



*Federal Aviation Administration
Office of Commercial Space Transportation*

January 2005

Commercial Space Transportation: 2004 Year In Review



INTRODUCTION

The *Commercial Space Transportation: 2004 Year in Review* summarizes U.S. and international launch activities for calendar year 2004 and provides a historical look at the past five years of commercial launch activities.

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) licensed nine commercial orbital launches and five suborbital launches in 2004.

Of the nine orbital licensed launches, six were of U.S.-built vehicles. International Launch Services (ILS) launched three Atlas 2AS boosters, carrying the AMC 10, AMC 11, and Superbird 6 communications satellites; these launches were the last commercial missions for the Atlas 2 family of vehicles, which ILS and Lockheed Martin retired in 2004. ILS also launched the MBSAT 1 and AMC 16 communications satellites on an Atlas 3A and an Atlas 5 521, respectively. Orbital Sciences Corporation launched Rocsat 2, a Taiwanese remote sensing satellite, on a Taurus XL.

Boeing Launch Services (BLS) performed three commercial launches, deploying the Estrela do Sul 1, DirecTV 7S, and APStar 5 communications spacecraft, each aboard a Ukrainian-built Zenit 3SL provided by Sea

Launch, LLC. The APStar 5 launch was considered a partial failure because the Zenit's upper stage shut down prematurely, placing the satellite in a lower-than-intended orbit, but the spacecraft was able to reach its destination in GEO using its onboard thrusters without reducing its on-orbit lifetime.

Overall, 15 commercial orbital launches occurred worldwide in 2004, representing 28 percent of the 54 total launches for the year. The 15 commercial launches represent a 12 percent decrease from 2003. FAA/AST-licensed orbital launch activity accounted for 60 percent of the worldwide commercial launch market in 2004. Russia conducted five commercial launch campaigns, bringing its commercial launch market share to about 33 percent for the year. Arianespace conducted only a single commercial launch in 2004.

FAA/AST issued its first-ever suborbital reusable mission licenses in 2004 to Scaled Composites and XCOR Aerospace. Scaled Composites carried out five licensed launches of its SpaceShipOne suborbital vehicle, including a June 21 flight that marked the first time a privately-developed manned vehicle flew into space, as well as flights on September 29 and October 4 to win the \$10-million Ansari X Prize.

ABOUT THE OFFICE OF COMMERCIAL SPACE TRANSPORTATION (AST)

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) licenses and regulates U.S. commercial space launch and reentry activity as authorized by Executive Order 12465 (*Commercial Expendable Launch Vehicle Activities*) and 49 United States Code Subtitle IX, Chapter 701 (formerly the *Commercial Space Launch Act*). AST's mission is to license and regulate commercial launch and reentry operations to protect public health and

safety, the safety of property, and the national security and foreign policy interests of the United States. Chapter 701 and the 2004 *U.S. Space Transportation Policy* also direct the Federal Aviation Administration to encourage, facilitate, and promote commercial launches and reentries.

Additional information concerning commercial space transportation can be found on AST's web site at <http://ast.faa.gov>.

DEFINITIONS

The following definitions apply to the *Commercial Space Transportation: 2004 Year in Review*.

COMMERCIAL SUBORBITAL OR ORBITAL LAUNCH

A commercial suborbital or orbital launch has one or both 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.

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).

INTERNATIONALLY COMPETED

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

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).

2004 FAA-LICENSED ORBITAL LAUNCH SUMMARY

Six of the nine FAA/AST-licensed commercial orbital launches for 2004 were conducted from U.S. ranges, while three launches were conducted from the Sea Launch Odyssey platform in the Pacific Ocean. Eight orbital flights were successfully executed for commercial customers, along with one partial failure that did not result in the loss or impairment of its payload. None of the launches carried multiple payloads. The nine FAA-licensed launches are listed in Table 1.

The nine FAA-licensed launches included the following characteristics:

- Eight launches were to GEO, and one to LEO.
- Eight launches, worth approximately \$560 million in revenue¹, were conducted for commercial clients. The remaining launch of a Taurus XL was conducted for the National Space Program Office (NSPO) of Taiwan, with an estimated value of \$25 million.

FAA-licensed launches decreased in frequency from 2000 to 2001, with a steady annual increase evident since then (see Figure 1). A similar trend was observed for estimated FAA-licensed commercial orbital launch revenues (see Figure 2).

Figure 1. FAA-Licensed Orbital Launch Events

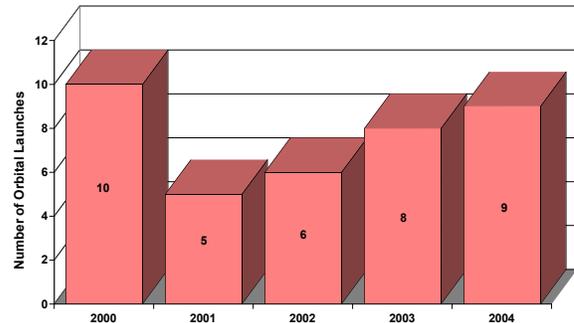


Figure 2. Estimated Revenues for FAA-Licensed Orbital Launch Events

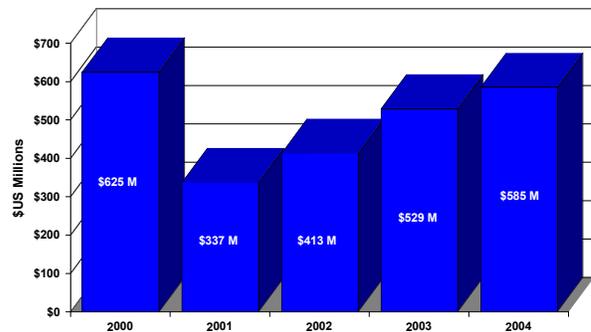


Table 1. 2004 FAA-Licensed Orbital Launch Events

Date	Vehicle	Payload	Launch Outcome	Orbit
Jan 10	Zenit 3SL	Estrela do Sul 1	Success	GEO
Feb 5	Atlas 2AS	AMC 10	Success	GEO
Mar 13	Atlas 3A	MBSAT 1	Success	GEO
Apr 15	Atlas 2AS	Superbird 6	Success	GEO
May 4	Zenit 3SL	DirectTV 7S	Success	GEO
May 19	Atlas 2AS	AMC 11	Success	GEO
May 20	Taurus XL	Rocsat 2	Success	LEO
Jun 28	Zenit 3SL	APStar 5	Partial	GEO
Dec 17	Atlas 5 521	AMC 16	Success	GEO

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

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

The United States carried out a total of 16 launches, six of which were licensed by FAA/AST. Sea Launch conducted three commercial launches, also licensed by the FAA. See Table 2 for a detailed breakdown of U.S. launch activity (including Sea Launch) during 2004 by vehicle.

