



**Federal Aviation  
Administration**

# **Commercial Space Transportation: 2008 Year In Review**

**January 2009**

SLOAN  
2009

## 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>.

Cover: Art by John Sloan (2009)

### NOTICE

Use of trade names or names of manufacturers in this document does not constitute an official endorsement of such products or manufacturers, either expressed or implied, by the Federal Aviation Administration.

## Table of Contents

<b>Introduction</b> .....	<b>1</b>
<b>2008 FAA-Licensed Orbital Launch Summary</b> .....	<b>3</b>
<b>U.S. and FAA-Licensed Orbital Launch Activity in Detail</b> .....	<b>5</b>
<b>2008 Worldwide Orbital Launch Activity</b> .....	<b>8</b>
<b>Worldwide Orbital Payload Summary</b> .....	<b>11</b>
<b>Launch Activities by Country</b> .....	<b>13</b>
<b>Five-Year Worldwide Space Transportation Trends</b> .....	<b>17</b>
<b>2008 FAA Experimental Permit Flight Summary</b> .....	<b>21</b>
<b>Appendix : 2008 Worldwide Orbital Launch Events</b> .....	<b>22</b>

## INTRODUCTION

The *Commercial Space Transportation: 2008 Year in Review* summarizes U.S. and international launch activities for calendar year 2008 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 eleven commercial orbital launches in 2008, over twice the four licensed launches in 2007. The year included the first successful launch of a new U.S. rocket, the Falcon 1 built by SpaceX.

Of the eleven orbital licensed launches, six used U.S.-built vehicles. Two launches were on the United Launch Alliance (ULA) Delta II operated by Boeing Launch Services, while one was a ULA Atlas V operated by Lockheed Martin. Two launches were by the privately-developed SpaceX Falcon 1 rocket. One launch was carried out by Orbital Sciences Corporation's Pegasus XL rocket. The other five launches used the multinational Sea Launch Zenit-3SL.

Overall, 28 commercial orbital launches occurred worldwide in 2008, representing 41 percent of the 69 total launches for the year. This marked an increase over 2007, which saw 23 commercial orbital launches worldwide.

Russia conducted 11 commercial launch campaigns in 2008, bringing its international commercial launch market share to 39 percent for the year, a decrease from 2007. FAA/AST-licensed orbital launch activity accounted for 39 percent of the worldwide commercial launch market in 2008 while Europe attained an 18 percent market share, conducting five commercial Ariane 5 launches.

Of the 69 worldwide orbital launches, there were three launch failures, including one non-commercial launch and two commercial launches. The non-commercial launch failure is attributed to Iran's August 17 launch attempt of the Safir vehicle. On the commercial side, a Russian Proton launch and a SpaceX Falcon 1 failed.

Five low-altitude flights under FAA experimental permits took place in 2008. Four suborbital permitted flights were carried out by Armadillo Aerospace and one permitted flight was performed by TrueZero.

The following definitions apply to the *Commercial Space Transportation: 2008 Year in Review*.

### Commercial Suborbital or Orbital Launch

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 Completed**

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

### **Commercial Payload**

A commercial payload 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 non-commercial (government civil, government military, or non-profit).

### **Orbits**

- A spacecraft in geostationary Earth orbit (GSO) is synchronized with the Earth's rotation, orbiting once every 24 hours, and appears to an observer on the ground to be stationary in the sky. 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).

## 2008 FAA-LICENSED ORBITAL LAUNCH SUMMARY

Recent trends in annual FAA-licensed orbital launches show that after a rough year in 2007, GEO launches took back center stage with 6 of 11 FAA-licensed commercial launches in 2008. In 2005 and 2006, FAA-licensed launches were dominated by GEO launches. After a Sea Launch failure in early 2007, there were no further launches of the Zenit-3SL 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. These eleven launches are summarized in Table 1.

The two Delta II launches both took place from a U.S. range: Vandenberg Air Force Base (VAFB) in California. The launches both successfully placed their respective remote sensing payloads into LEO.

Five Zenit-3SL launches from the Sea Launch Odyssey platform occurred during 2008. All five launches successfully placed their communications satellite payloads into GEO.

The 11 FAA-licensed launches included the following characteristics:

- Eight of the launches were conducted for commercial clients (DISH Network, DirecTV, Intelsat, SES New Skies, ICO, Thuraya, and Geoeye Inc.), while two were launches of the privately-developed Falcon 1 (one with a U.S. government customer) and a Delta II launch was for the Italian government.
- The eleven launches were worth an estimated US\$640 million.<sup>1</sup>

Date	Vehicle	Payload	Orbit	Launch Outcome
15-Jan-08	Zenit-3SL	Thuraya 3	GEO	Success
19-Mar-08	Zenit-3SL	DirecTV 11	GEO	Success
14-Apr-08	Atlas V 421	ICO G1	GEO	Success
16-Apr-08	Pegasus XL	C/NOFS	LEO	Success
21-May-08	Zenit-3SL	Galaxy 18	GEO	Success
15-Jul-08	Zenit-3SL	Echostar XI	GEO	Success
03-Aug-08	Falcon 1	Jumpstart, et al.	LEO	Failure
06-Sep-08	Delta II 7420-10	GeoEye 1	LEO	Success
24-Sep-08	Zenit-3SL	Galaxy 19	GEO	Success
28-Sep-08	Falcon 1	Flight 4	LEO	Success
24-Oct-08	Delta II 7420-10	COSMO-SkyMed 3	LEO	Success

Table 1. 2008 FAA-Licensed Orbital Launch Events

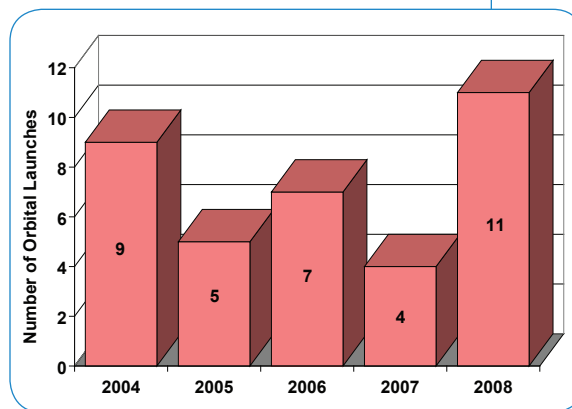


Figure 1. FAA-Licensed Orbital Launch Events, 2004-2008

<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 2008 was the highest since 1999. Since 2004, launch rates have fluctuated (see Figure 1) but the resurgence of the Sea Launch system saw revenues climb. A trend similar to that for annual launches is evident for estimated FAA-licensed commercial orbital launch revenues from 2004 to 2008 (see Figure 2).

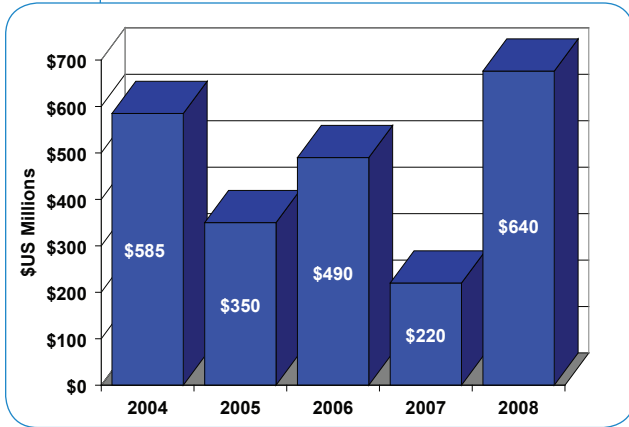


Figure 2. Estimated Revenues for FAA-Licensed Orbital Launch Events, 2004-2008

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

U.S. vehicles carried out a total of 15 launches in 2008, six of which were licensed by FAA/AST. Of the nine non-commercial U.S. launches, four were Space Shuttle missions, two carried U.S. Department of Defense (DoD) payloads or were sponsored by the DoD, and the remaining three were National Aeronautics and Space Administration (NASA) civil government missions.

