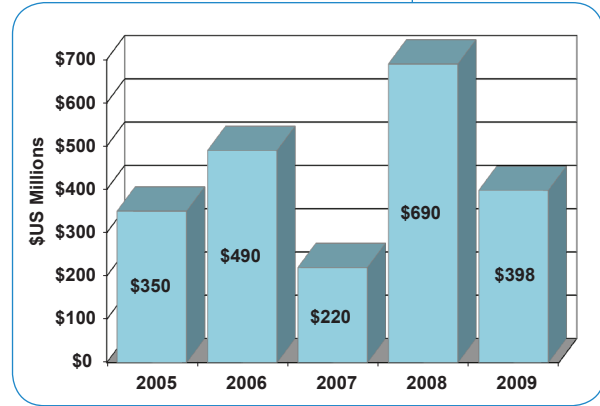


Figure 2. Estimated Revenues for FAA-Licensed Orbital Launch Events, 2005–2009

## U.S. AND FAA-LICENSED ORBITAL LAUNCH ACTIVITY IN DETAIL

U.S. vehicles carried out a total of 24 launches in 2009, four of which were licensed by FAA/AST. Of the 20 non-commercial U.S. launches, five were Space Shuttle missions, two carried classified U.S. National Reconnaissance Office (NRO) payloads, eight carried Department of Defense (DoD) payloads or were sponsored by the DoD, four were National Aeronautics and Space Administration (NASA) civil government missions, and the remaining launch was for NOAA.

A multinational company, Sea Launch, conducted the fifth FAA-licensed commercial launch in 2009.

See Table 2 for a detailed breakdown of U.S. launch activity (including Sea Launch) during 2009 by vehicle.








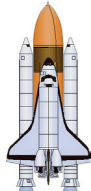

	UNITED STATES								SEA LAUNCH
									
Vehicle	Falcon I	Taurus XL	Minotaur	Delta II	Delta IV	Delta IV Heavy	Atlas V	Shuttle	Zenit-3SL
2009 Total Launches	1	1	1	8	2	1	5	5	1
2009 Licensed Launches	1	0	0	1	1	0	1	0	1
Launch Reliability (2009)	1/1 100%	0/1 0%	1/1 100%	8/8 100%	2/2 100%	1/1 100%	5/5 100%	5/5 100%	1/1 100%
Launch Reliability (Last 10 Years)	2/5 40%	3/5 60%	15/15 100%	60/60 100%	8/8 100%	3/3 100%	19/19 100%	33/33 100%	26/28 93%
Year of First Launch	2006	1994	2000	1990	2002	2004	2002	1981	1999
Active Launch Sites	Kwajalein	VAFB	VAFB, Wallops	CCAFS, VAFB	CCAFS, VAFB	CCAFS, VAFB	CCAFS, VAFB	KSC	Odyssey Pacific Ocean Platform
LEO kg (lbs)	454 (1,000)	1590 (3505)	640 (1410)	6,100 (13,440)	9,150 kg (20,170 lb) (Delta IV M)	22,560 kg (49,740 lb)	20,520 (45,240)	23,435 (51,557)	15,246 (33,541)
GTO kg (lbs)	--	--	--	2,170 (4,790)	4,300 kg (9,480 lb) (Delta IV M)	12,980 kg (28,620 lb)	8,670 (19,110)	5,663 (12,459)	6,100 (13,440)

Table 2. U.S. and FAA-Licensed Launch Vehicle Activity in 2009

CCAFS - Cape Canaveral Air Force Station, KSC - Kennedy Space Center, VAFB - Vandenberg Air Force Base, WFF - Wallops Flight Facility  
 Note: Launch reliability is determined by analyzing the number of successful and failed launches of a particular vehicle; mission outcome (success or failure) is not used in the calculation of launch vehicle reliability.



The following is a listing of U.S.-based launch service providers, highlighting their launch activity in 2009. It covers all companies that launched from the United States and/or under the regulatory oversight of the FAA Office of Commercial Space Transportation.

### **BOEING LAUNCH SERVICES (BLS)**

BLS is the provider of Delta series rockets for commercial customers.

BLS conducted two commercial launches in 2009, one using the Delta II vehicle and the other using a Delta IV. In June, a Delta IV was used to launch the GOES O GEO weather satellite. In October, a Delta II 7920 was used to place the WorldView 2 satellite into LEO. GOES O will supplement NOAA's weather coverage while WorldView 2 will significantly add to the imaging capabilities of its owner, DigitalGlobe. All U.S. government Delta vehicle launches were carried out by the United Launch Alliance (ULA), detailed below.

### **LOCKHEED MARTIN COMMERCIAL LAUNCH SERVICES**

Lockheed Martin Commercial Launch Services (LMCLS) manages all commercial launches of the Atlas V rocket.

In 2009, LMCLS performed one launch. The launch took place in November and was commercially licensed, placing the Intelsat 14 communications satellite into GEO. Intelsat 14 is owned and operated by Intelsat and provides fixed satellite services.

### **ORBITAL SCIENCES CORPORATION (OSC)**

OSC provides the Minotaur, Pegasus, and Taurus vehicles for orbital launch.

OSC performed two launches in 2009, one of which failed. The February 24 Taurus XL launch of NASA's Orbiting Carbon Observatory failed when the payload fairing did not fully separate during launch. The added weight and drag of the payload fairing kept the rocket from attaining orbital velocity, and the rocket is thought to have splashed down in the south Pacific Ocean. It was the United States' only launch failure of 2009. The second OSC launch took place on May 19 and used a Minotaur rocket to place the TacSat 3 satellite into orbit for the DoD, as well as the GeneSat 2 and PharmaSat 1 satellites for NASA.

### **SEA LAUNCH COMPANY, LLC**

Sea Launch offers the Zenit-3SL for commercial launches to GEO. The Zenit-3SL is launched from the mobile Odyssey Launch Platform along the Equator in the Pacific Ocean.

In 2009, Sea Launch carried out one successful commercial launch, placing a communications satellite in GEO for the Italian military. 2009 also saw three successful launches of the Land Launch system, operated by Sea Launch LLC and launched from Baikonur Cosmodrome. In June, Sea Launch filed for Chapter 11

bankruptcy protection and began restructuring its finances. Originally, Boeing was the majority shareholder (40 percent) of Sea Launch. Other partners included S. P. Korolev Rocket and Space Corporation Energia of Russia (25 percent), Aker ASA of Norway (20 percent), and SDO Yuzhnoye/NPO Yuzhmash of Ukraine (15 percent). As of the time of this writing, Sea Launch's corporate restructuring is ongoing and the fate of the company is still undecided.

### **SPACE EXPLORATION TECHNOLOGIES CORPORATION (SPACEX)**

SpaceX is developing the Falcon series of launch vehicles for the commercial market, as well as for government clients.

SpaceX conducted its fifth Falcon 1 launch in July. The launch took place at the SpaceX launch site on Omelek Island in the Kwajalein Atoll. The launch was the second successful commercial flight of the Falcon 1, carrying the Malaysian RazakSat remote sensing satellite into LEO.

### **UNITED LAUNCH ALLIANCE (ULA)**

ULA, which was formed on December 1, 2006, conducts launches for the non-commercial U.S. government launch market. Boeing-heritage Delta vehicles and Lockheed Martin-heritage Atlas vehicles are manufactured and operated by ULA. The company is a 50-50 joint partnership between The Boeing Company and Lockheed Martin Corporation.

In 2009, ULA conducted 13 U.S. government non-commercial launches. Seven Delta II vehicles launched the following payloads: NOAA N Prime for NOAA, the WISE satellite for NASA, the Kepler space telescope for NASA, the Navstar GPS 2RM-7 and 2RM-8 satellites for the DoD, and three STSS satellites for the DoD. Four ULA Atlas V vehicles were launched, placing the following payloads into orbit: the PAN electronic reconnaissance satellite, the WGS 2 communications satellite, and DMSP 5D-3-F18 weather satellite for the DoD, and the Lunar Reconnaissance Orbiter and LCROSS lunar probe for NASA. One ULA Delta IV Medium rocket put the WGS 3 communications satellite into orbit for the DoD and one Delta IV Heavy rocket put the NRO L-26 reconnaissance satellite into orbit for the NRO.