BOEING LAUNCH SERVICES (BLS)

BLS only offers the Zenit 3SL for commercial launches to GEO. Due to the downturn in commercial launch demand, Boeing elected to discontinue marketing the Delta 4 series of vehicles to potential commercial customers, instead relying on the Zenit 3SL to address the GEO market. BLS continues to offer the Delta 2 for commercial launches of NGSO payloads.

Sea Launch conducted three commercial launches in 2004. The Zenit 3SL is launched from the mobile Odyssey Launch Platform along the equator on the Pacific Ocean. The company launched Estrela do Sul 1 in January, DirecTV 7S in May, and APStar 5 (also known as Telstar 18) in June. The first

two launches were successful, but the APStar 5 launch was designated a partial failure when the vehicle's Block DM-SL upper stage shut down 54 seconds early, leaving the satellite in a lower transfer orbit than planned. APStar 5, which carried extra propellant for its onboard thrusters, was able to maneuver into its final GEO orbit without affecting its 13-year specified lifetime. An investigation later concluded that an electrical short in cables within the upper stage created interference that distorted data from a propellant flow sensor, causing the engine to consume more propellant than planned. Corrective measures have been implemented for future flights.

Boeing, which markets the Zenit 3SL, is the majority shareholder (40 percent) of Sea Launch, LLC, whose partners include S. P. Korolev Rocket and Space Corporation Energia of Russia (25 percent), Kvaerner of Norway (20 percent), and SDO Yuzhnoye/PO Yuzhmash of Ukraine (15 percent).

Table 2. U.S. and FAA-Licensed Launch Vehicle Performance in 2004

	United States							Sea Launch
								
Vehicle	Taurus	Delta 2	Atlas 2	Atlas 3	Atlas 5	Titan 4	Delta 4 Heavy	Zenit 3SL
2004 Total Launches	1	7	4	1	1	1	1	3
2004 Licensed Launches	1	0	3	1	1	0	0	3
Launch Reliability (2004)	1/1	7/7	4/4	1/1	1/1	1/1	1/1	3/3
	100%	100%	100%	100%	100%	100%	100%	100%
Launch Reliability (Last 10 Years)	5/6	74/75	52/52	5/5	4/4	23/26	1/1	13/14
	83%	99%	100%	100%	100%	88%	100%	93%
Year of First Launch	1994	1990	1991	2000	2002	1989	2004	1999
Launch Sites	VAFB	CCAFS, VAFB	CCAFS, VAFB	CCAFS	CCAFS	CCAFS, VAFB	CCAFS, VAFB	Odyssey Pacific Ocean Platform
LEO kg (lbs)	1,590 (3,505)	4,887 (10,751)	8,298 (18,256)	10,764 (23,709)	12,500 (27,558)	20,822 (45,808)	23,975 (52,855)	15,246 (33,541)
GTO kg (lbs)	557 (1,228)	1,769 (3,892)	3,833 (8,433)	4,500 (9,920)	7,640 (16,843)	8,276 (18,207)	12,757 (28,129)	6,000 (13,228)

CCAFS - Cape Canaveral Air Force Station, VAFB - Vandenberg Air Force Base
 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.

INTERNATIONAL LAUNCH SERVICES (ILS)

ILS, a joint venture since 1995 between Lockheed Martin and Khrunichev State Research and Production Space Center, provides launch services using the Atlas and Proton vehicles. The company successfully conducted nine commercial launch campaigns in 2004, four of which involved the Russian Proton vehicle. The other five used three variants of Lockheed Martin's Atlas vehicle, two of which were retired from commercial service during the year. Three Atlas 2AS vehicles launched AMC 10 in February, Superbird 6 in April, and AMC 11 in May. ILS and Lockheed Martin retired the Atlas 2AS, the last direct descendent of the original Atlas developed in the 1950s, after a final non-commercial launch in August 2004. The Atlas 2 family finished with a perfect record of 63 straight successful launches. An Atlas 3A

booster launched the MBSAT 1 satellite in March; this, too, was the final commercial launch of the Atlas 3, with a final non-commercial launch scheduled for early 2005. An Atlas 5 521 booster launched AMC 16 in December.

ORBITAL SCIENCES CORPORATION (OSC)

OSC, which specializes in providing small launch vehicles and payloads, launched one commercial Taurus XL in May carrying the Rocsat 2 remote sensing satellite for the National Space Program Office (NSPO) of Taiwan. While Rocsat 2 is not a commercial satellite, the launch is considered commercial because both the payload's launch contract was internationally competed and the launch was licensed by FAA/AST. No Pegasus XL vehicles launched to orbit during 2004.

2004 WORLDWIDE ORBITAL LAUNCH ACTIVITY

Launch providers from the United States, Russia, Europe, China, Israel, India, and the multinational consortium Sea Launch conducted a total of 54 launch events in 2004 (see Table 3 and Figure 3), 15 of which were commercial. The 54 total worldwide launches is the lowest tally since 1961, when 48 launches took place. See Table 4 for a list of non-FAA-licensed commercial launches.

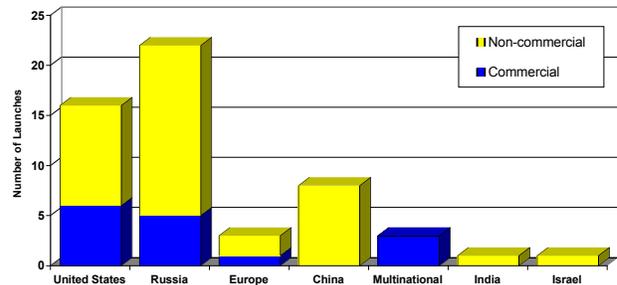
Table 3. 2004 Worldwide Orbital Launch Events

	Commercial Launches	Non-commercial Launches	Total Launches
United States	6	10	16
Russia	5	17	22
Europe	1	2	3
China	0	8	8
Multinational	3	0	3
India	0	1	1
Israel	0	1	1
TOTAL	15	39	54

Table 4. 2004 Non-FAA-Licensed Commercial Launch Events

Date	Vehicle	Payload(s)	Launch Outcome	Orbit
Mar 16	Proton M	Eutelsat W3A	Success	GEO
Jun 17	Proton M	Intelsat 10-02	Success	GEO
Jun 29	Dnepr 1	Demeter	Success	LEO
		AMSat-Echo		LEO
		Latinsat 3		LEO
		Latinsat 4		LEO
		SaudiComsat 1		LEO
		SaudiComsat 2		LEO
		Saudisat 2		LEO
		Unisat 3		LEO
Jul 17	Ariane 5G	Anik F2	Success	GEO
Aug 5	Proton M	Amazonas 1	Success	GEO
Oct 15	Proton M	AMC 15	Success	GEO