Sea Launch conducted five FAA-licensed commercial launches.

See Table 2 for a detailed breakdown of U.S. launch activity (including Sea Launch) during 2008 by vehicle.







	UNITED STATES					SEA LAUNCH
						
Vehicle	Pegasus XL	Falcon I	Delta II	Atlas V	Shuttle	Zenit-3SL
2008 Total Launches	2	2	5	2	4	5
2008 Licensed Launches	1	2	2	1	0	5
Launch Reliability (2008)	2/2 100%	1/2 50%	5/5 100%	2/2 100%	4/4 100%	5/5 100%
Launch Reliability (Last 10 Years)	13/13 100%	1/4 25%	62/62 100%	14/14 100%	31/31 100%	28/30 93%
Year of First Launch	1994	2006	1990	2002	1981	1999
Active Launch Sites	CCAFS, Kwajalein, VAFB, WFF	Kwajalein	CCAFS, VAFB	CCAFS, VAFB	KSC	Odyssey Pacific Ocean Platform
LEO kg (lbs)	443 (977)	454 (1,000)	6,100 (13,440)	20,520 (45,240)	23,435 (51,557)	15,246 (33,541)
GTO kg (lbs)	--	--	2,170 (4,790)	8,670 (19,110)	5,663 (12,459)	6,100 (13,440)

Table 2. U.S. and FAA-Licensed Launch Vehicle Performance in 2008

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.



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

BLS is the provider of Delta series rockets for commercial customers. BLS conducted two commercial launches in 2008, both using the Delta II vehicle. In September, a Delta II 7420-10 was used to launch the GeoEye-1 earth observation satellite, while the third COSMO-SkyMed satellite was launched by a Delta II in October. The COSMO-SkyMed satellites are the Italian government's new series of remote sensing spacecraft. 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 2008, LMCLS performed one launch. The launch took place in April and was commercially licensed, placing the ICO G1 communications satellite into GEO. ICO G1 is owned and operated by ICO Global Communications and provides mobile satellite services.

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

OSC provides the Minotaur, Pegasus, and Taurus vehicles for orbital launch. OSC performed two successful launches in 2008, one of which was commercially licensed and the other non-commercial. The April 16 launch of the commercially-licensed Pegasus XL placed the Communications/Navigation Outage Forecasting System (C/NOFS) into orbit, which is owned and operated by the U.S. Air Force. The second OSC launch took place on October 19 put the NASA Interstellar Boundary Explorer mission into a highly elliptical orbit using a Pegasus XL vehicle.

## **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. Sea Launch returned to flight in 2008, following a January 2007 launch failure. In 2008, Sea Launch carried out five successful commercial launches, taking communications satellites in GEO for DirecTV, the Dish Network, Intelsat, and Thuraya. 2008 also saw the April 28 premiere of the Land Launch system, operated by Sea Launch LLC and launched from Baikonur Cosmodrome. Boeing is the majority shareholder (40 percent) of Sea Launch. Other partners include 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).

## **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 third and fourth Falcon 1 launches in August and September. Both launches took place at the SpaceX launch site on Omelek Island in the Kwajalein Atoll. The third launch was

nominal until an error in stage separation timing caused the expended first stage to collide with the second shortly after separation, preventing the craft from attaining orbit. The fourth launch was completely successful, carrying a dummy payload into LEO and marking the first successful orbital flight of a privately-developed and operated liquid-fueled rocket.

### **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 2008, ULA conducted four U.S. government non-commercial launches. Three Delta II vehicles launched the following payloads: the Navstar GPS 2RM-6 for the DoD, the GLAST (Gamma-ray Large Area Space Telescope) and Jason 2 ocean topography spacecraft for NASA. A ULA Atlas V vehicle was launched April, placing the NRO L-28 reconnaissance satellite into an elliptical orbit.

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

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

## 2008 WORLDWIDE ORBITAL LAUNCH ACTIVITY

	Commercial Launches	Non-commercial Launches	Total Launches
United States	6	9	15
Russia	11	15	26
Europe	5	1	6
China	0	11	11
Multinational	6	0	6
India	0	3	3
Japan	0	1	1
Iran	0	1	1
<b>TOTAL</b>	<b>28</b>	<b>41</b>	<b>69</b>

Table 3. 2008 Worldwide Orbital Launch Events

Launch providers from the United States, Russia, Europe, China, Japan, India, Iran, and the multinational consortium Sea Launch conducted a total of 69 launch events in 2008, 28 of which were commercial (see Table 3 and Figure 3). 2008 saw a significant increase in commercial launches from 2007, helped in part by the return of the Sea Launch Zenit-3SL to service. See Table 4 for a list of non-FAA-licensed commercial launches.

U.S.-built vehicles conducted six commercial launches in 2008, accounting for 21 percent of the global commercial launch market (see Figure 4).

Russia led with 11 commercial launches, capturing 39 percent of the market, a decrease from last year. Europe conducted five Ariane 5 commercial launches in 2008, for a 18 percent market share. Sea Launch had five commercial launches while its Land Launch joint venture conducted its first-ever launch to comprise a 21 percent share for Multinational launch entities.

The Appendix at the end of this report shows all 69 orbital launches worldwide in 2008, including commercial, civil, and military missions.