### **UNITED SPACE ALLIANCE (USA)**

USA is the launch services company for noncommercial NASA Space Shuttle missions. Like ULA, USA is jointly owned by Boeing and Lockheed Martin.

USA conducted five successful shuttle launches from the Kennedy Space Center in 2008. Shuttles Atlantis, Endeavour, and Discovery all made flights to assist in the completion of the International Space Station and to repair the Hubble Space Telescope.

## 2009 WORLDWIDE ORBITAL LAUNCH ACTIVITY

This section highlights launch activity not licensed by the FAA in 2009. Launches, payloads, and revenue streams are described on a country-by-country basis. Launch providers from the United States, Russia, Europe, China, Japan, India, Iran, North Korea, South Korea, and the multinational consortium Sea Launch conducted a total of 78 launch events in 2009, 24 of which were commercial (see Table 3 and Figure 3).

2009 saw a dip in commercial launches from 2008, due in large part to the bankruptcy filing of Sea Launch. See Table 4 for a list of non-FAA-licensed commercial launches.

	Commercial Launches	Non-commercial Launches	Total Launches
United States	4	20	24
Russia	10	19	29
Europe	5	2	7
China	1	5	6
Multinational	4	0	4
India	0	2	2
Japan	0	3	3
North Korea	0	1	1
South Korea	0	1	1
Iran	0	1	1
<b>TOTAL</b>	<b>24</b>	<b>54</b>	<b>78</b>

Table 3. 2009 Worldwide Orbital Launch Events

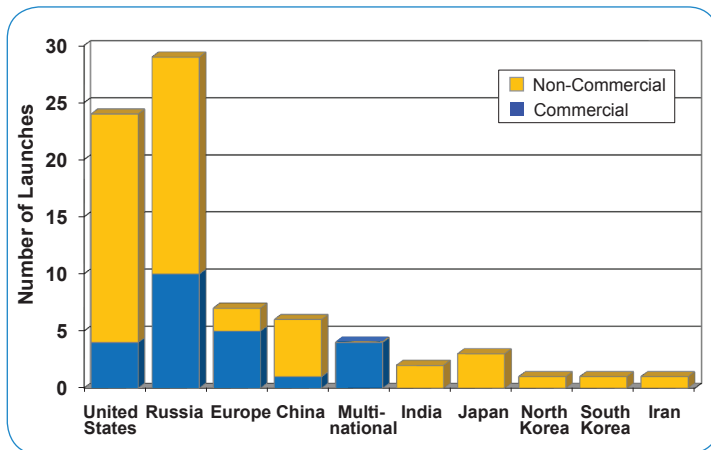


Figure 3. 2009 Total Worldwide Launch Activity

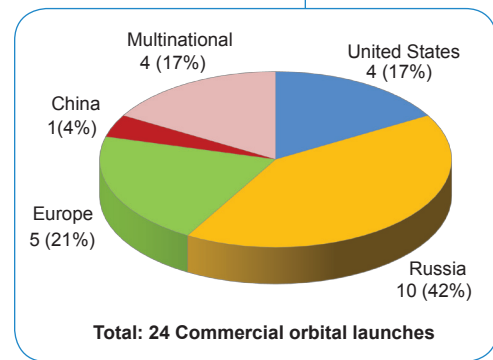


Figure 4. 2009 Worldwide Commercial Market Share

The following is a summary of all the worldwide 2009 commercial launches by country.

- U.S.-built vehicles conducted four commercial launches in 2009, accounting for 17 percent of the global commercial launch market (see Figure 4).
- Russia led with 10 commercial launches, capturing 42 percent of the market, an increase in percentage from last year.
- Europe conducted five Ariane 5 commercial launches in 2009, for a 21 percent market share.
- Sea Launch had one commercial launch while its Land Launch joint venture built upon the success of its 2008 debut, launching three rockets. Combined, Sea Launch and Land Launch accounted for 17 percent of the commercial launch market.

- China conducted one commercial launch in 2009, using a Long March 3B rocket to attempt to loft the Indonesian Palapa D communications satellite into orbit. However, due to a fault in the rocket, Palapa D was not inserted into the proper orbit, and had to use a significant portion of its internal maneuvering fuel to reach its planned orbit, at the expense of its lifetime in orbit.

Appendix I at the end of this report shows all 78 orbital launches worldwide in 2009, including commercial, civil, and military missions.

Date	Vehicle	Payload(s)	Orbit	Launch Outcome
12-Feb-09	Ariane 5 ECA	Hot Bird 10 SPIRALE 2 SPIRALE 1 NSS 9	GEO ELI ELI GEO	Success Success Success Success
26-Feb-09	Zenit-3SLB	Protostar II	GEO	Success
17-Mar-09	Rockot	Measat 3A	ELI	Success
3-Apr-09	Proton M	Eutelsat W2A	GEO	Success
16-May-09	Proton M	Protostar II	GEO	Success
21-Jun-09	Zenit-3SLB	Measat 3A	GEO	Success
1-Jul-09	Ariane 5 ECA	TerreStar 1	GEO	Success
1-Jul-09	Proton M	Sirius FM-5	GEO	Success
29-Jul-09	Dnepr 1	DEIMOS AprizeStar 3 AprizeStar 4 UK DMC 2 Nanosat 1B DubaiSat-1	LEO LEO LEO LEO LEO LEO	Success Success Success Success Success Success
11-Aug-09	Proton M	Asiasat 5	GEO	
21-Aug-09	Ariane 5 ECA	Optus D3 JCSAT 12	GEO GEO	Success Success
31-Aug-09	Long March 3B	Palapa D	GEO	Partial
18-Sep-09	Proton M	Nimiq 5	GEO	Success
1-Oct-09	Ariane 5 ECA	COMSATBw 1 Amazonas 2	GEO GEO	Success Success
29-Oct-09	Ariane 5 ECA	Thor 6 NSS 12	GEO GEO	Success
2-Nov-09	Rockot	SMOS Proba 2	ELI ELI	Success
23-Nov-09	Proton M	Eutelsat W7	GEO	Success
1-Dec-09	Zenit-3SLB	Intelsat 15	GEO	Success
29-Dec-09	Proton M	DirecTV 12	GEO	Success

Table 4. 2009 Non-FAA-Licensed Commercial Launch Events

## WORLDWIDE LAUNCH REVENUES

Revenues from the 24 commercial launch events in 2009 amounted to an estimated US\$2.41 billion, an increase of about US\$440 million from 2008. The following are the revenues broken down by country:

- U.S. commercial launch revenues for 2009 were estimated to be US\$298 million.
- Russian revenues were approximately US\$742 million.
- European revenues were about US\$1 billion.
- Chinese revenues were approximately \$70 million.
- Sea Launch/Land Launch had an estimated US\$280 million in commercial launch revenue (see Figure 5).

Payments for launch services are typically spread over one to two years prior to 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 in which the primary vehicle manufacturer is based, with the exception of Sea Launch/Land Launch, which is designated simply as "multinational."

In the past, most launch vehicles were manufactured, sold, and launched by the same organization entirely in one country or, in the case of Europe, within a particular economic region. With the rise of multinational launch service corporations, however, a clean division of revenue among countries for individual launches is difficult to assess.

Because of the proprietary nature of business transactions and the internal financing of each organization, estimated shared revenue totals are the basis for revenue analysis. Thus, it is difficult to determine exact annual revenues for each launch service or to characterize them in terms of allocated percentages between international partners. This is also true of some major component suppliers, such as NPO Energomash of Russia, which provides the RD-180 engines used to power the U.S. Atlas V vehicle.