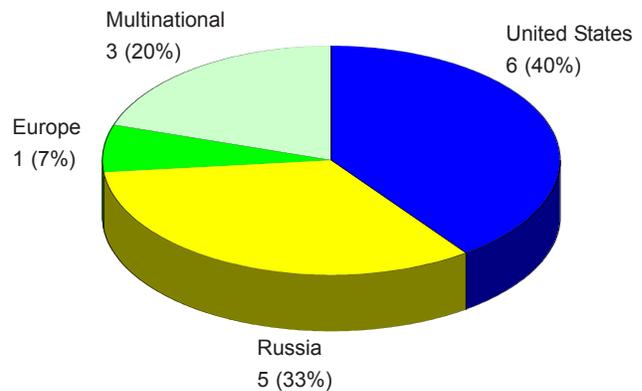
Figure 3. 2004 Total Worldwide Launch Activity



The U.S. conducted six commercial launch campaigns, accounting for 40 percent of the global commercial launch market (see Figure 4), while Russia performed five, for a 33-percent share. Sea Launch had three successful launch campaigns, accounting for 20 percent of commercial launches, while Europe had only a single commercial launch in 2004, for a seven-percent market share. China, Israel, and India did not conduct any commercial launches in 2004. U.S.-built vehicles captured the plurality of the worldwide commercial launch market in 2004.

The Appendix at the end of this report shows all 54 orbital launches worldwide in 2004 for commercial, civil, and military missions.

Figure 4. 2004 Worldwide Commercial Market Share

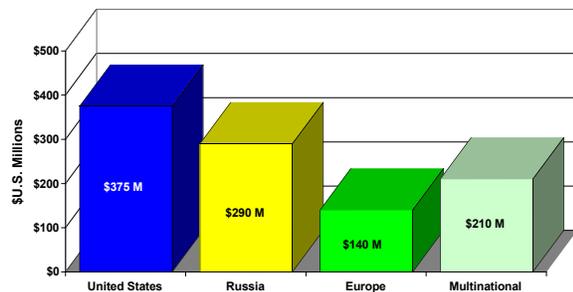


TOTAL: 15 Commercial Orbital Launches

WORLDWIDE LAUNCH REVENUES

Revenues from the 15 commercial launch events in 2004 were an estimated US\$1.0 billion, an 18 percent decrease from the 2003 total of approximately US\$1.2 billion. U.S. commercial launch revenues for 2004 were estimated to be US\$375 million; Russian revenues were about US\$290 million; European revenues were about US\$140 million; and Sea Launch earned approximately \$210 million. No other country conducted commercial orbital launches during the year (see Figure 5). Prices for individual launches to GEO dropped significantly since 2000. As a result, revenue estimates may be somewhat high.

Figure 5. 2004 Commercial Launch Revenues (approximate)



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, this method has worked well because 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 among countries of revenue for particular launches is becoming more difficult. For example, Russian launch activity is conducted in partnership with American and European launch service providers through a number of joint ventures. ILS markets launches of the Russian Proton vehicle in addition to the Atlas series. In 2004 the company made roughly US\$350 million conducting commercial launches of the Atlas vehicle family and about US\$280 million using the Proton M. The multinational Sea Launch represents a partnership among four organizations in four countries and launches from its own facility in international waters.

Because of the proprietary nature of business transactions and the internal financing of each organization, it is difficult to determine from estimated shared revenue totals the exact revenue amount earned for each launch service provider per year or 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 3 and 5 vehicles.

WORLDWIDE ORBITAL PAYLOAD SUMMARY

Fifty-four launch vehicles carried a total of 76 payloads in 2004 (see Figure 6, Figure 7, and Table 5). Of the 76 payloads, 17 provide commercial services (see Figure 8; these include two captive satellites from Russia whose launches were not internationally competed) and 59 were for government, scientific, or non-profit purposes.

Figure 6. 2004 Total Worldwide Launch Activity by Payload

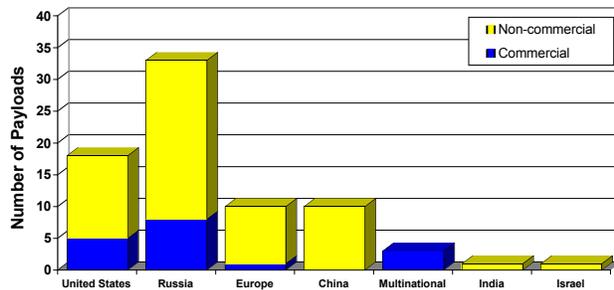
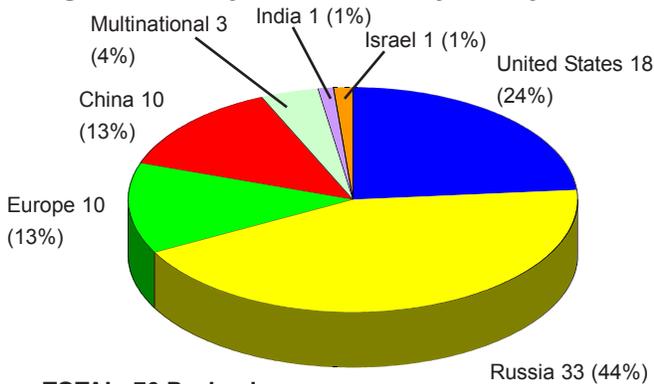


Table 5. Payloads Launched by Country in 2004

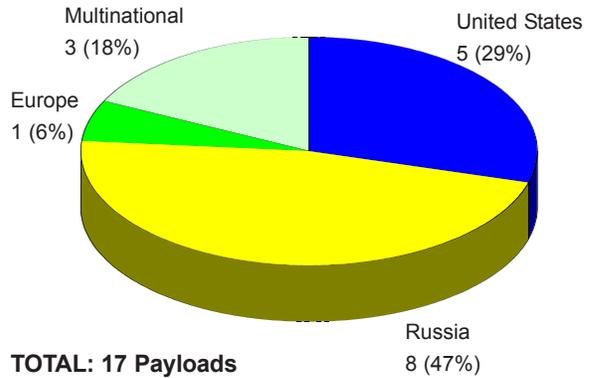
	Commercial Payloads (by service type)	Non-commercial Payloads (by service type)	Total Payloads
United States	5	13	18
Russia	8	25	33
Europe	1	9	10
China	0	10	10
Multinational	3	0	3
India	0	1	1
Israel	0	1	1
TOTAL	17	59	76

Figure 7. Total Payloads Launched by Country in 2004



TOTAL: 76 Payloads

Figure 8. Commercial Payloads Launched by Country in 2004



TOTAL: 17 Payloads

COMMERCIAL LAUNCHES

Fifteen commercial launches carried a total of 22 commercial and non-commercial payloads into orbit, all of which reached their intended orbit.