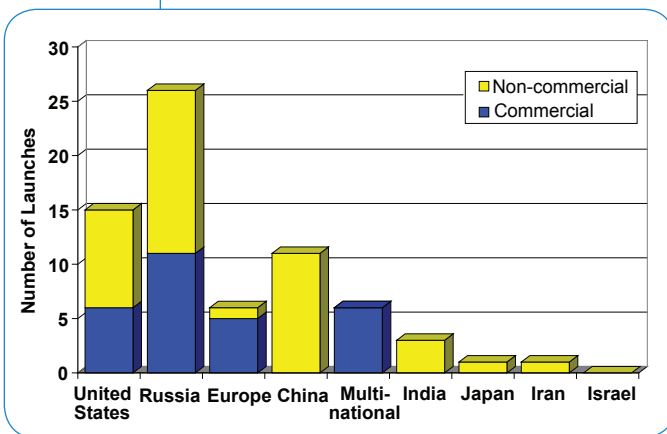


Figure 3. 2008 Total Worldwide Launch Activity

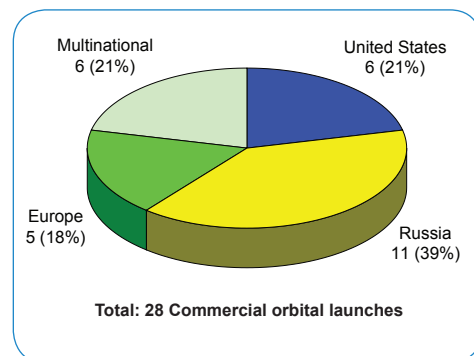


Figure 4. 2008 Worldwide Commercial Market Share

Date	Vehicle	Payload(s)	Orbit	Launch Outcome
11-Feb-08	Proton M	Thor 5	GEO	Success
14-Mar-08	Proton M	AMC 14	GEO	Failure
27-Mar-08	Kosmos 3M	SAR Lupe 4	LEO	Success
18-Apr-08	Ariane 5 ECA	Star One C2, Vinasat	GEO	Success
28-Apr-08	Zenit-3SLB	Amos 3	GEO	Success
12-Jun-08	Ariane 5 ECA	Turksat 3A, Skynet 5C	GEO	Success
19-Jun-08	Kosmos 3M	ORBCOMM CDS 3, ORBCOMM Replacement 1-5, UGATUSAT	LEO	Success
07-Jul-08	Ariane 5 ECA	BADR-6, Protostar 1	GEO	Success
22-Jul-08	Kosmos 3M	SAR Lupe 5	LEO	Success
14-Aug-08	Ariane 5 ECA	AMC 21, Superbird 7	GEO	Success
19-Aug-08	Proton M	Inmarsat-4 F3	GEO	Success
29-Aug-08	Dnepr I	RapidEye 1-5	LEO	Success
20-Sep-08	Proton M	Nimiq 4	GEO	Success
01-Oct-08	Dnepr I	THEOS	LEO	Success
06-Nov-08	Proton M	Astra 1M	GEO	Success
10-Dec-08	Proton M	Ciel 2	GEO	Success
20-Dec-08	Ariane 5 ECA	Eutelsat W2M, Hotbird 9	GEO	Success

Table 4. 2008 Non-FAA-Licensed Commercial Launch Events

## WORLDWIDE LAUNCH REVENUES

Revenues from the 28 commercial launch events in 2008 amounted to an estimated US\$1.97 billion, an increase of about US\$360 million from the commercial revenues achieved in 2007. U.S. commercial launch revenues for 2008 were estimated to be US\$215 million and Russian revenues were approximately US\$581 million. European revenues were about US\$700 million and Sea Launch had an estimated US\$475 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, 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

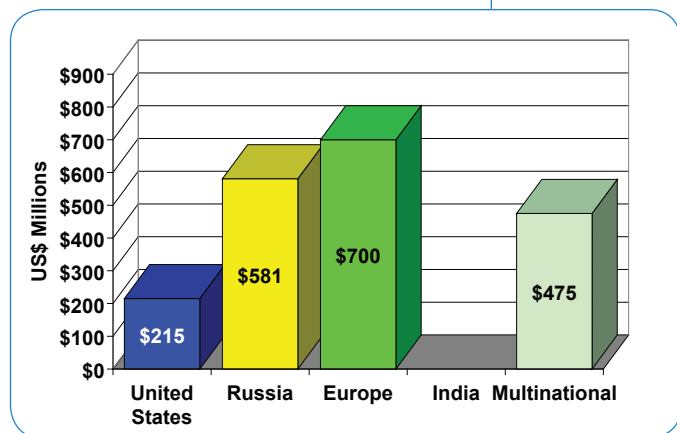


Figure 5. Approximate 2008 Commercial Launch Revenues

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.

For these reasons, all prices and revenue shares quoted throughout this report are estimates.

## WORLDWIDE ORBITAL PAYLOAD SUMMARY

In 2008, 69 launches carried a total of 106 payloads into orbit (see Figure 6, Figure 7, and Table 5). Of the 106 payloads, 42 provide commercial services (see Figure 8 for a breakdown of these payloads by launch country). The remaining 64 payloads were used for non-commercial civil government, military, or non-profit purposes.

### COMMERCIAL LAUNCHES

Twenty-eight commercial launches carried a total of 46 commercial and non-commercial payloads into orbit. Two of these launches failed. These vehicles were a Proton M carrying AMC 14 and the third Falcon 1 carrying Celestis 6, PREsat, NanoSail-D, and Jumpstart. All other commercial launches were successful.

Of the 46 commercially-launched payloads, 35 provide commercial services. Fourteen of these are NGSO satellites and 21 are GEO satellites:

- NGSO: ORBCOMM Replacements 1-5, ORBCOMM CDS 3, Celestis 6, Falcon 1 Flight 4's Mass Simulator, five RapidEye Sats, and GeoEye-1.
- GEO: Star One C2, Turksat 3A, BADR-6, AMC 21, Superbird 7, Protostar 1, Eutelsat W2M, Hot Bird 9, Thuraya 3, DirecTV 11, Amos 3, Galaxy 18, Echostar XI, Galaxy 19, Thor 5, AMC 14, Inmarsat-4 F3, Nimiq 4, Astra 1M, Ciel 2, and ICO G1.

	Commercial Payloads (by service type)	Non-Commercial Payloads (by service type)	Total Payloads
United States	4	14	18
Russia	22	21	43
Europe	8	3	11
China	1	13	14
Multinational	6	0	6
India	1	11	12
Japan	0	1	1
Iran	0	1	1
<b>TOTAL</b>	<b>42</b>	<b>64</b>	<b>106</b>

Table 5. Payloads Launched by Country in 2008

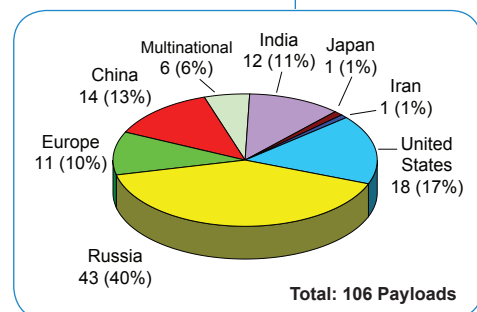


Figure 7. Total Payloads Launched by Country in 2008

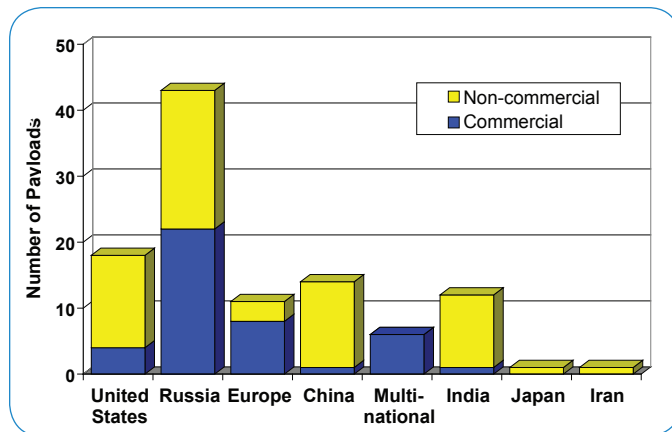


Figure 6. 2008 Total Worldwide Launch Activity by Payload

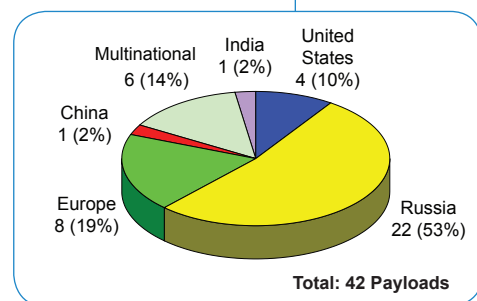


Figure 8. Commercial Payloads Launched by Country in 2008

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

- Five civil government satellites were launched: Vinasat to GEO, NanoSail-D, PRESat, Cosmo-Skymed 3, and THEOS to NGSO.
- Five military satellites were launched: Skynet 5C to GEO, SAR Lupe 4, SAR Lupe 5, C/NOFS, and Jumpstart to LEO.
- And one non-profit launch of UGATUSAT to LEO.