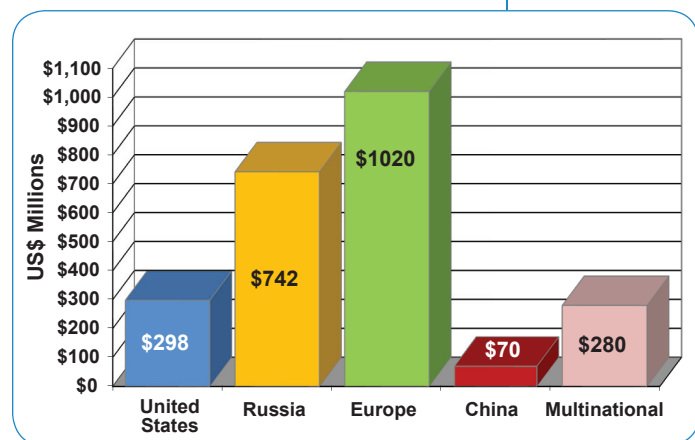


Figure 5. Approximate 2009 Commercial Launch Revenues

## WORLDWIDE ORBITAL PAYLOAD SUMMARY

In 2009, 78 launches carried a total of 111 payloads into orbit (see Figure 6, Figure 7, and Table 5). Of the 111 payloads, 26 provide commercial services (see Figure 8 for a breakdown of these payloads by launch country). The remaining 85 payloads were used for non-commercial civil government, military, or non-profit purposes.

	Commercial Payloads	Non-commercial Launches	Total Payloads
United States	2	26	28
Russia	12	30	42
Europe	8	6	14
China	1	6	7
Multinational	3	1	4
India	0	9	9
Japan	0	4	4
North Korea	0	1	1
South Korea	0	1	1
Iran	0	1	1
<b>TOTAL</b>	<b>26</b>	<b>85</b>	<b>111</b>

Table 5. Payloads launched by Country in 2009

### COMMERCIAL LAUNCHES

Twenty-four commercial launches carried a total of 36 commercial and non-commercial payloads into orbit. One of these launches, the August 31 launch of a Long March 3B carrying the Palapa D, was considered only a partial success, as the satellite was not inserted into the proper orbit. The satellite later used its own propellant to maneuver into the proper orbit. All other commercial launches were successful.

Of the 36 commercially-launched payloads, 24 provide commercial services. Four of these are NGSO satellites and 20 are GEO satellites:

- NGSO: AprizeStar 3 and AprizeStar 4, DEIMOS, and WorldView 2.
- GEO: NSS 9, Hot Bird 10, Telstar 11N, Eutelsat W2A, Protostar II, Measat 3A, TerreStar 1, Sirius FM-5, Asiasat 5, Optus D3, JCSAT 12, Palapa D, Nimiq 5, Amazonas 2, NSS 12, Thor 6, Eutelsat W7, Intelsat 14, Intelsat 15, and DirecTV 12.

Twelve payloads were commercially launched to perform civil government, military, or non-profit missions:

- Eight civil government satellites were launched: GOCE, RazakSat, Nanosat 1B, UK DMC 2, DubaiSat-1, Proba 2, and SMOS to LEO or an elliptical Sun-synchronous orbit, and GOES O to GEO.
- Four military satellites were launched: Sicral 1B and COMSATBw 1 to GEO, SPIRALE 1 and SPIRALE 2 to elliptical orbits.

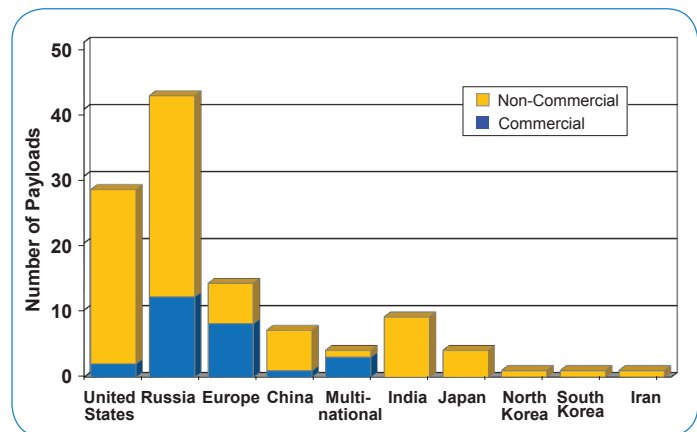


Figure 6. 2008 Total Worldwide Launch Activity by Payload

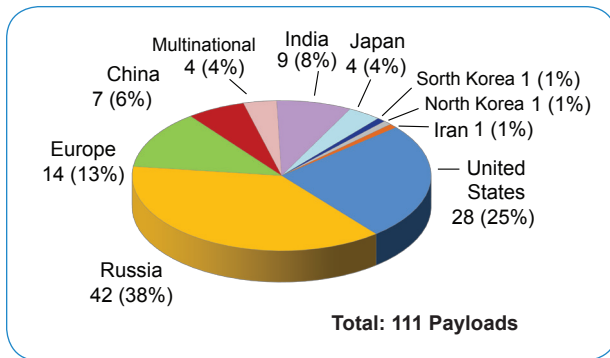


Figure 7. Total Payloads Launched by Country in 2009

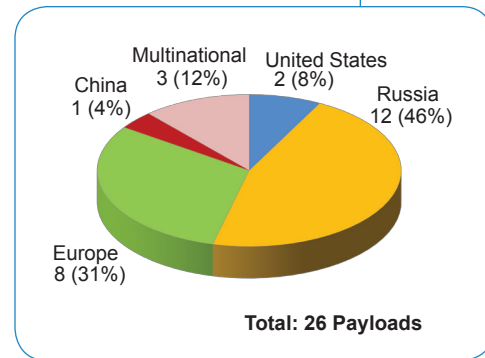


Figure 8. Commercial Payloads Launched by Country in 2009

## NON-COMMERCIAL LAUNCHES

Of the 78 orbital launches, 54 were noncommercial launches carrying a total of 75 commercial and non-commercial payloads.

Three of these non-commercial launches failed:

- February 24: the U.S. Taurus XL launch with NASA's Orbiting Carbon Observatory.
- April 5: North Korea's launch of its Taepodong 2 vehicle with the Kwangmyongsong-2 payload.
- August 25: South Korea's launch of its KSLV 1 launch vehicle with the STSAT 2A satellite.

All 51 of the remaining non-commercial launches were successful.

Two payloads were launched non-commercially to provide commercial services:

- Russia launched the Express MD-1 and Express AM44 communications satellites.

Thirty-eight payloads were launched non-commercially for civil government purposes:

- 13 U.S. payloads: NOAA N Prime, Orbiting Carbon Observatory, Kepler, STS 119, STS 125, GeneSat 2, PharmaSat 1, LCROSS, Lunar Reconnaissance Orbiter, STS 127, STS 128, STS 129, and WISE;
- 15 Russian payloads: Coronas Photon, Progress ISS 32P through Progress ISS 35P, Soyuz ISS 18S through 21S, Sterkh 1, Meteor M1, the Mini Research Module 2, and Glonass M R22 through R24;
- Three Chinese payloads: Compass G2, Shijian 11-01, and Yaogan 8;
- Two European payloads: Planck Surveyor and the Herschel Space Observatory;
- Three Japanese payloads: SDS-1, GOSAT, and the HTV;
- One Indian payload: Oceansat 2; and
- One South Korean payload: STSAT 2A.

Twenty-six payloads were launched non-commercially for military use:

- Eleven U.S. payloads: NRO L-26, Navstar GPS 2RM-7, Navstar GPS 2RM-8, WGS 2, STSS-ATRR, TacSat 3, PAN, STSS Demo 1 and 2, DMSP 5D-3-F16, and WGS 3;
- Eight Russian payloads: Raduga-1, Kosmos 2450, Meridian 2, Kosmos 2451, Kosmos 2452, Kosmos 2453, Kosmos 2454, and Kosmos 2455;
- Two Chinese payloads: Yaogan 6 and Yaogan 7;
- One North Korean payload: Kwangmyongsong-2;
- One French payload: Helios 2B;
- One Japanese payload: IGS Optical 3;
- One Indian payload: Risat 2; and
- One Iranian payload: Omid.

Finally, nine payloads were launched non-commercially for non-profit missions:

- One European Union payload: SwissCube-1;
- Four German payloads: BeeSat, Rubin 9.1, Rubin 9.2, and UWE-2;
- One Chinese payload: Hope 1;
- One South African payload: Sumbandila;
- One Indian payload: Anusat; and
- One Turkish payload: ITU-pSat.



## LAUNCH ACTIVITIES BY COUNTRY

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

### RUSSIA

In 2009, 29 Russian launches took place. Of these, 10 were commercial launches.