Fifteen payloads were launched to provide commercial services:

- Thirteen of these were GEO satellites (Amazonas 1, AMC 10, AMC 11, AMC 15, AMC 16, Anik F2, APStar 5, DirecTV 7S, Estrela do Sul 1, Eutelsat W3A, Intelsat 10-02, MBSAT 1, and Superbird 6); and
- Two were LEO satellites (LatinSat 3 and 4).

Seven payloads were launched to perform government or non-profit missions:

- Five civil satellites were launched to LEO (Demeter, Rocsat 2, SaudiComsat 1 and 2, and Saudisat 2); and
- Two non-profit satellites were launched to LEO (AMSat-Echo and Unisat 3).

NON-COMMERCIAL LAUNCHES

Of the 54 orbital launches, 39 were non-commercial launches carrying a total of 54 commercial and non-commercial payloads, one of which failed to achieve orbit.

Two payloads were launched to provide commercial services:

- Express AM1 and Express AM11

Twenty-three payloads were launched for military purposes:

- Six U.S. payloads (DSP F22, Heavy Lift Vehicle Operational Launch Service Demonstration Payload (HLVOLSDP), Navstar GPS 2R-11 through 2R-13, NRO L-1);
- Eleven Russian payloads (Kosmos 2405 through 2413, Kosmos Molniya 1T, and Kosmos Raduga 1);
- Five European satellites (Essaim 1 through 4 and Helios 2A); and
- One Israeli satellite (Ofeq 6), which suffered a launch failure.

Twenty-nine payloads were launched for civil or non-profit purposes:

- Six U.S. payloads (Aura, Gravity Probe B, Messenger, Swift, and 3CSat 1 and 2);
- Eight Russian payloads (MS-1TK, Progress 13P through 16P, Sich 1M, and Soyuz 8S and 9S);

- Four European payloads (Nanosat 01, Parasol, Philae, and Rosetta);
- Ten Chinese payloads (Double Star Polar, Experiment Satellite 1 and 2, Fengyun 2C, FSW 19 and 20, Nanosatellite 1, SJ 6A and 6B, and Ziyuan 2C); and
- One Indian payload (Edusat).

One non-commercial launch ended in failure and its satellite did not achieve orbit:

- Israel's Shavit 1, carrying Ofeq 6, on September 6.

Two other non-commercial launches experienced partial failures which resulted in their satellites not entering their desired orbits:

- The U.S. Delta 4 Heavy, carrying HLVOLSDP and 3CSat 1 and 2, on December 21, and;
- Russia's Cyclone 3, carrying MS-1TK and Sich 1M, on December 24.

There were no Space Shuttle launches in 2004 as NASA continued to implement recommendations made by the Columbia Accident Investigation Board (CAIB) after the February 2003 loss of the shuttle Columbia. The Space Shuttle is expected to return to flight with the launch of Discovery on mission STS-114 in mid-2005.

Japan did not attempt any orbital launches in 2004.

LAUNCH ACTIVITIES BY COUNTRY

RUSSIA

In 2004, Russia launched 22 vehicles; of these, five were commercial launches. ILS launched four Proton M vehicles during the year, carrying four commercial GEO satellites (Amazonas 1, AMC 15, Eutelsat W3A, and Intelsat 10-02). ISC Kosmotras launched a single Dnepr 1 vehicle in 2004, carrying a French science satellite, Demeter, as its primary payload, and a number of government, non-profit, and commercial secondary payloads (AMSat-Echo, Latinsat 3 and 4, SaudiComsat 1 and 2, Saudisat 2, and Unisat 3.) See Table 6 for a detailed breakdown of Russian launch activity during 2004 by vehicle.

Russia also conducted 17 non-commercial launches, some of which were dedicated to resupplying the ISS. Of these 17, four were Soyuz vehicles carrying Progress modules (ISS 13P through 16P), and two were Soyuz vehicles carrying replacement Soyuz modules for use as ISS lifeboats (ISS 8S and 9S). In addition, Russia conducted eight military launches, each carrying one or more satellites, and one civil launch (not including the ISS-related launches mentioned above). The military launches included one Molniya

communications satellite (Kosmos Molniya 1T) on a Molniya launch vehicle, four intelligence satellites (Kosmos Raduga 1 on a Proton K, Kosmos 2405 on a Cyclone 2, Kosmos 2406 on a Zenit 2, and Kosmos 2410 on a Soyuz), four navigation satellites (Kosmos 2407 on a Cosmos 3M and Kosmos 2411 through 2413—three GLONASS satellites—on a Proton K), and two communications satellites (Kosmos 2408 and 2409 on a Cosmos 3M). The sole non-ISS civil launch was of a Cyclone 3 vehicle, which carried two Ukrainian remote sensing satellites, Sich 1M and MS-1TK.

Russia also performed two non-commercial launches of Proton K vehicles carrying the Express AM1 and Express AM11 commercial communications satellites. The launches are considered non-commercial because the launch contracts were not internationally competed.

EUROPE

Europe conducted only three launches in 2004, only one of which was commercial. See Table 7 for a summary of European launch activity. All three launches used the generic version of the Ariane 5 vehicle. The sole com-

Table 6. Russian Vehicle Performance in 2004

								
Vehicle	Kosmos 3M	Molniya	Dnepr	Cyclone	Soyuz	Zenit 2	Proton K	Proton M
2004 Total Launches	2	1	1	2	7	1	4	4
Launch Reliability (2004)	2/2 100%	1/1 100%	1/1 100%	2/2 100%	7/7 100%	1/1 100%	4/4 100%	4/4 100%
Launch Reliability (Last 10 Years)	27/28 96%	22/22 100%	4/4 100%	14/15 93%	92/95 97%	9/11 82%	69/75 92%	7/7 100%
Year of First Launch	1964	1960	1999	1967	1963	1985	1967	2000
Launch Sites	Plesetsk	Plesetsk	Baikonur	Baikonur Plesetsk	Baikonur Plesetsk	Baikonur	Baikonur	Baikonur
LEO kg (lbs)	1,350 (2,970)	1,800 (3,960)	3,700 (8,150)	4,100 (9,040)	6,708 (14,758)	13,920 (30,695)	19,760 (46,999)	21,000 (46,305)
GTO kg (lbs)	--	--	--	--	1,350 (2,975)	--	4,430 (10,868)	5,500 (12,125)

mercial launch took place in July, placing the Anik F2 satellite in GEO. The sole commercial launch was the lowest rate since 1982. In February, an Ariane 5 launched the European Space Agency's Rosetta comet mission, which includes both the Rosetta orbiter and a separate lander spacecraft, Philae. In December, an Ariane 5 launched Helios 2A, a French military reconnaissance satellite, into LEO. The launch also carried four small Essaim satellites designed to test signals intelligence technologies, as well as two non-military payloads: Nanosat 01, a Spanish microsatellite; and Parasol, an Earth sciences spacecraft for the French space agency CNES. Arianespace is planning approximately six launches in 2005, including the non-commercial launch of the first Automated Transfer Vehicle (ATV) spacecraft to the International Space Station.

