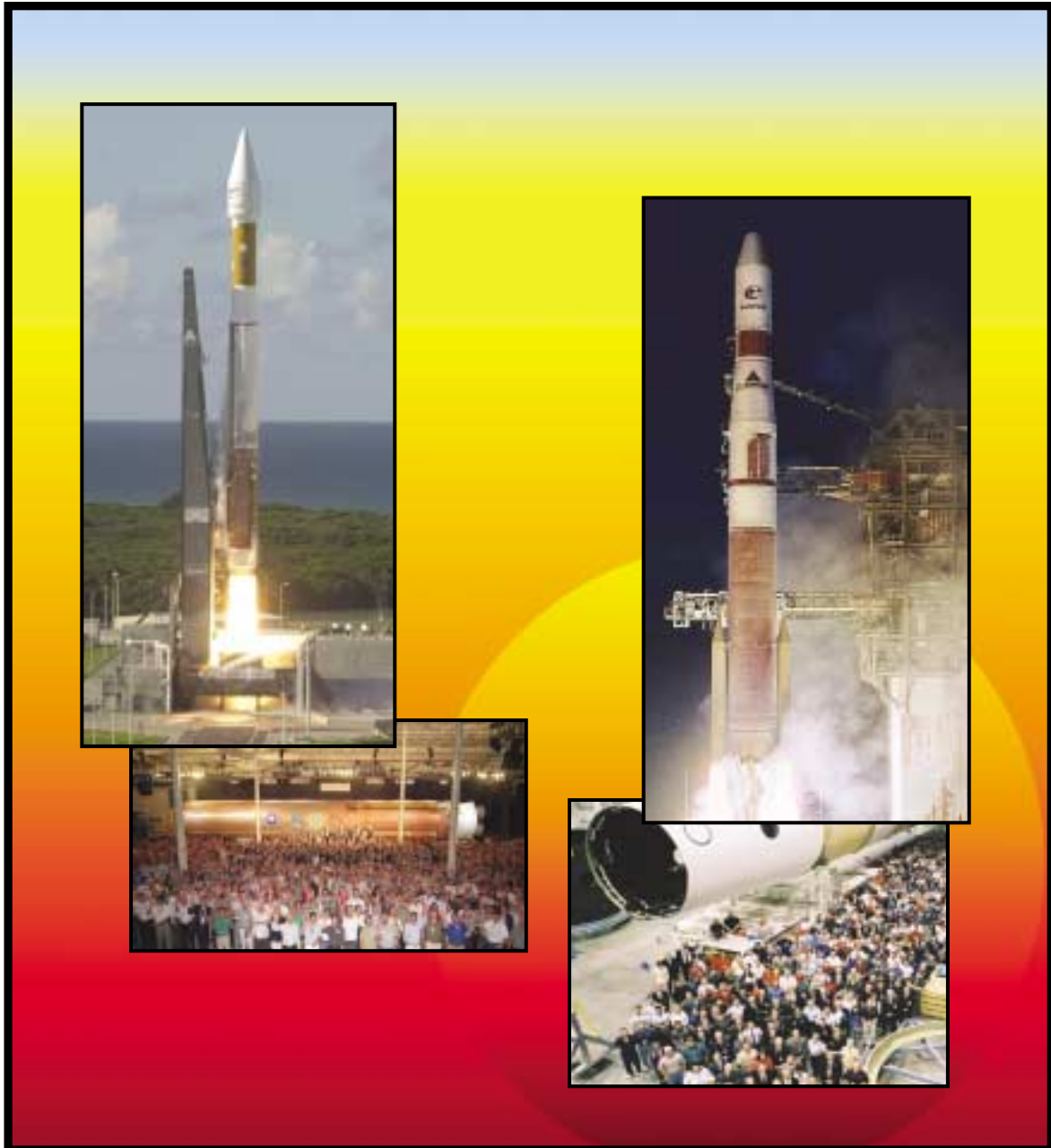




*Associate Administrator for Commercial Space Transportation  
Federal Aviation Administration*

**January 2003**

## **Commercial Space Transportation: 2002 Year In Review**



**Cover description (clockwise from top right):** A Boeing Launch Services' (BLS) Delta 4 Medium Plus (4,2) launches Eutelsat W5 to geosynchronous Earth orbit (GEO) on November 20, 2002; Boeing employees gather at the rollout ceremony of the first Delta 4 Common Booster Core (CBC) from Boeing's Decatur, Alabama, facility on May 23, 2002; Lockheed Martin employees pose with the first Atlas 5 Common Core Booster (CCB) at Lockheed Martin's Denver, Colorado, facility; an Atlas 5 401 provided by International Launch Services (ILS) lofts Hot Bird 6 to GEO on August 21, 2002.