## **NON-COMMERCIAL LAUNCHES**

Of the 69 orbital launches, 41 were non-commercial launches carrying a total of 60 commercial and non-commercial payloads. Only one of these non-commercial launches failed: Iran's August 18 launch of its Safir vehicle with a dummy payload. All 40 of the remaining non-commercial launches were successful.

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

- China's Chinasat 9 and Russia's Express AM33 to GEO; and
- Germany's Rubin-8 and Russia's Gonets D1M 2, Gonets D1M 3, Gonets D1M 4, and Yubileiny.

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

- Seven U.S. payloads: Interstellar Boundary Explorer, ISS 1E-STs 122, ISS 1J/A-STs 123, STS 124, GLAST, Jason 2, and STS 126;
- Six Russian payloads: Progress ISS 28P through 31P and Soyuz ISS 16S and 17S;
- Eleven Chinese payloads: Tianlian 1, Fengyun 2E, HJ 1B, Shijian 6E and 6F, HJ 1A, Shenzhou 7, Chuangxin 1-02, Shiyan Weixing 3, Yaogan 5, and Fengyun 3A;
- Two European payloads: ATV 1 and GIOVE B;
- One Japanese payload: WINDS;
- Two Indian payloads: Chandrayaan-1 and IMS-1;
- One Venezuelan payload: VENESAT 1; and
- One Iranian payload: Safir dummy payload, believed to be named Omid.

Fifteen payloads were launched non-commercially for military use:

- Two U.S. payloads: NRO L-28 and Navstar GPS 2RM-6;
- Ten Russian payloads: Glonass M R-13 through R-18, Kosmos 2440, Kosmos 2441, Kosmos 2445, and Kosmos 2446;
- One Chinese payload: Yaogan 4;
- One Indian payload: CartoSat 2A; and
- One Israeli payload: TECSAR.

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

- One Danish payload: AAUsat 2;
- One German payload: Compass 1;
- Two Japanese payloads: Cute 1.7 + APD 2 and SEEDS 2;
- One Dutch payload: Delfi C3; and
- Two Canadian payloads: CanX-2 and NLS-5.

## LAUNCH ACTIVITIES BY COUNTRY

### RUSSIA

In 2008, 26 Russian launches took place. Of these, 11 were commercial launches. ILS launched six Proton M vehicles during the year, one of which failed. All launches each carried one commercial GEO communications satellite. ISC Kosmotras launched two Dnepr rockets, carrying THEOS and RapidEye 1-5. Two commercial launches were carried out by the Russian Ministry of Defense. Both launches used Kosmos 3M vehicles and deployed the SAR Lupe 4 and 5 satellites for the German government. A final Kosmos 3M launch put 6 ORBCOMM satellites into orbit. See Table 6 for a detailed breakdown of 2007 Russian launch activity by vehicle.

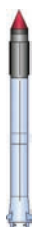






RUSSIA							
							
Vehicle	Kosmos 3M	Molniya	Dnepr	Rokot	Soyuz	Proton K	Proton M
2008 Total Launches	3	1	2	1	9	3	7
Launch Reliability (2008)	3/3 100%	1/1 100%	2/2 100%	1/1 100%	9/9 100%	3/3 100%	6/7 86%
Launch Reliability (Last 10 Years)	11/11 100%	12/13 92%	11/12 92%	8/9 89%	94/95 99%	51/54 95%	23/26 88%
Year of First Launch	2004	1960	1999	1994	1963	1967	2000
Active Launch Sites	Plesetsk	Plesetsk	Baikonur Dombrovskiy	Baikonur Plesetsk	Baikonur Plesetsk	Baikonur	Baikonur
LEO kg (lbs)	1,350 (2,970)	1,800 (3,960)	3,700 (8,150)	1,850 (4,075)	6,708 (14,758)	19,760 (43,570)	21,000 (46,305)
GTO kg (lbs)	--	--	--	--	1,350 (2,975)	4,430 (9,770)	5,500 (12,125)

Table 6. Russian Vehicle Performance in 2008



Russia conducted 15 non-commercial launches in 2008. Six of these were dedicated to ISS missions. Four were Soyuz rockets carrying Progress spacecraft (ISS 28P through 31P), while two were Soyuz vehicles carrying manned Soyuz spacecraft that ferried individuals to and from the ISS (ISS 16S and 17S). This was the same number of launches as 2007.

Russia conducted seven other government non-commercial launches in 2008. One launch, of a Soyuz rocket deploying GIOVE B, was for a civil mission, while the rest were for military purposes. Two Proton K vehicles successfully launched three Glonass K satellites each during the year. Four Kosmos satellites were launched during the year, each using a different vehicle: Molniya, Proton K, Soyuz, and a Soyuz 2 1B.

Russia also conducted two non-commercial launches of commercial payloads. A Proton M was used to lift Russia's Express AM33 communications satellite into GEO. Also, a Rockot was used to place three Gonets and one Yubileiny satellite into LEO.

## **EUROPE**

Europe conducted six Ariane 5 launches in 2008. Five were dual-manifested commercial launches from Kourou that placed communications satellites into GEO. The sixth was a non-commercial launch that sent ESA's Jules Verne ATV to the ISS. Five Ariane 5 ECA versions were used for the commercial launches and one ES version was used to launch the ATV. In March an ES launched the ATV for ESA. The second launch, using an ECA, took place in April, orbiting Star One C2 and Vietnam's Vinasat. In June the second ECA launch deployed the British military's Skynet 5C and the Turksat 3A satellite. In July, an ECA version launched the Saudi BADR-6 and the Protostar 1 into orbit. In August an ECA version placed the AMC 21 and the Superbird 7 into orbit. The final European launch of 2008 took place in December using an ECA version. This launch placed Eutelsat W2M and Hot Bird 9 into orbit.

Table 7 summarizes the 2008 European launch activity, as well as Chinese, Indian, Japanese, and Iranian launch activity, organized by country and vehicle.

## **CHINA**

China had an eventful 2008, conducting a record high 11 orbital launches, which were all non-commercial. This total is one more launch than what China conducted in 2007. China did not have any commercially-competed launches in 2008, though they did launch two GEO satellites that will provide commercial communications services: Chinasat 9 on a Long March 3B and Venezuela's VENESAT 1 on a Long March 3B, both from the Xichang launch site.

The remaining nine Chinese launches carried primary payloads with government missions. Most notable was the September launch of Shenzhou 7. This was China's third manned space launch and the first to carry a full complement of three taikonauts. Two taikonauts also performed a spacewalk, a first for China. Two

launches carried multiple satellites: a Long March 2C from Taiyuan in September that deployed HJ 1A and HJ 1B, and a Long March 4B, also from Taiyuan, that deployed Shijian 5 and 6. The rest of the flights used various Long March vehicles launching one government satellite each.

## INDIA

The Indian Space Research Organization (ISRO) performed three successful launches in 2008, including its first-ever lunar probe, the Chandrayaan-1. The lunar launch occurred in October using a Polar Satellite Launch Vehicle (PSLV). Chandrayaan-1 reached the Moon in early November and deployed a sub-probe to impact the lunar surface.