CHINA

China has not conducted any commercial launches since 1999, but did perform eight non-commercial launches in 2004, its highest level of launch activity to date. See Table 7 for a breakdown of Chinese launch activity. In April, a Long March 2C launched two small technology demonstration satellites, Experiment Satellite 1 and Nano-satellite 1,

into LEO. In July, another Long March 2C launched Double Star Polar, a space science satellite developed in cooperation with the European Space Agency, into an elliptical polar orbit. That satellite will work in conjunction with Double Star Equator, launched by China at the end of 2003.

China then performed three launches in just under a month. In late August, a Long March 2C launched FSW 19, a microgravity and earth sciences satellite with a recoverable payload that returned to Earth several weeks later. In early September, a Long March 4B launched a pair of small satellites, SJ 6A and SJ 6B, designed to measure the radiation environment in LEO. In late September, a Long March 2D launched FSW 20, another microgravity and earth sciences satellite with a recoverable payload.

China conducted three more launches over the course of four weeks in October and November. In mid-October, a Long March 3A launched the Fengyun 2C weather satellite into GEO. In early November, a Long March 4B launched the Ziyuan 2C remote sensing satellite into LEO. Finally, in mid-November, a Long March 2C launched Experiment Satellite 2, a technology demon-

Table 7. European, Chinese, Indian, and Israeli Launch Vehicle Performance in 2004

	Europe	China				India	Israel
							
Vehicle	Ariane 5	Long March 2C	Long March 2D	Long March 3A	Long March 4B	GSLV	Shavit 1
Country/Region	Europe	China	China	China	China	India	Israel
2004 Total Launches	3	4	1	1	2	1	1
Launch Reliability (2004)	3/3	4/4	1/1	1/1	2/2	1/1	0/1
	100%	100%	100%	100%	100%	100%	0%
Launch Reliability (Last 10 Years)	17/20	12/12	3/3	7/7	8/8	3/3	2/4
	85%	100%	100%	100%	100%	100%	50%
Year of First Launch	1996	1975	1992	1994	1999	2001	1988
Launch Sites	Kourou	Jiuquan	Jiuquan	Xichang	Taiyuan	Satish Dhawan	Palmachim
LEO kg (lbs)	17,250 (37,950)	3,200 (7,048)	3,500 (7,709)	7,200 (15,859)	3,500 (7,700)	5,000 (11,013)	350 (770)
GTO kg (lbs)	6,534 (14,375)	1,000 (2,203)	1,250 (2,753)	2,500 (5,507)	--	2,500 (5,507)	--

stration spacecraft, into LEO. In 2005 China is expected to perform a similar number of launches as in 2004, including the anticipated launch of Shenzhou 6, China's second manned spaceflight.

INDIA

The Indian Space Research Organization (ISRO) performed one launch in 2004 (see Table 7). A Geosynchronous Space Launch Vehicle (GSLV) launched from the Professor Satish Dhawan Space Center (formerly Sriharikota Space Center) in September, successfully placing the Edusat communications

satellite into GEO. This was the third launch of the GSLV. The satellite will be used to support distance-learning programs throughout India.

ISRAEL

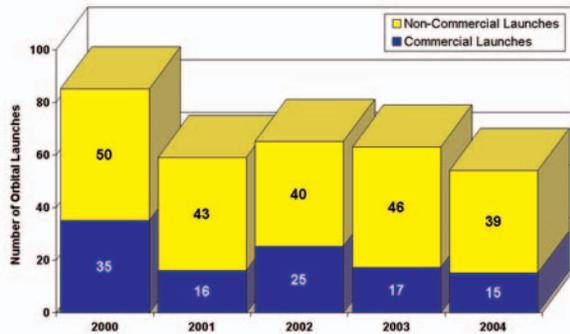
Israel performed one unsuccessful launch in 2004 (see Table 7). In September, a Shavit 1 vehicle lifted off from the Palmachim Air Force Base on Israel's Mediterranean coast, carrying the Ofeq 6 military reconnaissance satellite. However, the third stage of vehicle failed to ignite, causing it and the payload to crash into the sea.

FIVE-YEAR WORLDWIDE SPACE TRANSPORTATION TRENDS

OVERVIEW

Between 2000 and 2004 inclusive, there was an annual average of 65 orbital launches worldwide. However, excluding the 85 launches that occurred in 2000, the average for 2001-2004 was only 60 launches a year (see Figure 9).

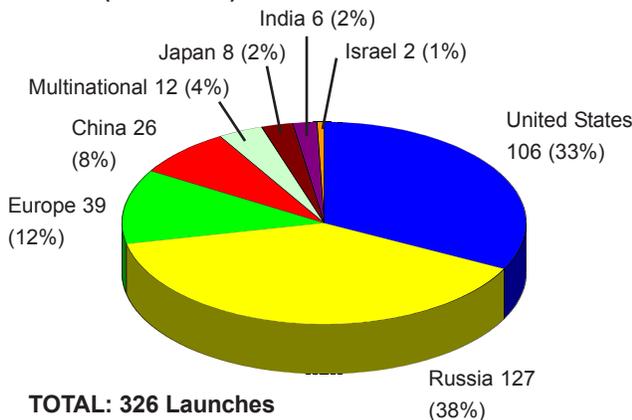
Figure 9. Five-Year Summary (2000–2004) of Commercial and Non-commercial Launch Events*



Over the past five years, the United States and Russia have conducted the most total orbital launches worldwide, followed by Europe and China (see Figure 10).

There were 108 commercial orbital launches during the same five-year period, with a high of 35 in 2000 and a low of 15 in 2004. Since 2000, the United States carried out 26 commercial launches. Europe and

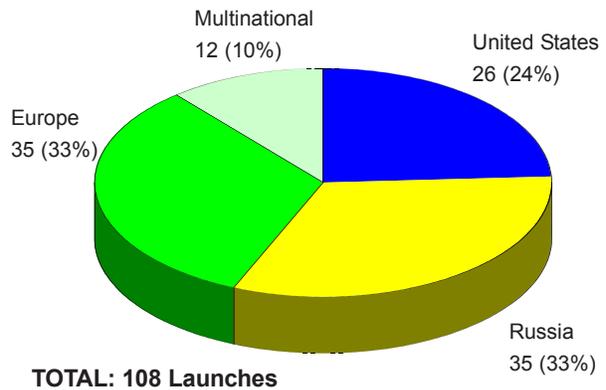
Figure 10. Five-Year Worldwide Total Orbital Commercial and Non-commercial Launch Industry Share (2000–2004)



* The 2002 data reflects a correction from previous reports. One launch was incorrectly counted as non-commercial.