## INTRODUCTION

The *Commercial Space Transportation: 2002 Year in Review* summarizes U.S. and international launch activities for calendar year 2002 and provides a historical look at the past five years of commercial launch activities.

The Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (FAA/AST) licensed six commercial orbital launches in 2002, all of which were successful.

Of the six FAA/AST-licensed launches in 2002, five were of U.S.-built vehicles, including the introduction of two new launch vehicles. ILS launched the first Atlas 5, Lockheed Martin's contribution to the U. S. Air Force Evolved Expendable Launch Vehicle (EELV) program, which lofted Hot Bird 6 into geosynchronous Earth orbit (GEO). ILS also launched an Atlas 2AS and an Atlas 3B for commercial customers. Boeing Launch Services (BLS) successfully launched the first Delta 4, Boeing's EELV entrant, which carried Eutelsat W5, as well as a single Delta 2 for Iridium Satellite, LLC.

Overall, 24 commercial orbital launches occurred worldwide in 2002, representing 37 percent of the 65 total launches for the year. The 24 commercial launches represent an increase of 50 percent from 2001, but the total remains significantly lower than in prior years (35 in 2000 and 39 in 1999). FAA/AST-licensed launch activity accounted for 25 percent of the worldwide commercial launch market in 2002. Arianespace captured the majority of the commercial launch market at 42 percent. Russia conducted eight commercial launch campaigns, bringing its commercial launch market share to about 33 percent for the year. Sea Launch, LLC, launched PanAmSat's Galaxy 3C aboard a Ukrainian-built Zenit 3SL in the summer of 2002.

In addition to the six orbital launches, the FAA/AST issued one suborbital license in 2002 for a HyShot hypersonic test launch from the Woomera Protected Area, Australia.

### ABOUT THE ASSOCIATE ADMINISTRATOR FOR COMMERCIAL SPACE TRANSPORTATION (AST)

The Federal Aviation Administration's Associate Administrator for 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 prop-

erty, and the national security and foreign policy interests of the United States. Chapter 701 and the 1996 *National Space 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: 2002 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.

2002 FAA-LICENSED LAUNCH SUMMARY

Five of the six FAA/AST-licensed commercial orbital launches for 2002 were conducted from U.S. ranges, while the remaining orbital launch was conducted from the Sea Launch Odyssey platform in the Pacific Ocean. All six orbital flights were successfully executed for commercial customers, with one carrying multiple payloads (the Delta 2 Iridium flight). The six FAA-licensed launches are listed in Table 1.

The six FAA-licensed launches included the following characteristics:

- All six launches, worth approximately \$413 million in revenue, were conducted for commercial clients.<sup>1</sup>
- Of the six launches, two were inaugural launches of the Atlas 5 and Delta 4, vehicles designed under the EELV program.
- Five launches were to GEO, and one to low Earth orbit (LEO).

The FAA also licensed one suborbital launch from Woomera, Australia, in support of the HyShot hypersonic test flight series being conducted by the University of Queensland. The successful launch was licensed because DTI Associates (formerly part of Astrotech Space Operations), provider of the Terrier-Orion sounding rocket, is a U.S.-based company.

FAA-licensed launches decreased in frequency each year from 1998 to 2001, with a slight increase for 2002 (see Figure 1). Toward the end of this five-year period, fewer satellite customers sought launch vehicles due in large part to the financial impact on new satellite ventures after bankruptcies of high-profile non-geosynchronous orbit (NGSO) systems, such as Iridium, LLC; ORBCOMM; ICO Global; and Globalstar.

The reduction in FAA-licensed orbital launches showed signs of leveling off during the 2001-2002 period. A similar trend was observed for estimated FAA-licensed orbital commercial launch revenues (see Figure 2).