	EUROPE	CHINA								INDIA	JAPAN	IRAN	LAND LAUNCH
													
Vehicle	Ariane 5	Long March 4B	Long March 2C	Long March 2D	Long March 2F	Long March 3C	Long March 4C	Long March 3A	Long March 3B	PSLV	H 2A	Safir	Zenit-3SLB
Country/Region	Europe	China	China	China	China	China	China	China	China	India	Japan	Iran	Ukraine
2008 Total Launches	6	2	1	2	1	1	1	1	2	3	1	1	1
Launch Reliability (2008)	6/6 100%	2/2 100%	1/1 100%	2/2 100%	1/1 100%	1/1 100%	1/1 100%	1/1 100%	2/2 100%	3/3 100%	1/1 100%	0/1 0%	1/1 100%
Launch Reliability (Last 10 Years)	38/39 97%	12/12 100%	10/10 100%	7/7 100%	7/7 100%	1/1 100%	2/2 100%	13/13 100%	6/6 100%	10/10 100%	13/15 87%	0/1 0%	1/1 100%
Year of First Launch	1996	1999	1975	1992	1999	2008	2007	1994	1996	1993	2001	2008	2007
Active Launch Sites	Kourou	Taiyuan	Jiuquan, Taiyuan, Xichang	Jiuquan	Jiuquan	Xichang	Taiyuan	Taiyuan, Xichang	Xichang	Satish Dhawan	Tanegashima	Iran Space Center	Baikonur Cosmodrome
LEO kg (lbs)	17,250 (37,950)	2,800 (6,170)	3,200 (7,048)	3,500 (7,700)	9,500 (20,900)	3,700 (8,200)	4,200 (9,250)	6,000 (13,225)	13,562 (29,900)	3,700 (8,150)	11,730 (25,860)	?	13,920 (30,624)
GTO kg (lbs)	10,500 (23,127)	--	1,000 (2,203)	1,250 (2,750)	3,500 (7,700)	--	1,500 (3,300)	2,600 (5,700)	4,491 (9,900)	800 (1,760)	5,800 (12,800)	?	4120 (9060)

Table 7. European, Chinese, Indian, Japanese, Iranian, and Ukrainian Launch Vehicle Performance in 2008

A non-commercial PSLV launch occurred in January 2008, carrying the TECSAR radar imaging satellite for the Israeli military. A second non-commercial PSLV launch took place in April placing ten satellites into orbit. The main payload was the Indian military's Cartosat 2A. Also aboard was a civilian Indian IMS imaging satellite. The German commercial Rubin-8 technology demonstrator was deployed. The remaining seven satellites were a series of experimental cubesats deployed on a non-profit basis from several European countries. All Indian launches took place from the Satish Dhawan Space Center.

## **JAPAN**

Japan had one successful launch in 2008 which used an H-2A vehicle launched from the government site at Tanegashima in February. The launch carried a satellite for the Japanese government. The WINDS experimental wideband internet satellite was placed in GEO.

## **IRAN**

Iran conducted its first orbital launch attempt on August 18. The payload, Omid, was believed to be a dummy satellite. The launch vehicle was a Safir two-stage orbital rocket. The non-commercial flight did not reach orbit and is considered a launch failure. Further information has not been released by the Iranian government.

# FIVE-YEAR WORLDWIDE SPACE TRANSPORTATION TRENDS

## OVERVIEW

Between 2004 and 2008, there was an average of 62 orbital launches per year worldwide (see Figure 9).

Over the past five years, Russia and the United States have conducted the most orbital launches, followed by China and Europe (see Figure 10). There have been a total of 312 orbital launches conducted during the past five years.

One hundred and six commercial orbital launches took place during the same five-year period, with an increasing trend from 15 in 2004 to 28 in 2008. Since 2004, the United States has carried out 18 commercial launches. Russia and Europe both exceed this count with 45 and 22 commercial launches, respectively. The multinational Sea Launch Company performed 19 commercial launches, while India and China each have one (see Figure 11).

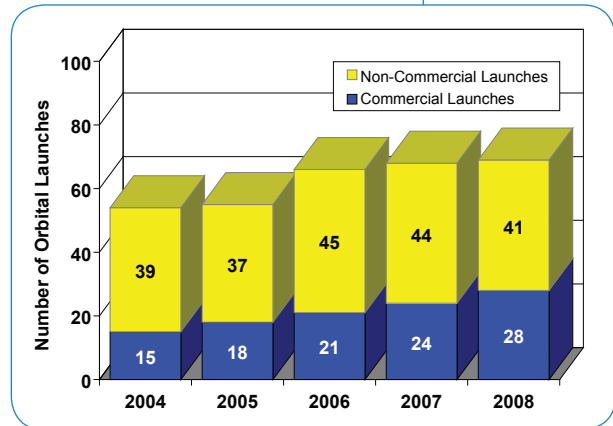


Figure 9. Five-Year Summary (2004–2008) of Commercial and Non-commercial Launch Events

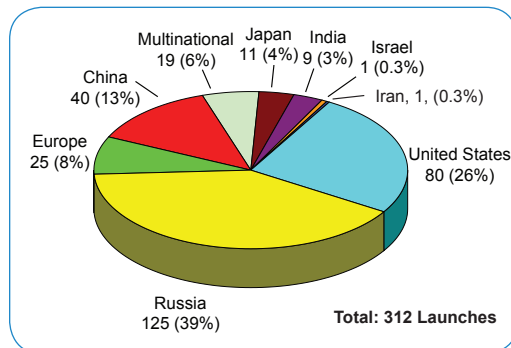


Figure 10. Five-Year Worldwide Total Orbital Commercial and Non-commercial Launch Industry Share (2004–2008)

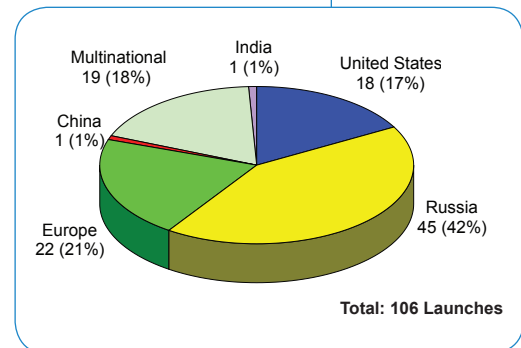


Figure 11. Five-Year Worldwide Commercial Orbital Launch Market Share (2004–2008)

The demand for commercial NGSO launches, which reached its zenith in the late 1990s, had been lagging during the four years prior to 2007. Both 2007 and 2008 showed a significant rebound in this demand. 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 number of commercial GEO satellites launched each year since 2003 has remained between

15 and 23 satellites. 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 breaks this previous low trend. There was a slight dip in the number of commercial NGSO launches in 2008, but it still remains higher than the three years previous to 2007.