- ILS launched seven Proton M vehicles during the year. All launches each carried one commercial GEO communications satellite.
- ISC Kosmotras launched one Dnepr rocket, carrying AprizeStar 3 and 4, DEIMOS, Nanosat 1B, UK DMC 2, and DubaiSat-1.
- Two Rokot launches carried GOCE, Proba 2, and SMOS into orbit.

See Table 6 for a detailed breakdown of 2009 Russian launch activity by vehicle.

Russia conducted 19 non-commercial launches in 2009. Nine of these were dedicated to ISS missions.

- Four were Soyuz rockets carrying Progress spacecraft (ISS 32P through 35P).
- Four were Soyuz vehicles carrying manned Soyuz spacecraft that ferried individuals to and from the ISS (ISS 18S through 21S).





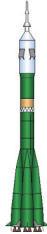



RUSSIA								
								
Vehicle	Kosmos 3M	Cyclone	Dnepr	Rokot	Soyuz	Soyuz 2	Proton K	Proton M
2009 Total Launches	1	1	1	3	11	2	1	9
Launch Reliability (2009)	1/1 100%	1/1 100%	1/1 100%	3/3 100%	11/11 100%	2/2 100%	1/1 100%	9/9 100%
Launch Reliability (Last 10 Years)	13/13 100%	7/8 88%	11/12 92%	10/11 91%	92/93 99%	7/7 100%	45/46 98%	33/36 92%
Year of First Launch	2004	1969	1999	1994	1963	2004	1967	2000
Active Launch Sites	Plesetsk	Baikonur, Plesetsk	Baikonur, Dombrovskiy	Baikonur, Plesetsk	Baikonur, Plesetsk	Baikonur, Plesetsk	Baikonur	Baikonur
LEO kg (lbs)	1,350 (2,970)	3,000 (6,600)	3,700 (8,150)	1,850 (4,075)	6,708 (14,758)	7,800 (17,100)	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 6. Russian Launch Vehicle Activity in 2009

- A final mission in November lofted the Mini Research Module 2 to the ISS on a Soyuz rocket. This was an increased launch rate compared to 2008.

Russia conducted nine other government non-commercial launches in 2009. Three launches were for civil missions, while the rest were for military purposes. The civil missions included:

- A Cyclone 3 rocket put Coronas Photon into orbit.
- A Soyuz 2 1B lofted the Meteor M1.
- A Proton M placed three new Glonass navigation satellites into orbit.

Russia conducted six non-commercial launches for the military.

- Four launches placed military Kosmos satellites into orbit. Three of those launches lofted one Kosmos apiece, while the fourth deployed three Kosmos satellites.
- A Proton K launch placed the Raduga-1 communications satellite into GEO.
- A Soyuz 2 1A placed the Meridian 2 communications satellite into an elliptical orbit.

Russia also conducted one non-commercial launch of a commercial payload.

- A Proton M was used to lift Russia's Express AM44 communications satellite into GEO.

## **EUROPE**

Europe conducted seven Ariane 5 launches in 2009.

- Five were commercial launches from Kourou that placed communications satellites into GEO.
- A sixth was a non-commercial launch that sent ESA's Planck and Herschel observatories into orbit beyond the Moon.
- The seventh Ariane 5 launch placed the French Helios 2B reconnaissance satellite into a sun-synchronous orbit.

Six Ariane 5 ECA versions were used for the commercial launches and the Herschel/Planck mission. An Ariane 5 GS version was used to launch Helios 2B.

- On February 12, an ECA launched the NSS 9 and Hot Bird 10 communications satellites, as well as the French SPIRALE 1 and SPIRALE 2 military satellites.
- The second launch, using an ECA, took place on May 14, orbiting the ESA Planck and Herschel telescopes.
- On July 1, the third ECA launch deployed the TerreStar 1 mobile communications satellite, noteworthy as the single heaviest communications satellite ever placed into orbit.

- On August 21, an ECA version launched the Optus D3 and JCSAT 12 communications satellites.
- On October 1, an ECA version placed the commercial Amazonas 2 and German military COMSATBw 1 into GEO.
- On October 29, an ECA version orbited the NSS 12 and Thor 6 communications satellites.
- The final European launch of 2009 took place on December 18, using a GS version. This launch placed the French Helios 2B reconnaissance satellite into orbit.

Table 7 summarizes the 2009 European launch activity, as well as Chinese, Indian, Japanese, Iranian, North Korean, and South Korean launch activity, organized by country and vehicle.














	EUROPE	CHINA					JAPAN		INDIA	NORTH KOREA	SOUTH KOREA	IRAN	LAND LAUNCH
													
Vehicle	Ariane 5	Long March 2C	Long March 2D	Long March 3C	Long March 4C	Long March 3B	H 2A	H 2B	PSLV	Taepodong 2	KSLV-I	Safir	Zenit-3SLB
Country/Region	Europe	China	China	China	China	China	Japan	Japan	India	North Korea	South Korea	Iran	Ukraine
2009 Total Launches	7	2	1	1	1	1	2	1	2	1	1	1	3
Launch Reliability (2009)	7/7 100%	2/2 100%	1/1 100%	1/1 100%	1/1 100%	1/1 100%	2/2 100%	1/1 100%	2/2 100%	0/1 0%	0/1 0%	1/1 100%	3/3 100%
Launch Reliability (Last 10 Years)	44/46 96%	11/11 100%	8/8 100%	2/2 100%	3/3 100%	7/7 100%	15/16 94%	1/1 100%	11/11 100%	0/1 0%	0/1 0%	1/2 50%	4/4 100%
Year of First Launch	1996	1975	1992	2008	2007	1996	2001	2009	1993	2009	2009	2008	2007
Active Launch Sites	Kourou	Jiuquan, Taiyuan, Xichang	Jiuquan	Xichang	Taiyuan	Xichang	Tanegashima	Satish Dhawan	Tonghae	Naro	Iran Space Center	Baikonur	
LEO kg (lbs)	17,250 (37,950)	3,200 (7,048)	3,500 (7,700)	3,700 (8,200)	4,200 (9,250)	13,562 (29,900)	11,730 (25,860)	19,000 (42,000)	3,700 (8,150)	100? (220)?	100 (220)	?	13,920 (30,624)
GTO kg (lbs)	10,500 (23,127)	1,000 (2,203)	1,250 (2,750)	--	1,500 (3,300)	4,491 (9,900)	5,800 (12,800)	8,000 (17,600)	800 (1,760)	--	--	?	4120 (9060)

Table 7. European, Chinese, Indian, Japanese, Iranian, North Korean, and South Korean Launch Vehicle Activity in 2009

## CHINA

China conducted six orbital launches in 2009, of which one was commercial. This is just over half the 11 launches that China conducted in 2008.

China's one commercially-competed launch in 2009 was only a partial success, as the Indonesian Palapa D communications satellite was not inserted into the proper orbit.

The remaining five Chinese launches carried primary payloads with government missions. Three launches carried civilian payloads into space.

- A Long March 3C carried the Compass G2 navigation satellite to GEO
- A Long March 2C carried the Shijian 11-01 scientific satellite into LEO.
- A Long March 4C carried the Yaogan 8 remote sensing satellite into LEO as well as the non-profit Hope 1 scientific satellite.

Two launches carried military payloads.

- A Long March 2C carried the Yaogan 6 reconnaissance satellite to LEO.
- A Long March 2D carried the Yaogan 7 reconnaissance satellite into a sun-synchronous orbit.

## INDIA

The Indian Space Research Organisation (ISRO) performed two successful launches in 2009. Both launches used PSLV launch vehicles and were non-commercial.

- An April 20 launch carried the military Risat reconnaissance satellite and the non-profit Anusat into LEO.
- A September 23 launch carried seven payloads into orbit, the civilian Oceansat 2 and six non-profit educational/scientific satellites.

Both Indian launches took place from the Satish Dhawan Space Centre.

## JAPAN

Japan had three successful launches in 2009, one of which marked the debut of the H-2B rocket and the H-2 Transfer Vehicle (HTV), Japan's automated ISS resupply vehicle. All three were launched from the government site at Tanegashima.

Two launches were civilian, the January launch carrying SDS-1 and GOSAT and the September HTV launch.

The final Japanese launch of 2009 took place in late November and placed the military IGS Optical 3 reconnaissance satellite into orbit.