Table 1. 2002 FAA-Licensed Orbital Launch Events

Date	Vehicle	Payload	Launch Outcome	Orbit
Feb 11	Delta 2 7920	Iridium 90, 91, 94, 95, 96	Success	LEO
Feb 21	Atlas 3B	EchoStar 7	Success	GEO
Jun 15	Zenit 3SL	Galaxy 3C	Success	GEO
Aug 21	Atlas 5 401	Hot Bird 6	Success	GEO
Sep 18	Atlas 2AS	Hispasat 1D	Success	GEO
Nov 20	Delta 4 Med (4,2)	Eutelsat W5	Success	GEO

Figure 1. FAA-Licensed Orbital Launch Events

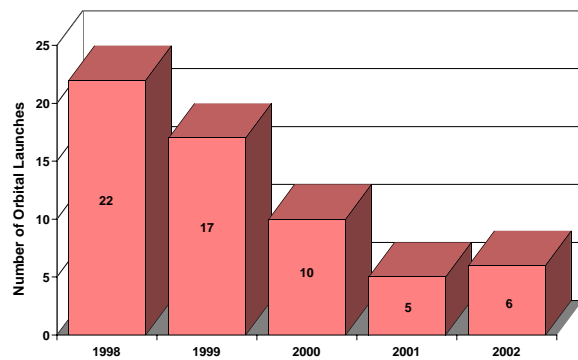
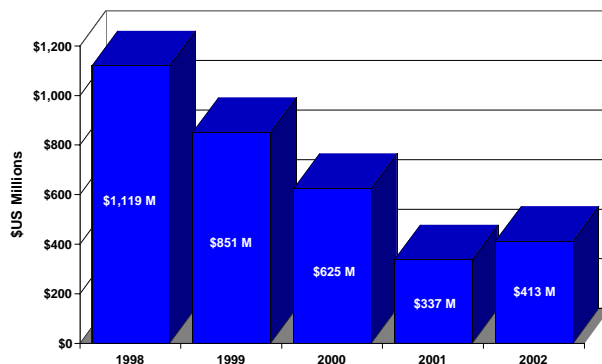


Figure 2. Estimated Revenues for FAA-Licensed Orbital Launch Events



<sup>1</sup> Revenues for both U.S. and foreign commercial launches are based on open source information and estimates by FAA/AST and are approximations only.

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

The United States carried out a total of 16 launches, five of which were licensed by FAA/AST. The multinational Sea Launch, LLC conducted one commercial launch, also licensed by the FAA. See Table 2 for a detailed breakdown of U.S. launch activity during 2002 by vehicle.

**BOEING LAUNCH SERVICES (BLS)**

Boeing, which offers the Delta 2, Delta 3, Delta 4, and Zenit 3SL, all marketed through the company's new division called Boeing Launch Services (BLS), conducted three commercial launches in 2002. The introduction of Boeing's Delta 4 took place with the successful launch of a Delta 4 Medium Plus (4,2) carrying Eutelsat W5 in the fall of 2002. The Delta 4, consisting of five variants, is Boeing's contribution to the EELV program. A cluster of five Iridium satellites was successfully launched aboard a Delta 2 (7920), placing them as spares within the existing constellation of 66 satellites operated by Iridium Satellite, LLC.











Sea Launch successfully conducted one commercial launch in 2002, using the Zenit 3SL to send PanAmSat's Galaxy 3C to GEO in June. The Zenit 3SL is launched from the mobile Odyssey Launch Platform along the equator on the Pacific Ocean. Boeing is the majority shareholder (40 per-

cent) 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).

**INTERNATIONAL LAUNCH SERVICES (ILS)**

ILS, a joint venture since 1995 between Lockheed Martin, Khrunichev State Research and Production Space Center, and S. P. Korolev Rocket and Space Corporation Energia, provides launch services using the Atlas and Proton vehicles. The company successfully conducted eight commercial launch campaigns in 2002, five of which used the Russian Proton vehicle. Three launches involved each of three existing Atlas variants, including the newly introduced Atlas 5 vehicle. As the Atlas 5 entered service during the year, Lockheed Martin and ILS continue to phase out the Atlas 2. The Atlas 3 will remain in service over the next few years until the Atlas 5 is fully transitioned into the market. The Atlas 5 401 successfully placed Eutelsat's Hot Bird 6 into GEO in late summer. Earlier in the year, an Atlas 3B was successfully launched, carrying the GEO-bound EchoStar 7. The launch of Hispasat 1D in September 2002 represents one of the final commercial launches of the highly successful Atlas 2 series.