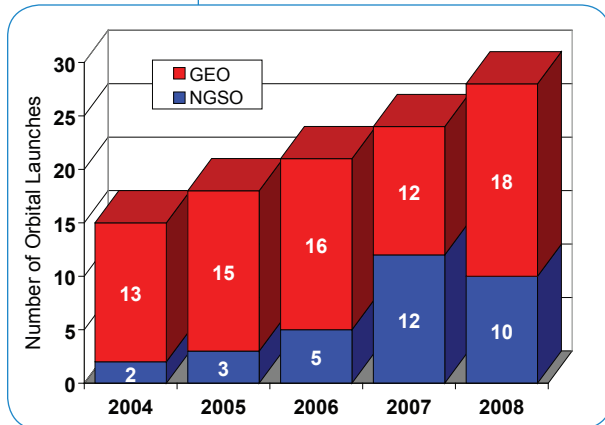


Figure 12. Five-Year Worldwide Commercial GEO and NGSO Launch Events (2004–2008)

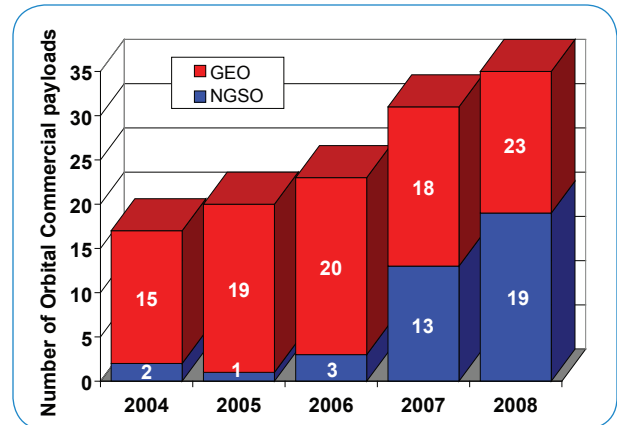


Figure 13. Five-Year Summary of Commercial Payloads Launched by Orbit (2004–2008)

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 2004 to 2008. Revenues grew almost 100 percent between 2004 and 2008, from roughly US\$1 billion to nearly US\$2 billion.

	2004	2005	2006	2007	2008
United States	375	70	140	150	215
Russia	290	350	374	477	700
Europe	140	490	560	840	581
India	0	0	0	11	0
Multinational	210	280	350	70	475
<b>TOTAL</b>	<b>1,015</b>	<b>1,190</b>	<b>1,424</b>	<b>1,548</b>	<b>1,971</b>

Table 8. Approximate Launch Revenues for Commercial Launch Events 2004–2008 (US\$M)

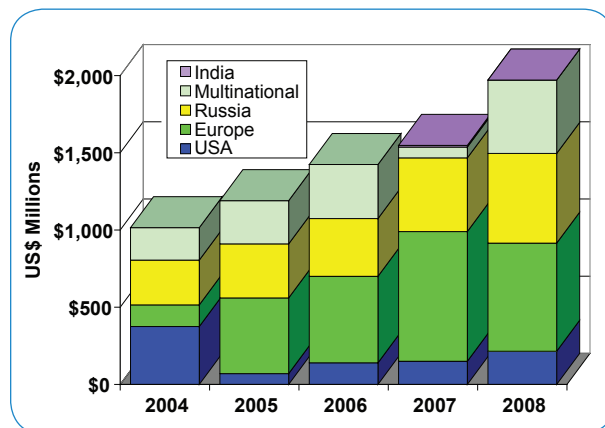


Figure 14. Approximate Launch Revenues for Commercial Launch Events (2004–2008)

## 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 the last two years. Since 2004, nearly 70 percent of commercial launches have been to GEO, which generates more revenue than the NGSO market and generally deploys larger payloads. GEO satellites lead again in 2008 and they will likely still be the primary commercial market driver in the near term. The following trends are expected:

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

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. China is likely to 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 two FAA-licensed launches in 2008, being the third and fourth launches of the Falcon 1 rocket. The fourth launch, which took place in September, was the first completely successful launch of the Falcon 1. SpaceX is also developing its larger Falcon 9 rocket. With its first test launch scheduled for 2009, 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 2010 debut.

2008 also saw the debut of the Land Launch Zenit-3SLB rocket. It is essentially a Zenit-3SL slightly modified to launch from Baikonur Cosmodrome instead of the Sea Launch platform. Its April launch lifted the Israeli AMOS-3 communications satellite into GEO. Land Launch is a collaboration between Sea Launch and Moscow-based Space International Services.

South Korea is also developing a small launch vehicle, designated the Korea Space Launch Vehicle (KSLV), that may eventually help that country enter the commercial market. Europe’s Vega small launch vehicle could also enter the commercial market in 2010.

## INTERNATIONALLY COMPETED LAUNCHES

As commercial space business increases and replaces various forms of traditionally government-operated activities, the definitions of “commercial payload” and

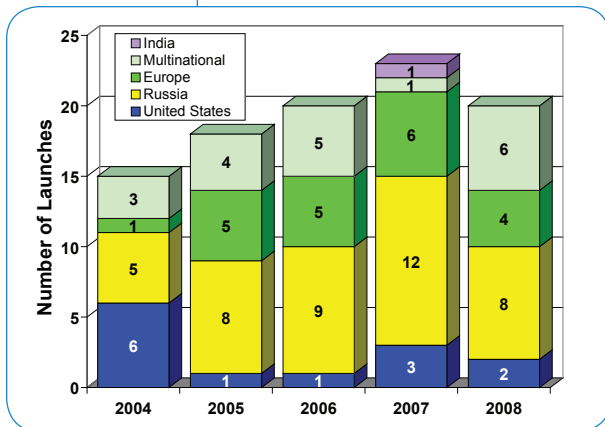


Figure 15. Five-Year Worldwide Internationally Competed Launch Events (2004-2008)\*

“commercial launch” become more complex and open to interpretation. 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 2004 to 2008, there were 97 internationally-competed launch events.

\* 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.

## 2008 FAA EXPERIMENTAL PERMIT FLIGHT SUMMARY

In 2008, there were five low-altitude flights conducted under the authority of FAA experimental permits. This total is four less than what occurred in 2007. All 2008 flights used developmental vertical-takeoff, vertical-landing vehicles. Four were conducted by perennial flyer Armadillo Aerospace with two different vehicles (Pixel and MOD-1) and one was conducted by a new entrant, TrueZero.

All five permit flights took place at Las Cruces International Airport in New Mexico as part of the Northrop Grumman Lunar Lander Challenge. Table 9 lists details of the five flights that took place in 2008.

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.

Flight Date	Operator	Vehicle	Launch Site
October 24	TrueZero	Ignignokt	Las Cruces International Airport, NM
October 24	Armadillo Aerospace	MOD 1	Las Cruces International Airport, NM
October 24	Armadillo Aerospace	MOD 1	Las Cruces International Airport, NM
October 24	Armadillo Aerospace	MOD 1	Las Cruces International Airport, NM
October 25	Armadillo Aerospace	Pixel	Las Cruces International Airport, NM