## **IRAN**

Iran conducted its first successful orbital launch on February 2. The payload was a small scientific satellite called Omid, the Farsi word for “hope”. The launch vehicle was a Safir three-stage orbital rocket. The non-commercial flight reached orbit and successfully deployed its small payload into LEO.

## **NORTH KOREA**

North Korea conducted its first orbital launch attempt since 1998 on April 5, but the launch was not a success. The Taepodong 2 rocket failed to place its payload, a satellite named Kwangmyongsong 2, into orbit.

The launch was unannounced, and the North Korean government released little information beyond the fact that it had occurred. The name of the rocket has not been confirmed by the North Koreans and the true nature of the payload was not revealed. There are suspicions that the launch was in fact a thinly-veiled ballistic missile test, much like the 1998 launch the North Koreans claimed as a satellite launch.

## **SOUTH KOREA**

The Korean Satellite Launch Vehicle (KSLV) 1 is a mixture of South Korean and Russian technology, using a modified Russian Angara as its first stage with an indigenously-developed second stage and payload assembly.

After years of preparation, South Korea performed its first orbital launch on August 25. However, the launch was not successful and the payload, the scientific STSAT 2A satellite, was not placed into orbit.

The cause of launch failure is thought to be a malfunctioning second stage, which failed to eject its payload fairing, preventing the rocket from achieving orbital velocity.

## FIVE-YEAR WORLDWIDE SPACE TRANSPORTATION TRENDS

Between 2005 and 2009, there was an average of 67 orbital launches per year worldwide (see Figure 9). There have been a total of 336 orbital launches conducted during the past five years.

Russia and the United States have conducted the most orbital launches, followed by China and Europe (see Figure 10).

One hundred and fourteen commercial orbital launches took place during the same five-year period, with an overall increasing trend from 18 in 2005 to 24 in 2009.

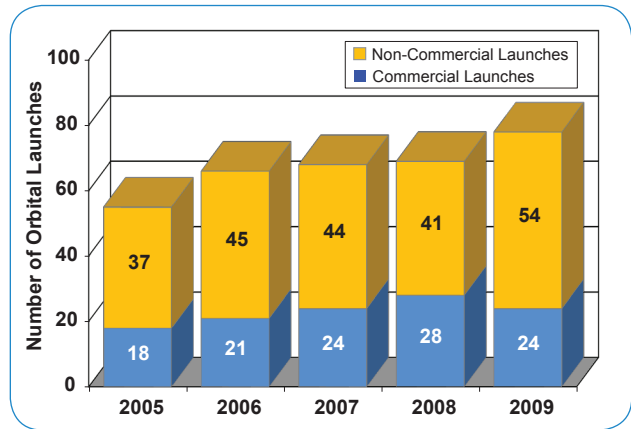


Figure 9. Five-Year Summary (2005–2009) of Commercial and Non-commercial Launch Events

- Since 2005, the United States has carried out 16 commercial launches,
- Russia exceeded this count with 50 commercial launches,
- Europe also surpassed the U.S. with 26 commercial launches, and
- The multinational Sea Launch Company performed 20 commercial launches, while India and China each have one. (see Figure 11).

The demand for commercial NGSO launches, which reached its zenith in the late 1990s, had been lagging during the four years prior to 2007. There was a brief jump in the number of commercial NGSO launches in 2007 and 2008, but this trend did not continue into 2009, as the number of commercial NGSO launches decreased

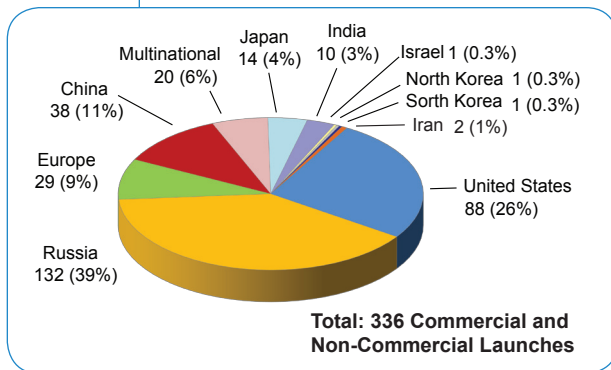


Figure 10. Five-Year Worldwide Total Orbital Launch Market Share (2005–2009)

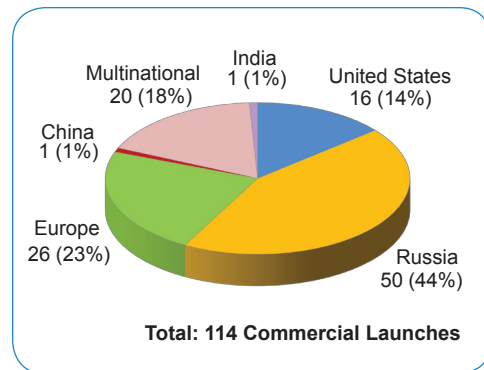


Figure 11. Five-Year Worldwide Commercial Orbital Launch Market Share (2005–2009)

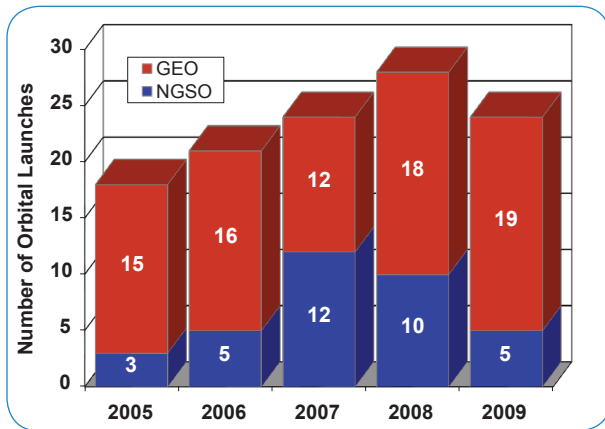


Figure 12. Five-Year Global Summary of Commercial Launch Events by Orbit (2005–2009)

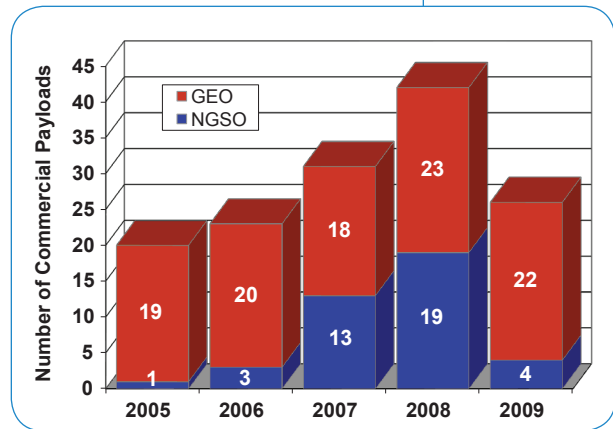


Figure 13. Five-Year Global Summary of Commercial Payloads by Orbit (2005–2009)

back to the its pre-2007 level. See Figure 12 for a breakdown of commercial launches by orbit type for the last five years.

Figure 13 shows the number of payloads providing commercial services launched on commercial and non-commercial vehicles over the past five years. The following points highlight the trends as depicted in the data:

- Between 2005 and 2009, the number of commercial GEO satellites launched each year remained between 15 and 20 satellites, but 2009 saw a jump in GEO commercial payloads to 23.
- The number of commercial NGSO satellites launched per year averaged two from 2004 to 2006, but the 13 payloads in 2007 and 19 in 2008 broke this previous low trend.
- 2009 saw a return to the smaller number of NGSO commercial a satellites.