**Table 2. U.S. and FAA-Licensed Launch Vehicle Performance in 2002**

	United States									Sea Launch
										
Vehicle	Pegasus XL	Titan 2	Delta 2	Atlas 2	Atlas 3	Atlas 5 400 series	Delta 4 Medium Plus	Shuttle	Titan 4	Zenit 3SL
2002 Total Launches	1	1	3	3	1	1	1	5	1	1
2002 Licensed Launches	0	0	1	1	1	1	1	0	0	1
Reliability (2002)	1/1 100%	1/1 100%	3/3 100%	3/3 100%	1/1 100%	1/1 100%	1/1 100%	5/5 100%	1/1 100%	1/1 100%
Reliability (Last 10 Years)	18/21 86%	9/9 100%	82/83 99%	57/57 100%	2/2 100%	1/1 100%	1/1 100%	68/68 100%	25/29 86%	7/8 88%
Year of First Launch	1994	1964	1990	1991	2000	2002	2002	1981	1989	1999
Launch Sites	CCAFS, VAFB, Wallops	VAFB	CCAFS, VAFB	CCAFS, VAFB	CCAFS	CCAFS	CCAFS, VAFB	KSC	CCAFS, VAFB	Odyssey Pacific Ocean Platform
LEO kg (lbs)	443 (977)	1,900 (4,200)	4,887 (10,751)	8,298 (18,256)	10,764 (23,709)	12,500 (27,558)	11,475 (25,300)	23,435 (51,557)	20,822 (45,808)	15,246 (33,541)
GTO kg (lbs)	--	--	1,769 (3,892)	3,833 (8,433)	4,500 (9,920)	7,640 (16,843)	6,565 (14,475)	5,663 (12,459)	8,276 (18,207)	6,000 (13,228)

CCAFS - Cape Canaveral Air Force Station, KSC - Kennedy Space Center, VAFB - Vandenberg Air Force Base

2002 WORLDWIDE LAUNCH ACTIVITY

Launch providers from the United States, Russia, Europe, China, Japan, India, Israel, and the multinational consortium Sea Launch conducted a total of 65 launch events in 2002 (see Table 3 and Figure 3), 24 of which were commercial. See Table 4 for a list of non-FAA-licensed commercial launches.

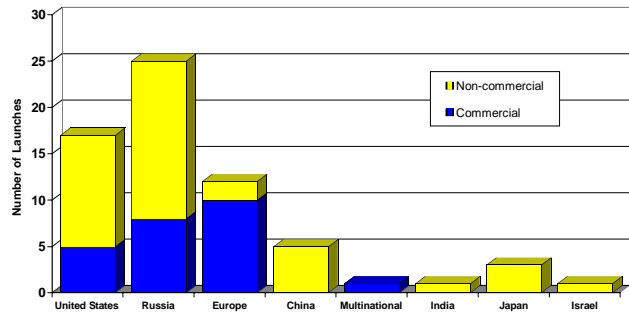
Table 3. 2002 Worldwide Orbital Launch Events

	Commercial Launches	Non-commercial Launches	Total Launches
United States	5	12	17
Russia	8	17	25
Europe	10	2	12
China	0	5	5
Multinational	1	0	1
India	0	1	1
Japan	0	3	3
Israel	0	1	1
TOTAL	24	41	65

Table 4. 2002 Non-FAA-Licensed Commercial Launch Events

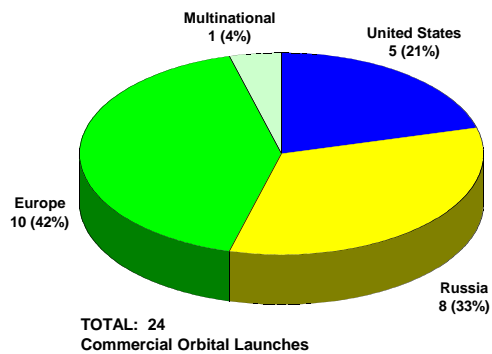
Date	Vehicle	Payload(s)	Launch Outcome	Orbit
Jan 24	Ariane 42L	Insat 3C	Success	GEO
Feb 23	Ariane 44L	Intelsat 904	Success	GEO
Mar 17	Rocket	Grace 1 and 2	Success	LEO
Mar 28	Ariane 44L	Astra 3A JCSAT 8	Success	GEO
Mar 30	Proton	Intelsat 903	Success	GEO
Apr 16	Ariane 44L	NSS 7	Success	GEO
May 7	Proton	DirecTV 5	Success	GEO
Jun 5	Ariane 44L	Intelsat 905	Success	GEO
Jun 20	Rocket	Iridium 97 and 98	Success	LEO
Jul 5	Ariane 5G	Atlantic Bird 3 N-Star C	Success	GEO
Aug 22	Proton	EchoStar 8	Success	GEO
Aug 28	Ariane 5G	Atlantic Bird 1 MSG 1	Success	GEO
Sep 6	Ariane 44L	Intelsat 906	Success	GEO
Nov 26	Proton	Astra 1K	Failure	GEO
Dec 11	Ariane 5 ECA	Hot Bird 7 Stentor	Failure	GEO
Dec 18	Ariane 44L	NSS 6	Success	GEO
Dec 20	Dnepr	Latinsat 1 and 2 RUBIN 2 SaudiSat 2 Unisat 2 Trailblazer Structural Test Article	Success	LEO
Dec 29	Proton	Nimiq 2	Success	GEO