Table 9. FAA-Permitted Launches in 2008



## APPENDIX: 2008 WORLDWIDE ORBITAL LAUNCH EVENTS

Date	Vehicle	Site	Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l Price	L	M
15-Jan-2008	V Zenit-3SL	Odyssey Launch Platform	* Thuraya 3	GEO	Thuraya Satellite Communications Company	Boeing Satellite Systems	Communications	\$85M	S	S
21-Jan-2008	PSLV	Satish Dhawan Space Center	TECSAR	LEO	Israel MoD	Israel Aerospace Industries	Intelligence		S	S
28-Jan-2008	Proton M	Baikonur	* Express AM33	GEO	Russian Satellite Communication Co.	NPO PM	Communications		S	S
5-Feb-2008	Soyuz	Baikonur	Progress ISS 28P	LEO	Roscosmos	RSC Energia	Supply		S	S
7-Feb-2008	Shuttle Atlantis	Kennedy Space Center	STS 122 Columbus ISS 1E	LEO LEO LEO	NASA European Space Agency NASA	Rockwell International EADS EADS	Crewed Space Station Space Station		S S S	S S S
11-Feb-2008	V Proton M	Baikonur	* Thor 5	GEO	Telenor A.S.	Orbital Sciences Corp.	Communications	\$85M	S	S
23-Feb-2008	H 2A 2024	Tanegashima	WINDS	GEO	JAXA	JAXA	Development		S	S
9-Mar-2008	Ariane 5 ES-ATV	Kourou	ATV 1	LEO	European Space Agency	EADS	Space Station		S	S
11-Mar-2008	Shuttle Endeavour	Kennedy Space Center	STS 123 ISS 1J/A	LEO LEO	NASA JAXA	Rockwell International Mitsubishi	Crewed Space Station		S S	S S
13-Mar-2008	Atlas 5 411	Vandenberg AFB	NRO L-28	ELI	NRO	The Boeing Company	Classified		S	S
14-Mar-2008	V Proton M	Baikonur	* AMC 14	GEO	SES Americom	Lockheed Martin Commercial Space Systems	Communications	\$85M	F	F
15-Mar-2008	Delta 2 7925-10	Cape Canaveral AFS	Navstar GPS 2RM-6	MEO	U.S. Air Force	Lockheed Martin Corp.	Navigation		S	S
19-Mar-2008	V Zenit-3SL	Odyssey Launch Platform	* DirecTV 11	GEO	DirecTV, Inc.	Boeing Satellite Systems	Communications	\$85M	S	S
27-Mar-2008	V Kosmos 3M	Plesetsk	SAR Lupe 4	LEO	German Defense Ministry	OHB System	Intelligence	\$12M	S	S
8-Apr-2008	Soyuz	Baikonur	Soyuz ISS 16S	LEO	Roscosmos	RSC Energia	Space Station		S	S
14-Apr-2008	V Atlas 5 421	Cape Canaveral AFS	* ICO G1	GEO	ICO Global Communications	Space Systems/Loral	Communications	\$85M	S	S
16-Apr-2008	V Pegasus XL	Kwajalein Island	C/NOFS	LEO	U.S. Air Force	Spectrum Astro, Inc.	Scientific	\$16M	S	S
18-Apr-2008	V Ariane 5 ECA	Kourou	Vinasat	GEO	Vietnamese Ministry of Post and Telecommunications	Lockheed Martin Corp.	Communications	\$140M	S	S
			* Star One C2	GEO	Star One	Alcatel Espace	Communications		S	S
25-Apr-2008	Long March 3C	Xichang	Tianlian 1	GEO	Chinese National Space Administration	Chinese Academy of Space Technology	Communications		S	S
27-Apr-2008	Soyuz	Baikonur	GIOVE B	MEO	European Space Agency	Galileo Industries	Navigation		S	S
28-Apr-2008	V Zenit-3SLB	Baikonur	* Amos 3	GEO	SpaceCom Limited	Israel Aerospace Industries	Communications	\$50M	S	S
28-Apr-2008	PSLV	Satish Dhawan Space Center	* Cartosat 2A	LEO	ISRO	ISRO	Remote Sensing		S	S
			* Rubin-8	LEO	Cosmos International GmbH	Cosmos International GmbH	Communications		S	S
			AAUsat 2	LEO	Aalborg University	Aalborg University	Development		S	S
			Cute 1.7 + APD 2	LEO	Tokyo Institute of Technology	Tokyo Institute of Technology	Development		S	S
			Delfi C3	LEO	Delft University	Delft University	Development		S	S
			NLS-5	LEO	University of Toronto	University of Toronto	Remote Sensing		S	S
			CanX-2	LEO	University of Toronto	University of Toronto	Development		S	S
			IMS 1	LEO	ISRO	ISRO	Remote Sensing		S	S
			SEEDS 2	LEO	Nihon University	Nihon University	Development		S	S
			Compass 1	LEO	Aachen University of Applied Sciences	Aachen University of Applied Sciences	Development		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 page 1 and 2 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: 2008 WORLDWIDE ORBITAL LAUNCH EVENTS (CONT'D)

Date	Vehicle	Site	Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l		
								Price	L	M
15-May-2008	Soyuz	Baikonur	Progress ISS 29P	LEO	Roscosmos	RSC Energia	Supply		S	S
21-May-2008	V Zenit-3SL	Odyssey Launch Platform	* Galaxy 18	GEO	Intelsat	Space Systems/Loral	Communications	\$85M	S	S
23-May-2008	Rokot	Plesetsk	* Gonets DIM 2	LEO	Roscosmos	NPO PM	Communications		S	S
			* Yubileiny	LEO	Roscosmos	NPO PM	Communications		S	S
			* Gonets DIM 3	LEO	Roscosmos	NPO PM	Communications		S	S
			* Gonets DIM 4	LEO	Roscosmos	NPO PM	Communications		S	S
27-May-2008	Long March 4C	Taiyuan	Fengyun 3A	SSO	China Meteorological Administration	Shanghai Bureau of Astronautics	Meteorological		S	S
31-May-2008	Shuttle Discovery	Kennedy Space Center	STS 124	LEO	NASA	Rockwell International	Crewed		S	S
			Cupola 1	LEO	NASA	NASA	Space Station		S	S
			Port Rails 1	LEO	NASA	NASA	Space Station		S	S
			JEM RMS	LEO	NASA	Mitsubishi	Space Station		S	S
			Solar Arrays SPP	LEO	NASA	NASA	Space Station		S	S
9-Jun-2008	Long March 3B	Xichang	* Chinasat 9	GEO	Chinese Telecommunications Broadcasting Satellite Corp.	Alcatel Alenia Space	Communications		S	S
11-Jun-2008	Delta 2 7920H	Cape Canaveral AFS	GLAST	LEO	NASA	General Dynamics	Scientific		S	S
12-Jun-2008	V Ariane 5 ECA	Kourou	SkyNet 5C	GEO	Paradigm Secure Communications Ltd.	EADS	Communications	\$140M	S	S
			* Turksat 3A	GEO	Turkish Telecom	Alcatel Alenia Space	Communications		S	S
19-Jun-2008	V Kosmos 3M	Kapustin Yar	* Orbcomm CDS 3	LEO	Orbital Communications Corp. (ORBCOMM)	OHB System	Development	\$12M	S	S
			* Orbcomm Replacement 1	LEO	Orbital Communications Corp. (ORBCOMM)	OHB System	Communications		S	S
			* Orbcomm Replacement 2	LEO	Orbital Communications Corp. (ORBCOMM)	OHB System	Communications		S	S
			* Orbcomm Replacement 3	LEO	Orbital Communications Corp. (ORBCOMM)	OHB System	Communications		S	S
			* Orbcomm Replacement 4	LEO	Orbital Communications Corp. (ORBCOMM)	OHB System	Communications		S	S
			* Orbcomm Replacement 5	LEO	Orbital Communications Corp. (ORBCOMM)	OHB System	Communications		S	S
			UGATUSAT	LEO	UGATU	UGATU	Scientific		S	S
20-Jun-2008	Delta 2 7320	Vandenberg AFB	Jason 2	LEO	Eumetsat	Alcatel Alenia Space	Meteorological		S	S
27-Jun-2008	Proton (SL-12)	Baikonur	Kosmos 2440	GEO	Russian MoD	NPO PM	Military		S	S
7-Jul-2008	V Ariane 5 ECA	Kourou	* Protostar	GEO	Protostar Ltd.	Space Systems/Loral	Communications	\$140M	S	S
			* BADR-6	GEO	Arab Satellite Communications Organization (Arabsat)	EADS Astrium	Communications		S	S
15-Jul-2008	V Zenit-3SL	Odyssey Launch Platform	* EchoStar XI	GEO	EchoStar Communications Corporation	Space Systems/Loral	Communications	\$85M	S	S
22-Jul-2008	V Kosmos 3M	Plesetsk	SAR Lupe 5	LEO	German Defense Ministry	OHB System	Intelligence	\$12M	S	S
26-Jul-2008	Soyuz 2 1B	Plesetsk	Kosmos 2441	MEO	Russian MoD	NPO PM	Military		S	S
3-Aug-2008	V Falcon 1	Kwajalein Island	* Jumpstart	LEO	ORS Office	SpaceDev, Inc.	Development	\$7M	F	F
			Celestis 6	LEO	Celestis, Inc.	Celestis, Inc.	Other		F	F
			NanoSail-D	LEO	NASA	NASA	Scientific		F	F
			PRESat	LEO	NASA	NASA	Scientific		F	F
14-Aug-2008	V Ariane 5 ECA	Kourou	* Superbird 7	GEO	Space Communications Corp.	Mitsubishi Electric Corp.	Communications	\$140M	S	S
			* AMC 21	GEO	SES Americom	Alcatel Alenia Space	Communications		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 page 1 and 2 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: 2008 WORLDWIDE ORBITAL LAUNCH EVENTS (CONT'D)