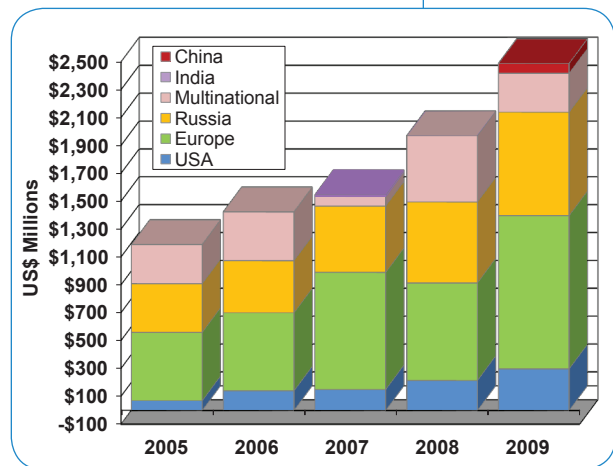


Figure 14. Approximate Launch Revenues for Commercial Launch Events (2005–2009)

Commercial launch revenues during the period, highlighted in Figure 14 and Table 8, showed a similar trend to the total number of commercial launches. Revenues steadily increased from 2005 to 2009. Revenues grew over 100 percent between 2005 and 2009, from US\$1.2 billion to over US\$2.4 billion.

	2005	2006	2007	2008	2009
USA	\$70	\$140	\$150	\$215	\$298
Europe	\$490	\$560	\$840	\$700	\$1,020
Russia	\$350	\$374	\$477	\$581	\$742
India	\$0	\$0	\$11	\$0	\$0
China	\$0	\$0	\$0	\$0	\$70
Multinational	\$280	\$350	\$70	\$475	\$280
<b>TOTAL</b>	<b>\$1,190</b>	<b>\$1,424</b>	<b>\$1,548</b>	<b>\$1,971</b>	<b>\$2,410</b>

Table 8. Approximate Launch Revenues for Commercial Launch Events 2005–2009 (US\$M)

## 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 extent, a variety of NGSO satellites, especially in 2007 and 2008.

Since 2005, nearly 70 percent of commercial launches have been to GEO, which generates more revenue than the NGSO market and generally deploys larger payloads.

2009 saw GEO satellites leading again and they will likely still be the primary commercial market driver in the near term. The following trends are expected:

- Growth in launch demand for NGSO communications satellites as existing constellations are replenished or replaced with next generation systems and new vehicles become available;
- Limited growth of launch demand for GEO communications satellites;
- A near-term trend of heavier GEO satellites followed by a decline and;
- Some limited growth in small mass GEO satellites.

These satellite industry trends will be augmented by continued competition among the United States, Europe, Russia, India, Japan and multinational firms such as Sea Launch to provide launch services.

The Chapter 11 filing by Sea Launch in June 2009 has had some impact on the launch industry, as customers have moved their payloads to other launch providers, most notably to the Russian Proton M, which is marketed commercially by International Launch Services.

2009 saw three launches of the Land Launch Zenit-3SLB rocket. This rocket, essentially a Zenit-3SL slightly modified to launch from Baikonur Cosmodrome instead of the Sea Launch platform, debuted in 2008, and successfully completed all three of its 2009 launches. Land Launch is collaboration between the Sea Launch Company and Moscow-based Space International Services.

China will continue with non-competed launches of commercial satellites, some of which, known as “ITAR-free” satellites, have excluded U.S. components in order to avoid U.S. export controls.

SpaceX made one FAA-licensed launch in 2009, successfully launching a remote-sensing satellite into LEO for the Malaysian government. The launch, which took place in July, was the first successful commercial launch of the Falcon 1. SpaceX is also developing its larger Falcon 9 rocket. Expected to have its first test launch in the first quarter of 2010, the Falcon 9 could grow to compete with other heavy lift rockets such as the Zenit-3SL, Proton, and Ariane 5. The Taurus II medium-class vehicle is being developed by Orbital Sciences for a 2011 debut.

South Korea debuted its own small launch vehicle, designated the Korea Space Launch Vehicle (KSLV) 1, in August. The debut launch of the KSLV 1 was



not successful, as the payload fairing failed to separate, preventing the second stage from achieving orbital velocity. Also on the horizon is Europe's Vega small launch vehicle. The Vega, developed predominantly in Italy, could also enter the commercial market after its debut in late 2010 or early 2011.

## INTERNATIONALLY COMPETED LAUNCHES

As commercial space business increases and replaces various forms of traditionally government-operated activities, the definitions of "commercial payload" and "commercial launch" become more complex and open to interpretation. See Appendix II that gives definitions to these terms.

Figure 15 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 2005 to 2009, there were 108 internationally-competeted launch events.

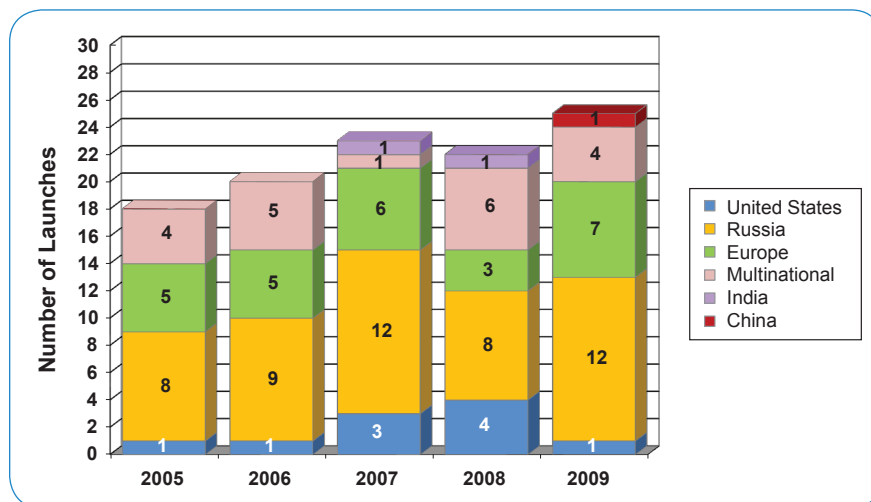


Figure 15. Five-Year Worldwide Internationally Competed Launch Events (2005–2009)\*

\* An internationally competed launch contract is one in which the launch opportunity was available in principle to any capable launch service provider. For Figure 15 only, this definition precludes government sponsored payloads launched commercially (some have been licensed by FAA/AST) when government policy prohibits open competition for the launch. The definition also does not cover payloads captive to their own launch providers (a distinction that is made by either a country or launch service company), test payloads, dummy payloads, or small secondary payloads.

## **2009 FAA EXPERIMENTAL PERMIT FLIGHT SUMMARY**

In 2009, there were no low altitude flights conducted under the authority of FAA experimental permits. This contrasts to the five tests conducted in 2008, and the nine tests conducted in 2007. Previous permitted flights were competitors in the Northrop Grumman Lunar Lander Challenge. Prior to 2009, these vehicles required FAA permits to fly, but in 2009 FAA regulations changed, allowing competitors to fly their vehicles under the amateur rocketry regulations.

In contrast to FAA licensed flights, permitted flights are limited to reusable suborbital launch vehicles and intended for technology development, particular testing for crew, or testing prior to obtaining a license. Vehicles cannot carry property or people for compensation or hire. The first permit flights took place in 2006 after authority was granted by the U.S. Congress in 2004.