Figure 3. 2002 Total Worldwide Launch Activity



Europe dominated the commercial launch industry in 2002 (see Figure 4). Commercial launch providers in the United States captured 21 percent of the launch industry’s global commercial market share. Russia captured 33 percent of the world’s commercial launch market, and Europe’s 10 commercial launches represented a 42 percent market share. Sea Launch’s single commercial launch accounted for four percent of the market. China, Japan, India, and Israel did not conduct any commercial launches in 2002. The Appendix at the end of this report shows all 65 orbital launches worldwide in 2002 for commercial, civil, and military missions.

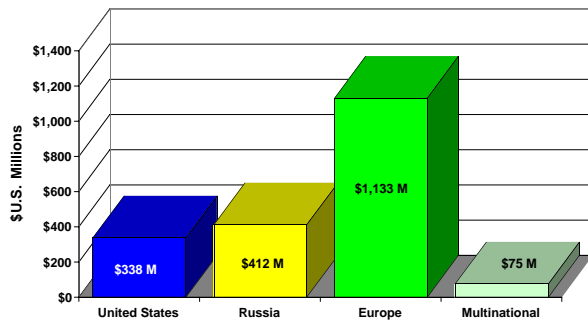
Figure 4. 2002 Worldwide Commercial Market Share



## WORLDWIDE LAUNCH REVENUES

Revenues from the 24 commercial launch events in 2002 were an estimated \$1.9 billion, a 22 percent increase from the 2001 total of approximately \$1.5 billion. U.S. commercial launch revenues for 2002 were estimated to be \$338 million; Russian revenues were about \$412 million; European revenues were about \$1,133 million; and Sea Launch earned approximately \$75 million. No other country conducted commercial orbital launches during the year (see Figure 5). Prices for individual launches to GEO dropped significantly during 2000-2002 compared to prior years. As a result, revenue estimates may be somewhat high.

**Figure 5. 2002 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 2002 the company made roughly \$210 million conducting commercial launches of the Atlas vehicle family and about \$375 million using the Proton. Starsem, a French-Russian partnership, provides commercial launches of the Soyuz vehicle. 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

Sixty-five launch vehicles carried a total of 94 payloads in 2002 (see Figure 6, Figure 7, and Table 5). Twenty-four of these launches were commercial, and 41 were non-commercial (Figure 8).

Of the 94 payloads, 34 provide commercial services (including one captive satellite each from Russia and Europe - these launches were not internationally competed) and 60 were for government or scientific purposes.

Figure 6. 2002 Total Worldwide Launch Activity by Payloads

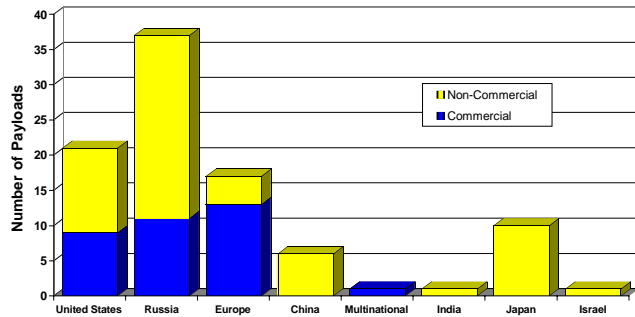


Table 5. Payloads Launched by Country in 2002

	Commercial Payloads (by service type)	Non-commercial Payloads (by service type)	Total Payloads
United States	9	12	21
Russia	11	26	37
Europe	13	4	17
China	0	6	6
Multinational	1	0	1
India	0	1	1
Japan	0	10	10
Israel	0	1	1
<b>TOTAL</b>	<b>34</b>	<b>60</b>	<b>94</b>