Date	Vehicle	Site	Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l Price	L	M
17-Aug-2008	Safir	Iran	Iran Dummy Satellite	LEO	Iran's Aerospace Organization	Iran's Aerospace Organization	Development		F	F
19-Aug-2008	V Proton M	Baikonur	* Inmarsat-4 F3	GEO	Inmarsat	EADS Astrium	Communications	\$85M	S	S
29-Aug-2008	V Dnepr I	Baikonur	* RapidEye 1	SSO	RapidEye AG	MacDonald, Dettwiler and Associates	Remote Sensing	\$17.5M	S	S
			* RapidEye 2	SSO	RapidEye AG	MacDonald, Dettwiler and Associates	Remote Sensing		S	S
			* RapidEye 3	SSO	RapidEye AG	MacDonald, Dettwiler and Associates	Remote Sensing		S	S
			* RapidEye 4	SSO	RapidEye AG	MacDonald, Dettwiler and Associates	Remote Sensing		S	S
			* RapidEye 5	SSO	RapidEye AG	MacDonald, Dettwiler and Associates	Remote Sensing		S	S
6-Sep-2008	V Delta 2 7420-10	Vandenberg AFB	* GeoEye 1	SSO	GeoEye	General Dynamics	Remote Sensing	\$50M	S	S
06-Sep-08	Long March 2C	Xichang	HJ 1A	LEO	China National Space Administration	CAST	Remote Sensing		S	S
			HJ 1B	LEO	China National Space Administration	CAST	Remote Sensing		S	S
10-Sep-08	Soyuz	Baikonur	Progress ISS 30P	LEO	Roscosmos	RSC Energia	Supply		S	S
20-Sep-08	V Proton M	Baikonur	* Nimiq 4	GEO	Telesat Canada	EADS Astrium	Communications	\$85M	S	S
24-Sep-08	V Zenit-3SL	Odyssey Launch Platform	* Galaxy 19	GEO	Intelsat	Space Systems/Loral	Communications	\$85M	S	S
25-Sep-08	Long March 2F	Jiuquan	Shenzhou 7	LEO	China National Space Administration	Shanghai Academy of Spaceflight Technology Division	Crewed		S	S
25-Sep-08	Proton (SL-12)	Baikonur	Glonass M R13	MEO	Russian MoD	NPO PM	Navigation		S	S
			Glonass M R14	MEO	Russian MoD	NPO PM	Navigation		S	S
			Glonass M R15	MEO	Russian MoD	NPO PM	Navigation		S	S
28-Sep-08	V Falcon I	Kwajalein Island	* Flight 4	LEO	Space Exploration Technologies	Space Exploration Technologies	Development	\$7M	S	S
01-Oct-08	V Dnepr I	Dombrovskiy	THEOS	SSO	GISTDA	EADS Astrium	Remote Sensing	\$17.5M	S	S
12-Oct-08	Soyuz	Baikonur	Soyuz ISS 17S	LEO	Roscosmos	RSC Energia	Space Station		S	S
19-Oct-08	Pegasus XL	Kwajalein Island	Interstellar Boundary Explorer	ELI	NASA	Orbital Sciences Corp.	Scientific		S	S
22-Oct-08	PSLV	Satish Dhawan Space Center	Chandrayaan 1	EXT	ISRO	ISRO	Scientific		S	S
24-Oct-08	V Delta 2 7420-10	Vandenberg AFB	Cosmo-Skymed 3	LEO	Italian Space Agency (ASI)	Alenia Spazio	Remote Sensing	\$50M	S	S
25-Oct-08	Long March 4B	Taiyuan	Shijian 6F	LEO	China National Space Administration	China Great Wall Industry Corp. (CGWIC)	Scientific		S	S
			Shijian 6E	LEO	China National Space Administration	China Great Wall Industry Corp. (CGWIC)	Scientific		S	S
30-Oct-08	Long March 3B	Xichang	VENESAT 1	GEO	Venezuelan Ministry of Science and Technology	China Great Wall Industry Corp. (CGWIC)	Communications		S	S
05-Nov-08	Long March 2D	Jiuquan	Shiyan Weixing 3	LEO	China	Harbin Institute of Technology	Development		S	S
			Chuangxin 1-02	LEO	China Meteorological Administration	Chinese Academy of Sciences	Meteorological		S	S
06-Nov-08	V Proton M	Baikonur	* Astra 1M	GEO	SES Astra	EADS Astrium	Communications	\$85M	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 page 1 and 2 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: 2008 WORLDWIDE ORBITAL LAUNCH EVENTS (CONT'D)

Date	Vehicle	Site	Payload(s)	Orbit	Operator	Manufacturer	Use	Comm'l Price	L	M
14-Nov-08	Soyuz	Baikonur	Kosmos 2445	LEO	Russian MoD	Russia - TBA	Intelligence		S	S
14-Nov-08	Shuttle Endeavour	Kennedy Space Center	STS 126 MPLM 5	LEO LEO	NASA NASA	Rockwell International NASA	Crewed Space Station		S	S
26-Nov-08	Soyuz	Baikonur	Progress ISS 31P	LEO	Roscosmos	RSC Energia	Supply		S	S
01-Dec-08	Long March 2D	Jiuquan	Yaogan 4	LEO	China National Space Administration	Chinese Academy of Space Technology	Remote Sensing		S	S
02-Dec-08	Molniya	Plesetsk	Kosmos 2446	ELI	Russian Space Forces	NPO Lavotchkin	Military		S	S
10-Dec-08	V Proton M	Baikonur	* Ciel 2	GEO	Ciel Satellite	Thales Alenia Space	Communications	\$85M	S	S
15-Dec-08	Long March 4B	Taiyuan	Yaogan 5	LEO	China National Space Administration	CAST	Remote Sensing		S	S
20-Dec-08	V Ariane 5 ECA	Kourou	* Hot Bird 9 * Eutelsat W2M	GEO GEO	Eutelsat Eutelsat	EADS Astrium EADS Astrium	Communications Communications	\$140M	S	S
23-Dec-08	Long March 3A	Xichang	Fengyun 2E	GEO	China Meteorological Administration	Shanghai Academy of Spaceflight Technology Division	Meteorological		S	S
25-Dec-08	Proton (SL-12)	Baikonur	Glonass M R16 Glonass M R17 Glonass M R18	MEO MEO MEO	Russian MoD Russian MoD Russian MoD	NPO PM NPO PM NPO PM	Navigation Navigation Navigation		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 page 1 and 2 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.