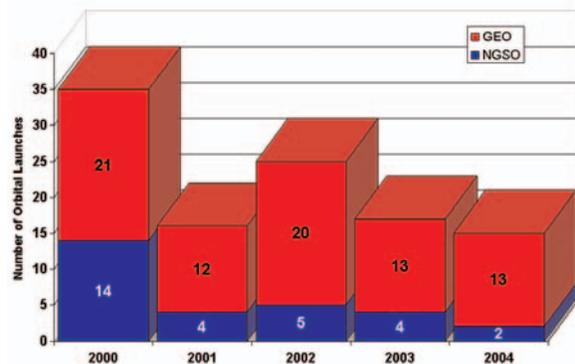
Russia exceeded this number with 35 commercial launches each (see Figure 11). The lower number of U.S. launches reflects a decrease in the demand for commercial LEO launches, which peaked in 1998. GEO commercial launches for Arianespace averaged around 10 per year from 2000–2002 until the Ariane 5 ECA launch failure in late 2002. Russia GEO commercial launches have fluctuated between two and five per year since 1996.

Figure 11. Five-Year Worldwide Commercial Orbital Launch Market Share (2000–2004)



In 2004, the number of commercial launches decreased by 12 percent from the previous year to 15. Since 2000, the number of commercial launches to GEO per year has stabilized at about 12-13, with a peak of 20 in

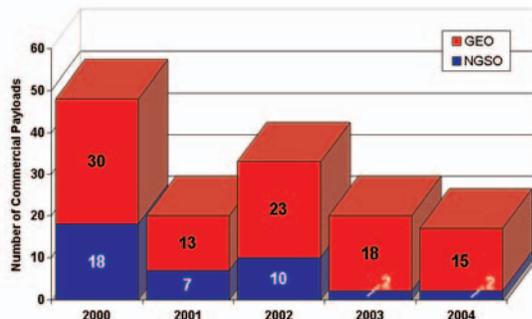
Figure 12. Five-Year Worldwide Commercial GEO and NGSO Launch Events (2000–2004)



2002. Commercial launches to LEO have declined sharply over the past five years, with only two commercial launches to LEO in 2004 compared to 14 in 2000 (see Figure 12).

Figure 13 shows the number of commercial payloads launched on commercial and non-commercial launch vehicles over the past five years. The data shows that, while the number of commercial GEO satellites launched each year since 2000 has not changed significantly, the number of commercial NGSO satellites has decreased substantially. In 2004, only two commercial NGSO satellites were placed in orbit, Latinsat 3 and 4.

Figure 13. Five-Year Summary of Commercial Payloads Launched by Orbit (2000–2004)



Revenues during the period, highlighted in Figure 14 and Table 8, show 2004, with a revenue total of US\$1.0 billion, to be the lowest during the five-year period, sinking below the US\$1.2 billion figure of 2003.

Figure 14. Launch Revenues for Commercial Launch Events (approximate, in \$U.S. millions)

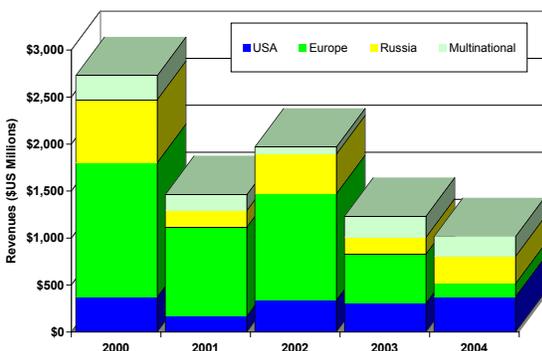


Table 8. Launch Revenues for Commercial Launch Events (approximate, in \$U.S. millions)

	2000	2001	2002	2003	2004
United States	370	167	338	304	375
Russia	671	178	423	178	290
Europe	1,433	948	1,133	525	140
Multinational	255	170	75	225	210
TOTAL	2,729	1,463	1,969	1,232	1,015

COMMERCIAL SATELLITE TRENDS

The GEO telecommunications satellite industry is expected to remain essentially flat for a variety of reasons, and commercial launch providers can expect to remain in a very competitive stance. Today, the commercial space transportation market is driven largely by the demand for launches of GEO telecommunications satellites. Therefore, developments in the industry over the next few years will parallel developments in satellite systems, including:

- Anticipated steady demand for launch of GEO communications satellite systems with a small but steady demand for LEO remote sensing systems;
- A near-term trend of heavier GEO telecommunications satellites (based on planned manifests) with a mid-term trend of more moderate and smaller satellites (based on recent orders); and
- Current demand shows that about one-half of NGSO payloads will be international science missions. The remainder will be a mix of remote sensing and telecommunications payloads, with some growth in the latter category as existing NGSO communications systems are replenished or replaced.

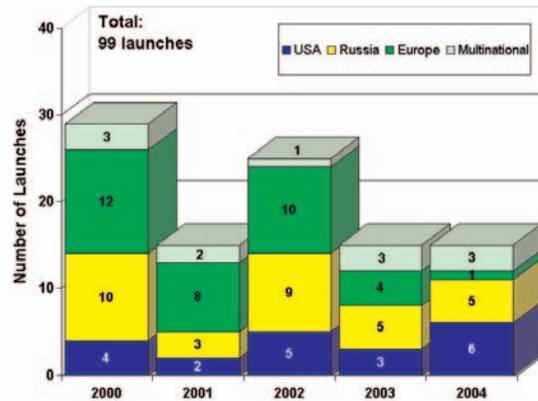
These satellite industry trends will be augmented by continued international competition to provide launch services by the U.S., Europe, Russia, and Ukraine. China could reenter the launch services market. Possible new entrants into the international launch services market include India, Japan, and Brazil. South Korea is also developing a small launch vehicle.

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. Figure 15 shows trends for each country with launch providers competing in the international marketplace. The chart reflects only launch service providers competing in the international marketplace for open bid launch service contracts.

From 2000 to 2004, 150 payloads had launch contracts that were internationally competed. Due to multimanifesting, this translates to 99 internationally-competed launch events. In contrast, 20 payloads launched on commercial launches were not internationally competed and are considered captive payloads. Because of multimanifesting, this equates to nine launches.

Figure 15. Five-Year Worldwide 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.

2004 SIGNIFICANT COMMERCIAL SUBORBITAL ACTIVITY

There were five FAA/AST-licensed commercial suborbital launches in 2004 (see Table 9). This is the largest number of licensed suborbital launches in any year since the Department of Transportation began licensing in 1989, and the first since 2002 (see Figure 16).