Figure 7. Total Payloads Launched by Country in 2002

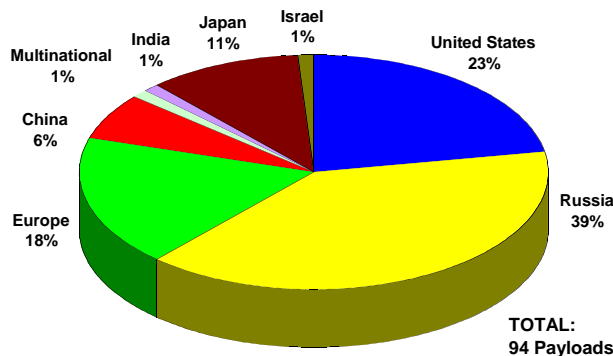
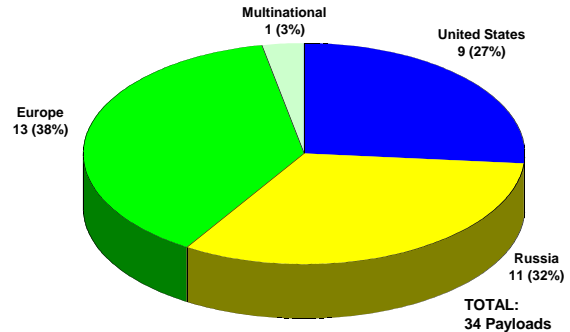


Figure 8. Commercial Payloads Launched by Country in 2002



COMMERCIAL LAUNCHES

Twenty-four commercial launches carried a total of 39 commercial and non-commercial payloads into orbit, three of which did not reach intended orbit.

Thirty-two payloads were launched to provide commercial services:

- Twenty-two of these were GEO satellites (Astra 3A and 1K, Atlantic Bird 1 and 3, DirecTV 5, EchoStar 7 and 8, Eutelsat W5, Galaxy 3C, Hispasat 1D, Hot Bird 6 and 7, Insat 3C, Intelsat 903-906, JCSAT 8, Nimiq 2, NSS 6 and 7, and N-Star C); and
- Ten were LEO satellites (Iridium 90, 91, 94-98; LatinSat 1-2, and Trailblazer Structural Test Article).

Seven payloads were launched to perform civil missions:

- Five are in LEO (GRACE 1 and 2, RUBIN 2, SaudiSat 1, and Unisat 2); and
- Two destined for GEO (MSG 1 and Stentor).

Two commercial launches ended in failure, and three satellites did not reach intended orbit:

- Russia’s Proton K carrying Astra 1K on November 26; and
- Europe’s Ariane 5 ECA carrying Hot Bird 7 and Stentor on December 11.

**NON-COMMERCIAL LAUNCHES**

Of the 65 orbital launches, 41 were non-commercial launches carrying a total of 55 commercial and non-commercial payloads, two of which did not achieve orbit.

Two payloads were launched to provide commercial services:

- SPOT 5 and Express A1R.

Five missions (each with a variety of payloads) were launched by the U.S. Space Shuttle:

- STS-109 Hubble Space Telescope servicing mission; and
- International Space Station (ISS) missions ISS 8A (STS-110), UF-2 (STS-111), ISS 9A (STS-112), and ISS 11A (STS-113).

Fourteen satellites were launched for military purposes:

- One U.S. payload (Milstar F5);
- Twelve Russian payloads (Kosmos 2387, Kosmos 2388, Kosmos 2389, Kosmos 2390-2391, Kosmos 2392, Kosmos 2393, Kosmos 2394-2396 [Glonass M R4-R6], Nadezhda M-2, and Mozhayets); and
- One Israeli payload (Ofeq 5).

Excepting the Shuttle missions listed above, 34 payloads were launched for civil or non-profit purposes:

- Six U.S. payloads (Aqua, Contour, HESSI, NOAA 17, TDRS I and J); and
- Twenty-eight foreign payloads (ADEOS 2, Alsat 1, DASH, DRTS W, ENVISAT 1, FedSat 1, Fengyun 1D, Foton 13, H 2A VEP 3, Haiyang 1, Idefix, INTEGRAL, Metsat, MDS 1, MicroLabSat, Progress 7P-9P, RUBIN 3-DSI, Shenzhou 3 and 4, Soyuz ISS 4S and 5S, Tsinghua 2, USERS REM, USERS SEM, WEOS, and Ziyaun 2B).