## APPENDIX I: 2009 WORLDWIDE ORBITAL LAUNCH EVENTS

Date	Vehicle	Site	Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l Price	L	M
17-Jan-09	Delta 4 Heavy	Cape Canaveral AFS	NRO L-26	GEO	NRO	USA	Intelligence		S	S
23-Jan-09	H 2A 202	Tanegashima	SDS-1 GOSAT	SSO LEO	JAXA JAXA	Mitsubishi Electric Corp. JAXA	Scientific Development		S S	S S
30-Jan-09	Cyclone 3	Plesetsk	Coronas Photon	LEO	Roscosmos	Roscosmos	Scientific		S	S
02-Feb-09	Safir	Semnan Province	Omid	LEO	Iran's Aerospace Organisation	Iranian Space Agency	Development		S	S
06-Feb-09	Delta 2 7320	Vandenberg AFB	NOAA N Prime	LEO	NOAA	Lockheed Martin Corp.	Meteorological		S	S
10-Feb-09	Soyuz	Baikonur	Progress ISS 32P	LEO	Federal Space Agency	RSC Energia	Supply		S	S
11-Feb-09	Proton M	Baikonur	* Express MD 1 * Express AM44	GEO GEO	Russian Satellite Communication Co. Russian Satellite Communication Co.	Reshetnev Company Khronichev State Research and Production Space Center	Communications Communications		S S	S S
12-Feb-09	V Ariane 5 ECA	Kourou	* NSS 9 SPIRALE 1 SPIRALE 2 * Hot Bird 10	GEO ELI ELI GEO	Eutelsat DGA DGA SES New Skies	EADS Astrium Alcatel Espace Alcatel Espace Orbital Sciences Corp.	Communications Intelligence Intelligence Communications	\$220 M	S S S S	S S S S
24-Feb-09	Taurus XL	Vandenberg AFB	Orbiting Carbon Observatory	LEO	NASA/GSFC	Orbital Sciences Corp.	Scientific		F	F
26-Feb-09	V Zenit 3SLB	Baikonur	* Telstar 11N	GEO	Loral Skynet	Space Systems/Loral	Communications	\$60 M	S	S
28-Feb-09	Proton (SL-13)	Baikonur	Raduga-1	GEO	Russian MoD	Reshetnev Company	Communications		S	S
06-Mar-09	Delta 2 7925-10	Cape Canaveral AFS	Kepler	EXT GEO	NASA	Ball Aerospace and Technologies Corp.	Scientific		S	S
15-Mar-09	Shuttle Discovery	Kennedy Space Center	ISS 15A STS 119 MPLM 4	LEO LEO LEO	NASA NASA NASA	Rockwell International The Boeing Company NASA	Crewed Space Station Space Station		S S S	S S S
17-Mar-09	V Rockot	Plesetsk	GOCE	SSO	European Space Agency	Thales Alenia Space	Scientific	\$15 M	S	S
24-Mar-09	Delta 2 7925	Cape Canaveral AFS	Navstar GPS 2RM-7	MEO	U.S. Air Force	Lockheed Martin Corp.	Navigation		S	S
26-Mar-09	Soyuz	Baikonur	Soyuz ISS 18S	LEO	Roscosmos	RSC Energia	Space Station		S	S
03-Apr-09	Atlas 5 412	Cape Canaveral AFS	* WGS 2	GEO	DoD	The Boeing Company	Communications	\$100 M	S	S
03-Apr-09	V Proton M	Baikonur	Eutelsat W2A	GEO	Eutelsat	Thales Alenia Space	Communications	\$100 M	S	S
05-Apr-09	Taepodong 2	Musudan-ri	Kwangmyongsong-2	LEO	North Korea	North Korea	Communications		F	F
15-Apr-09	Long March 3C	Xichang	Compass G2	GEO	China	CAST	Navigation		S	S
20-Apr-09	PSLV	Sriharikota	Anusat Risat 2	LEO LEO	ISRO ISRO	Anna University Israel Aerospace Industries	Communications Remote Sensing		S S	S S
20-Apr-09	V Zenit 3SL	Sea Launch/Odyssey Launch Platform	Sicral 1B	GEO	Italian Ministry of Defense	Thales Alenia Space	Communications	\$100 M	S	S
22-Apr-09	Long March 2C	Taiyuan	Yaogan 6	LEO	China	CAST	Remote Sensing		S	S
29-Apr-09	Soyuz	Plesetsk	Kosmos 2450	LEO	Russian Space Forces	TsSKB Progress	Intelligence		S	S
05-May-09	Delta 2 7920	Vandenberg AFB	STSS-ATRR	LEO	Missile Defense Agency (MDA)	Northrop Grumman Corporation	Military		S	S
07-May-09	Soyuz	Baikonur	Progress ISS 33P	LEO	Federal Space Agency	RSC Energia	Supply		S	S
11-May-09	Shuttle Atlantis	Kennedy Space Center	Hubble Servicing Mission 4 STS 125	LEO LEO	NASA NASA	Rockwell International Hubble Space Telescope Project	Crewed Other		S S	S S

V Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed, or privately-financed launch activity.

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

See Appendix II for definitions of payload orbits.

L and M refer to the outcome of the Launch and Mission: S=Success, P=Partial Success, F=Failure.

Note: All launch dates are based on local time at the launch site.

Note: All prices are estimates.

## APPENDIX I (CONT'D)

Date	Vehicle	Site	Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l Price	L	M
14-May-09	Ariane 5 ECA	Kourou	Planck Surveyor Herschel Space Observatory	EXT EXT	European Space Agency European Space Agency	Thales Alenia Space Thales Alenia Space	Scientific Scientific		S S	S S
16-May-09	V Proton M	Baikonur	* Protostar II	GEO	Protostar Ltd.	Boeing Satellite Systems	Communications	\$100 M	S	S
19-May-09	Minotaur	Wallops Flight Facility	GeneSat 2 PharmaSat 1 TacSat 3	LEO LEO LEO	U.S. Air Force NASA NASA	Swales Aerospace NASA NASA	Development Scientific Scientific		S S S	S S S
22-May-09	Soyuz 2 1A	Plesetsk	Meridian 2	ELI	Russian MoD	NPO PM	Communications		S	S
27-May-09	Soyuz	Baikonur	ISS 19S	LEO	Russian Space Agency	Russian Space Agency	Supply		S	S
18-Jun-09	Atlas 5 401	Cape Canaveral AFS	LCROSS  Lunar Reconnaissance Orbiter	EXT  EXT	NASA  NASA	Northrop Grumman Corporation NASA/GSFC	Scientific  Scientific		S  S	S  S
21-Jun-09	V Zenit 3SLB	Baikonur	* Measat 3A	GEO	MEASAT Satellite Systems Sdn. Bhd.	Orbital Sciences Corp.	Communications	\$60 M	S	S
27-Jun-09	V Delta 4 Medium-Plus (4,2)	Cape Canaveral AFS	GOES 0	GEO	NOAA	The Boeing Company	Meteorological	\$170 M	S	S
01-Jul-09	V Ariane 5 ECA	Kourou	* TerreStar 1	GEO	TerreStar Networks Inc.	Space Systems/Loral	Communications	\$140 M	S	S
01-Jul-09	V Proton M	Baikonur	* Sirius FM-5	GEO	Sirius Satellite Radio Inc.	Space Systems/Loral	Communications	\$100 M	S	S
06-Jul-09	Rocket	Plesetsk	Kosmos 2452 Kosmos 2453 Kosmos 2451	LEO LEO LEO	Russian MoD Russian MoD Russian MoD	NPO PM NPO PM NPO PM	Communications Communications Communications		S S S	S S S
13-Jul-09	V Falcon 1	Kwajalein Island	RazakSAT	LEO	Malaysia National Space Agency	Astronautic Technology (M) Sdn Bhd	Development	\$8 M	S	S
15-Jul-09	Shuttle Endeavour	Kennedy Space Center	AggieSat-2 BEVO 1  STS 127	LEO LEO LEO	NASA University of Texas - Austin Texas A&M University	Rockwell International University of Texas - Austin Texas A&M University	Crewed Development Development		S S S	S S S
21-Jul-09	Kosmos 3M	Plesetsk	Sterkh 1 Kosmos 2454	LEO LEO	Russian MoD Russia - TBA	Reshetnev Company AKO Polyot	Navigation Other		S S	S S
24-Jul-09	Soyuz	Baikonur	Progress ISS 34P	LEO	Russian Space Agency	RSC Energia	Supply		S	S
29-Jul-09	V Dnepr 1	Baikonur	* AprizeStar 3  * AprizeStar 4 * DEIMOS Nanosat 1B  UK DMC 2 DubaiSat-1	LEO  LEO LEO LEO LEO LEO	Deimos Imaging SL  Aprize Satellite Aprize Satellite British National Space Centre Instituto Nacional de Tecnica Aeroespacial (INTA) EIAST	Surrey Satellite Technology Ltd.  SpaceQuest, Ltd. SpaceQuest, Ltd. Surrey Satellite Technology Ltd. Instituto Nacional de Tecnica Aeroespacial (INTA) KARI	Remote Sensing  Communications Communications Remote Sensing Communications Remote Sensing	\$15 M	S  S S S S S	S  S S S S S
11-Aug-09	V Proton M	Baikonur	* Asiasat 5	GEO	Asia Satellite Telecommunications Co. (Asiasat)	Space Systems/Loral	Communications	\$100 M	S	S
17-Aug-09	Delta 2 7925	Cape Canaveral AFS	Navstar GPS 2RM-8	MEO	U.S. Air Force	Lockheed Martin Commercial Space Systems	Navigation		S	S
21-Aug-09	V Ariane 5 ECA	Kourou	* Optus D3 * JCSAT 12	GEO GEO	Singtel/Optus Japan Satellite Systems (JSAT)	Orbital Sciences Corp. Lockheed Martin Commercial Space Systems	Communications Communications	\$220 M	S S	S S
25-Aug-09	KSLV 1	Naro Space Center	STSAT 2A	LEO	KARI	KARI	TBA		F	F

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

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Note: All prices are estimates.