All five licensed suborbital launches were conducted by Mojave Aerospace Ventures (MAV), a joint venture between aerospace company Scaled Composites and financier Paul Allen. MAV developed and operates SpaceShipOne, a manned reusable suborbital vehicle designed to compete for the \$10-million Ansari X Prize. SpaceShipOne is air-launched from a carrier aircraft, White Knight, and flies a suborbital trajectory using a single hybrid rocket engine before gliding to a runway landing at Mojave Airport in California.

AST granted a license for SpaceShipOne to MAV on April 1. SpaceShipOne’s first two FAA-licensed flights under that license, on April 8 and May 13, were test flights that remained in the atmosphere. The third flight, on June 21, marked the first time a privately-

developed manned vehicle flew into space, as SpaceShipOne achieved a peak altitude of just over 100 kilometers. SpaceShipOne flew into space again on September 29 and October 4, flights that won the Ansari X Prize for MAV.

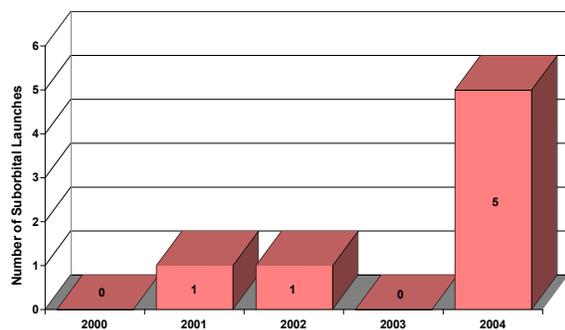
SpaceShipOne was one of two suborbital vehicles granted AST suborbital reusable mission licenses during the year. In April 2004 AST awarded a license to XCOR Aerospace for its proposed Sphinx manned suborbital vehicle. Additionally, AST awarded a spaceport license in June 2004 to East Kern Airport District for suborbital operations at Mojave Airport in California.

SpaceShipOne was one of approximately two dozen international teams competing for the Ansari X Prize. Many of the teams competing for the prize continued to develop their vehicles even after MAV won the prize. Other companies who did not compete for the prize are also developing suborbital vehicles for public space travel and other markets, but have not disclosed specific plans.

Table 9. 2004 FAA-Licensed Suborbital Launch Events

Date	Vehicle	Payload	Launch Outcome
Apr 8	SpaceShipOne	Flight 13P	Success
May 13	SpaceShipOne	Flight 14P	Success
Jun 21	SpaceShipOne	Flight 15P	Success
Sep 29	SpaceShipOne	Flight 16P	Success
Oct 4	SpaceShipOne	Flight 17P	Success

Figure 16. FAA-Licensed Suborbital Launch Events



APPENDIX: 2004 WORLDWIDE ORBITAL LAUNCH EVENTS

Date	Vehicle	Site	Payload(s)	Orbit	Operator	Manufacturer	Use	Comm Price	L	M
1/10/2004	v Zenit 3SL	Odyssey Launch Platform	* Estrela do Sul 1	GEO	Loral Skynet do Brasil	Space Systems/Loral	Communications	\$65-85M	S	S
1/29/2004	Soyuz	Baikonur	Progress ISS 13P	LEO	Rosaviakosmos	RSC Energia	ISS		S	S
2/5/2004	v Atlas 2AS	CCAFS	* AMC 10	GEO	SES Americom	Lockheed Martin Corp.	Communications	\$65-75M	S	S
2/14/2004	Titan 4B/IUS	CCAFS	DSP F22	GEO	DoD	TRW	Intelligence		S	S
2/18/2004	Molniya	Plesetsk	Kosmos Molniya 1T	ELI	Russian MoD	NPO Lavotchkin	Communications		S	S
3/2/2004	Ariane 5G	Kourou	Rosetta Orbiter	EXT	European Space Agency (ESA)	Astrium	Scientific		S	S
3/13/2004	v Atlas 3A	CCAFS	* MBSAT 1	GEO	Mobile Broadcasting Corp.	Space Systems/Loral	Communications	\$65-75M	S	S
3/16/2004	v Proton M	Baikonur	* Eutelsat W3A	GEO	Eutelsat	Astrium	Communications	\$65-85M	S	S
3/20/2004	Delta 2 7925-10	CCAFS	Navstar GPS 2R-11	MEO	USAF	Lockheed Martin Corp.	Navigation		S	S
3/27/2004	Proton K	Baikonur	Kosmos Raduga 1	LEO	Russian MoD	NPO Prikladnoy Mekhaniki (NPO PM)	Intelligence		S	S
4/15/2004	v Atlas 2AS	CCAFS	* Superbird 6	GEO	Space Communications Corp.	Boeing	Communications	\$65-75M	S	S
4/18/2004	Long March 2C	Xichang	Experiment Satellite 1	LEO	China National Space Administration (CNSA)	Harbin Institute of Technology	Development		S	S
			Nano-satellite 1	LEO	Qinqhua National University	Qinqhua National University	Remote Sensing			S
4/19/2004	Soyuz	Baikonur	Soyuz ISS 8S	LEO	Federal Space Agency	RSC Energia	ISS		S	S
4/20/2004	Delta 2 7920	VAFB	Gravity Probe B	LEO	NASA	Lockheed Martin Corp.	Scientific		S	S
4/27/2004	Proton K	Baikonur	* Express AM11	GEO	Russian Satellite Communciation Co.	NPO Prikladnoy Mekhaniki	Communications		S	S
5/4/2004	v Zenit 3SL	Odyssey Launch Platform	* DirecTV 7S	GEO	DirecTV, Inc.	Space Systems/Loral	Communications	\$65-85M	S	S
5/19/2004	v Atlas 2AS	CCAFS	* AMC 11	GEO	SES Americom	Lockheed Martin Corp.	Communications	\$65-75M	S	S
5/20/2004	v Taurus XL	VAFB	Rocsat 2	LEO	National Space Program Office (NSPO)	NSPO	Remote Sensing	\$20-30M	S	S
5/25/2004	Soyuz	Baikonur	Progress ISS 14P	LEO	Federal Space Agency	RSC Energia	ISS		S	S
5/28/2004	Cyclone 2	Baikonur	Kosmos 2405	LEO	Russian MoD	KB Arsenal	Intelligence		S	S
6/10/2004	Zenit 2	Baikonur	Kosmos 2406	LEO	Russian MoD	NPO Yuzhnoye	Intelligence		S	S
6/17/2004	v Proton M	Baikonur	* Intelsat 10-02	GEO	Intelsat	Astrium	Communications	\$65-85M	S	S
6/23/2004	Delta 2 7925-10	CCAFS	Navstar GPS 2R-12	MEO	USAF	Lockheed Martin Corp.	Navigation		S	S
6/28/2004	v Zenit 3SL	Odyssey Launch Platform	* APStar 5	GEO	APT Satellite Co., Ltd.	Space Systems/Loral	Communications	\$65-85M	P	S
6/29/2004	v Dnepr 1	Baikonur	Demeter	LEO	Centre National d'Etudes Spatiales (CNES)	CNES	Scientific	\$8-11M	S	S
			AMSat-Echo	LEO	Amateur Radio Satellite Corp.	SpaceQuest, Ltd.	Communications			S
			* Latinsat 3	LEO	Aprize Satellite	SpaceQuest, Ltd.	Communications			S
			* Latinsat 4	LEO	Aprize Satellite	SpaceQuest, Ltd.	Communications			S
			* SaudiComsat 1	LEO	Space Research Institute	Space Research Institute	Communications			S
			SaudiComsat 2	LEO	Space Research Institute	Space Research Institute	Communications			S
			Saudisat 2	LEO	Space Research Institute	Space Research Institute	Communications			S
			Unisat 3	LEO	University of Rome	University of Rome	Development			S
7/15/2004	Delta 2 7920	VAFB	Aura	LEO	NASA	TRW	Remote Sensing		S	S
7/17/2004	v Ariane 5G	Kourou	* Anik F2	GEO	Telesat Canada	Boeing	Communications	\$125-155M	S	S
7/22/2004	Kosmos 3M	Plesetsk	Kosmos 2407	LEO	Russian MoD	NPO PM	Navigation		S	S
7/25/2004	Long March 2C	Taiyuan	Double Star Polar	ELI	CNSA	Chinese Academy of Space Technology (CAST)	Scientific		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 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.