Two non-commercial launches ended in failure and the satellites did not achieve orbit:

- China's new Kaitouzhe 1 carrying Tsinghua 2 on September 15; and
- Russia's Soyuz carrying Foton 13 on October 15.

## LAUNCH ACTIVITIES BY COUNTRY








## RUSSIA

In 2002 Russia launched 25 vehicles, and of these, eight were commercial launches. ILS launched four Proton K vehicles carrying commercial payloads (Astra 1K, DirecTV 5, EchoStar 8, and Intelsat 903) and one Proton M (Nimiq 2). The Proton K carrying Astra 1K, launched on November 26, did not successfully place the satellite in the proper geosynchronous transfer orbit (GTO) because the Block DM upper stage failed to re-ignite. After almost two weeks of analysis to determine if the satellite could be salvaged from LEO, SES Astra controllers decided Astra 1K could not be saved and commanded it to reenter Earth's atmosphere over the Pacific Ocean. Eurockot, a joint venture between Astrium GmbH and Khrunichev State Research and Production Space Center, launched one Rockot for Iridium Satellite, LLC (Iridium 97 and 98) and one for NASA and the German Aerospace Center (DLR) (GRACE 1 and 2). Finally, ISC Kosmotras successfully launched a Dnepr vehicle carrying an assortment of commercial and non-commercial payloads (LatinSat 1 and 2, RUBIN 2, SaudiSat 2, Unisat 2, and a Trailblazer Structural Test Article). Both LatinSats represent the first members of a new commercial "Little LEO" satellite constella-

tion. See Table 6 for a detailed breakdown of Russian launch activity during 2002 by vehicle.

Russia also conducted 17 non-commercial launches, some of which were dedicated to resupplying the ISS. Of these 17, three were Soyuz vehicles carrying Progress modules (ISS 7P, 8P and 9P), and two were Soyuz vehicles carrying replacement Soyuz modules for use as ISS lifeboats (ISS 4S and 5S). In addition, Russia conducted 10 military launches, each carrying one or more satellites (Foton 13, Kosmos 2387, Kosmos 2388, Kosmos 2389, Kosmos 2390-2391, Kosmos 2392, Kosmos 2393, Kosmos 2394-2396, Nadezhda M-2, and Mozhayets). The Soyuz vehicle carrying Foton 13, however, exploded a few seconds after launch due to debris lodged in the propulsion plumbing. The European Space Agency (ESA), through an intergovernmental agreement, arranged to have its INTEGRAL scientific satellite launched aboard a Proton K. Algeria's first satellite, Alsat 1, was launched by a Cosmos vehicle (along with Mozhayets, the primary payload) as part of the five-satellite international Disaster Monitoring Constellation (DMC). One non-commercial launch of a Russian commercial satellite, Express A1R, was also conducted using a Proton K vehicle.

Table 6. Russian Vehicle Performance in 2002

							
<b>Vehicle</b>	Rockot	Cosmos	Dnepr	Molniya	Soyuz	Proton K	Proton M
<b>2002 Total Launches</b>	2	4	1	2	7	8	1
<b>Reliability (2002)</b>	2/2 100%	4/4 100%	1/1 100%	2/2 100%	6/7 86%	7/8 88%	1/1 100%
<b>Reliability (Last 10 Years)</b>	4/4 100%	40/41 98.00%	3/3 100%	38/38 100%	132/136 97%	88/96 92%	2/2 100%
<b>Year of First Launch</b>	1994	1964	1999	1960	1963	1967	2001
<b>Launch Sites</b>	Plesetsk Baikonur	Plesetsk	Baikonur	Plesetsk	Baikonur Plesetsk	Baikonur	Baikonur
<b>LEO kg (lbs)</b>	1,800 (3,970)	1,350 (2,970)	4,500 (9,920)	1,800 (3,960)	6,708 (14,758)	19,760 (46,999)	21,000 (46,297)
<b>GTO kg (lbs)</b>	--	--	--	1,600 (3,520)	1,350 (2,975)	4,430 (10,868)	6,190 (13,647)

**EUROPE**

Europe conducted 12 launches, 10 of which were commercial. Of the 12 launches, eight were conducted using the Ariane 4 family of vehicles, with the remaining four launches represented by the Ariane 5 series. The last Ariane 5 launch of the year failed due to a first-stage engine anomaly. The failure involved the new Ariane 5 ECA version, which uses a first stage with greater capacity than the Ariane 5G model and a new cryogenic upper stage. The Ariane 4 family is being phased out of service, paving the way for the Ariane 5 series. Arianespace plans to launch its last Ariane 4 during the first quarter of 2003.