## APPENDIX I (CONT'D)

Date	Vehicle	Site	Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l Price	L	M
28-Aug-09	Shuttle Discovery	Kennedy Space Center	STS 128	LEO	NASA	Rockwell International	Crewed		S	S
31-Aug-09	V Long March 3B	Xichang	* Palapa D	GEO	PT Indosat Tbk	Thales Alenia Space	Communications	\$70 M	P	P
08-Sep-09	Atlas 5 401	Cape Canaveral AFS	PAN	GEO	USA - TBA	Lockheed Martin Corp.	Military		S	S
10-Sep-09	H 2B	Tanegashima	HTV	LEO	JAXA	Mitsubishi Heavy Industries	Supply		S	S
17-Sep-09	Soyuz 2 1B	Baikonur	Sumbandila	LEO	Russian Meteorological Service	VNIIElektromekhaniki	Meteorological		S	S
			Meteor M1	MEO	University of Stellenbosch	University of Stellenbosch	Development		S	S
18-Sep-09	V Proton M	Baikonur	* Nimiq 5	GEO	Telesat Canada	Space Systems/Loral	Communications	\$100 M	S	S
23-Sep-09	PSLV	Satish Dhawan Space Center	BeeSat	LEO	OHB System	OHB System	Scientific		S	S
			ITU-pSat	LEO	OHB System	OHB System	Development		S	S
			Rubin 9.1	LEO	Technical University of Berlin	Technical University of Berlin	Development		S	S
			Rubin 9.2	LEO	University of Wurzburg	University of Wurzburg	Scientific		S	S
			SwissCube-1	LEO	Istanbul Technical University Turkey	Istanbul Technical University Turkey	Scientific		S	S
			UWE-2	LEO	Ecole Polytechnique Federale De Lausanne	Ecole Polytechnique Federale De Lausanne	Scientific		S	S
			Oceansat 2	SSO	ISRO	ISRO	Remote Sensing		S	S
25-Sep-09	Delta 2 7920	Cape Canaveral AFS	STSS Demo 2	LEO	U.S. Air Force	Northrop Grumman Corporation	Development		S	S
			STSS Demo 1	LEO	U.S. Air Force	Northrop Grumman Corporation	Development		S	S
30-Sep-09	Soyuz	Baikonur	ISS 20S	LEO	Russian Space Agency	RSC Energia	Crewed		S	S
01-Oct-09	V Ariane 5 ECA	Kourou	COMSATBw 1	GEO	EADS Astrium	EADS Astrium	Communications	\$220 M	S	S
			* Amazonas 2	GEO	Hispasat	EADS Astrium	Communications		S	S
08-Oct-09	V Delta 2 7920	Vandenberg AFB	* WorldView 2	LEO	DigitalGlobe	Ball Aerospace and Technologies Corp.	Remote Sensing	\$65 M	S	S
15-Oct-09	Soyuz	Baikonur	Progress ISS 35P	LEO	Russian Space Agency	RSC Energia	Supply		S	S
18-Oct-09	Atlas 5 401	Vandenberg AFB	DMSP 5D-3-F18	SSO	DoD	Lockheed Martin Corp.	Meteorological		S	S
29-Oct-09	V Ariane 5 ECA	Kourou	* NSS 12	GEO	Telenor A.S.	Thales Alenia Space	Communications	\$220 M	S	S
			* Thor 6	GEO	SES New Skies	Space Systems/Loral	Communications		S	S
02-Nov-09	V Rockot	Plesetsk	Proba 2	SSO	European Space Agency	Alcatel Espace	Remote Sensing	\$15 M	S	S
			SMOS	SSO	European Space Agency	Verhaert Design and Development	Development		S	S
10-Nov-09	Soyuz	Baikonur	Mini Research Module 2	LEO	Russian Space Agency	RSC Energia	Scientific		S	S
12-Nov-09	Long March 2C	Jiuquan	Shijian 11-01	LEO	China National Space Administration	China - TBA	Scientific		S	S
16-Nov-09	Shuttle Atlantis	Kennedy Space Center	STS 129	LEO	NASA	Rockwell International	Crewed		S	S
20-Nov-09	Soyuz-U	Plesetsk	Kosmos 2455	ELI	Russian MoD	Russia - TBA	Intelligence		S	S
23-Nov-09	V Proton M	Baikonur	* Eutelsat W7	GEO	Eutelsat	Thales Alenia Space	Communications	\$100 M	S	S
23-Nov-09	V Atlas 5 431	Cape Canaveral AFS	* Intelsat 14	GEO	Intelsat	Space Systems/Loral	Communications	\$125 M	S	S
28-Nov-09	H 2A 2024	Tanegashima	IGS Optical 3	LEO	Japan Defense Agency	Mitsubishi Heavy Industries	Intelligence		S	S
01-Dec-09	V Zenit 3SLB	Baikonur	* Intelsat 15	GEO	Intelsat	Orbital Sciences Corp.	Communications	\$60 M	S	S

V Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed, or privately-financed launch activity.

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

See Appendix II for definitions of payload orbits.

L and M refer to the outcome of the Launch and Mission: S=Success, P=Partial Success, F=Failure.

Note: All launch dates are based on local time at the launch site.

Note: All prices are estimates.

## APPENDIX I (CONT'D)

Date	Vehicle	Site	Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l Price	L	M
05-Dec-09	Delta 4 Medium-Plus (5,4)	Cape Canaveral AFS	WGS 3	GEO	DoD	The Boeing Company	Communications		S	S
09-Dec-09	Long March 2D	Jiuquan	Yaogan 7	SSO	China	CAST	Remote Sensing		S	S
14-Dec-09	Proton M	Baikonur	Glonass M R23	MEO	Russian MoD	NPO PM	Navigation		S	S
			Glonass M R24	MEO	Russian MoD		Navigation		S	S
			Glonass M R22	MEO	Russian MoD		Navigation		S	S
14-Dec-09	Delta 2 7320	Vandenberg AFB	WISE	SSO	JPL	Ball Aerospace and Technologies Corp.	Scientific		S	S
15-Dec-09	Long March 4C	Taiyuan	Hope 1	SSO	China	China	Scientific		S	S
			Yaogan 8	SSO	China	CAST	Remote Sensing		S	S
18-Dec-09	Ariane 5 GS	Kourou	Helios 2B	SSO	Delegation Generale pour l'Armement (DGA)	EADS Astrium	Intelligence		S	S
21-Dec-09	Soyuz	Baikonur	ISS 21S	LEO	Roscosmos	RSC Energia	Space Station		S	S
29-Dec-09	V Proton M	Baikonur	* DirecTV 12	GEO	DirecTV, Inc.	Boeing Satellite Systems	Communications	\$100 M	S	S

V Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed, or privately-financed launch activity.

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

See Appendix II for definitions of payload orbits.

L and M refer to the outcome of the Launch and Mission: S=Success, P=Partial Success, F=Failure.

Note: All launch dates are based on local time at the launch site.

Note: All prices are estimates.

## APPENDIX II: DEFINITIONS

### COMMERCIAL SUBORBITAL OR ORBITAL LAUNCH

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A commercial suborbital or orbital launch has one or more of the following 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.

### INTERNATIONALLY COMPETED

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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

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A commercial payload is described as having one or both of the following 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 telecommunication satellites whose transponders are partially or totally leased to a variety of organizations, some or all of which generate revenues. Examples are Russia's Express and Ekran series of spacecraft. All other payloads are classified as noncommercial (government civil, government military, or non-profit).

### ORBITS

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- 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. 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., over 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), and all other high or elliptical orbits or trajectories. ELI is used to describe a highly elliptical orbit (such as those used for Russian Molniya satellites), and EXT is a designation used for orbits beyond GEO (such as interplanetary trajectories).