2004 WORLDWIDE ORBITAL LAUNCH EVENTS (CONTINUED)

Date	Vehicle	Site	Payload(s)	Orbit	Operator	Manufacturer	Use	Comml Price	L	M
8/3/2004	Delta 2 7925H	CCAFS	Messenger	EXT	NASA	Applied Physics Laboratory	Scientific		S	S
8/5/2004	✓ Proton M	Baikonur	* Amazonas 1	GEO	Hispasat	Astrium	Communications	\$65-85M	S	S
8/11/2004	Soyuz	Baikonur	Progress ISS 15P	LEO	Federal Space Agency	RSC Energia	ISS		S	S
8/29/2004	Long March 2C	Jiuquan	FSW 19	LEO	CNSA	CAST	Scientific		S	S
8/31/2004	Atlas 2AS	CCAFS	NRO L-1	ELI	USAF	Classified	Classified		S	S
9/6/2004	Shavit 1	Palmachim AFB	Ofeq 6	LEO	Israeli MoD	Israel Aircraft Industries	Intelligence		F	F
9/9/2004	Long March 4B	Taiyuan	SJ 6A	LEO	CNSA	Shanghai Academy of Spaceflight Technology	Scientific		S	S
			SJ 6B	LEO	CNSA	Chinese Academy of Sciences	Scientific			S
9/20/2004	GSLV	Satish Dhawan Space Center	Edusat	GEO	Indian Space Research Organization (ISRO)	ISRO	Communications		S	S
9/23/2004	Kosmos 3M	Plesetsk	Kosmos 2408	LEO	Russian MoD	NPO PM	Communications		S	S
			Kosmos 2409	LEO	Russian MoD	NPO PM	Communications			S
9/24/2004	Soyuz	Plesetsk	Kosmos 2410	LEO	Russian MoD	TsSKB Progress	Intelligence		S	S
9/27/2004	Long March 2D	Jiuquan	FSW 20	LEO	CNSA	Chinese Academy of Sciences	Scientific		S	S
10/14/2004	Soyuz	Baikonur	Soyuz ISS 9S	LEO	Federal Space Agency	RSC Energia	ISS		S	S
10/15/2004	✓ Proton M	Baikonur	* AMC 15	GEO	SES Americom	Lockheed Martin Corp.	Communications	\$65-85M	S	S
10/19/2004	Long March 3A	Xichang	Fengyun 2C	GEO	China Meteorological Administration	Shanghai Institute of Satellite Engineering	Meteorological		S	S
10/30/2004	Proton K	Baikonur	* Express AM1	GEO	Russian Satellite Communication Co.	NPO PM	Communications		S	S
11/6/2004	Delta 2 7925-10	CCAFS	Navstar GPS 2R-13	MEO	USAF	Lockheed Martin Corp.	Navigation		S	S
11/6/2004	Long March 4B	Taiyuan	Ziyuan 2C	LEO	CNSA	CAST	Remote Sensing		S	S
11/18/2004	Long March 2C	Xichang	Experiment Satellite 2	LEO	CNSA	China Aerospace Corporation	Development		S	S
11/20/2004	Delta 2 7320	CCAFS	Swift	LEO	NASA/GSFC	Spectrum Astro, Inc.	Scientific		S	S
12/17/2004	✓ Atlas 5 521	CCAFS	* AMC 16	GEO	SES Americom	Lockheed Martin Corp.	Communications	\$65-85M	S	S
12/18/2004	Ariane 5G	Kourou	Helios 2A	LEO	Delegation Generale pour l'Armement (DGA)	Astrium	Intelligence		S	S
			Essaim 1	LEO	French MoD	CNES	Intelligence			S
			Essaim 2	LEO	French MoD	CNES	Intelligence			S
			Essaim 3	LEO	French MoD	CNES	Intelligence			S
			Essaim 4	LEO	French MoD	CNES	Intelligence			S
			Parasol	LEO	CNES	CNES	Scientific			S
			Nanosat 01	LEO	Instituto Nacional de Technica Aeroespacial (INTA)	INTA	Communications			S
12/21/2004	Delta 4 Heavy	CCAFS	HLVOLSDP	GEO	USAF	USAF	Test		P	P
			3CSat 1	LEO	Univ. of Colorado	Arizona State Univ.	Development			F
			3CSat 2	LEO	Univ. of Colorado	Arizona State Univ.	Development			F
12/24/2004	Soyuz	Baikonur	Progress ISS 16P	LEO	Federal Space Agency	RSC Energia	ISS		S	S
12/24/2004	Cyclone 3	Plesetsk	Sich 1M	LEO	Ukraine Space Agency (NKAU)	NPO Yuzhnoye	Remote Sensing		P	P
			MS-1TK	LEO	NKAU	NPO Yuzhnoye	Development			P
12/26/2004	Proton K	Baikonur	Kosmos 2411	MEO	Russian MoD	NPO PM	Navigation		S	S
			Kosmos 2412	MEO	Russian MoD	NPO PM	Navigation		S	S
			Kosmos 2413	MEO	Russian MoD	NPO PM	Navigation		S	S

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