All of the commercial launches involved satellites bound for GEO, while each of the two non-commercial launches placed a satellite into LEO. Arianespace successfully launched the following satellites using seven commercially procured Ariane 4 vehicles: Astra 3A, Insat 3C, Intelsat 904-906, JCSAT 8, and NSS 6 and 7. Commercial launches of the Ariane 5 family were used to loft Atlantic Bird 1 (along with a government weather satellite, MSG 1), Atlantic Bird 3 (formerly called Stellan 5), Hot Bird 7, N-Star C, and Stentor all to GEO. The upgraded Ariane 5 ECA used to launch Hot Bird 7 and Stentor, however, experienced problems with the





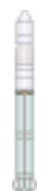



Vulcain 2 first-stage engine, and Kourou range safety personnel commanded the vehicle to self destruct. A review board released a report in January 2003 concluding that the most probable cause of the failure was the degraded thermal condition of the Vulcain 2 engine nozzle due to fissures in the cooling tubes combined with unexpected loads on the engine during flight.

Arianespace conducted two non-commercial launches during 2002. In the first case, the launch of an Ariane 42L was considered non-commercial because the launch contract of the payload, SPOT 5 (launched with secondary payload Idefix), was not internationally competed. In the other instance, ESA's ENVISAT 1 remote sensing satellite was launched aboard an Ariane 5G to LEO. ENVISAT 1, with a mass of 8,211 kilograms (18,105 pounds) was the heaviest payload launched by Arianespace to date.

**JAPAN**

Japan launched more vehicles in 2002 than in any year since 1998. Three launches, all non-commercial, were conducted using the new H 2A to carry a total of nine satellites into a variety of orbits. In February an H 2A 202 vehicle sent MDS 1 (also called Tsubasa) for Japan's National Space Development Agency (NASDA), DASH for

**Table 7. European, Japanese, Chinese, Indian, and Israeli Launch Vehicle Performance in 2002**

	Europe		Japan	China			India	Israel
								
<b>Vehicle</b>	Ariane 4	Ariane 5	H 2A 202	Long March 2F	Long March 4B	Kaituoze 1	PSLV	Shavit
<b>Country/Region</b>	Europe	Europe	Japan	China	China	China	India	Israel
<b>2002 Total Launches</b>	8	4	3	2	2	1	1	1
<b>Reliability (2002)</b>	8/8 100%	3/4 75%	3/3 100%	2/2 100%	2/2 100%	0/1 0%	1/1 100%	1/1 100%
<b>Reliability (Last 10 Years)</b>	92/95 97%	11/14 79%	4/4 100%	4/4 100%	5/5 100%	0/1 0%	5/6 83%	2/3 67%
<b>Year of First Launch</b>	1988	1996	2001	1999	1999	2002	2000	1995
<b>Launch Sites</b>	Kourou	Kourou	Tanegashima	Jiuquan	Taiyuan	Taiyuan	Sriharikota	Palmachim AFB
<b>LEO kg (lbs)</b>	9,191 (20,220)	17,250 (37,950)	9,940 (21,868)	9,500 (20,900)	3,500 (7,700)	100-300 (221-662)	3,700 (8,140)	225 (495)
<b>GTO kg (lbs)</b>	4,748 (10,446)	6,534 (14,375)	4,100 (9,020)	3,500 (7,700)	--	--	800 (1,760)	--

Japan's Institute for Space and Astronautical Science (ISAS), and a vehicle telemetry package (VEP 3) into LEO. While the vehicle performed flawlessly, DASH failed to separate from the upper stage due to a manufacturing flaw in the connector between DASH and the vehicle. In September an H 2A 202 vehicle was successfully launched carrying NASDA's DRTS W (also called Kodama) to GEO, and the USERS Recovery and Service Modules to LEO. The USERS satellites are operated by Japan's Institute for Unmanned Space Experiment Free Flyer. In mid-December another H 2A 202 was sent on its way carrying four satellites: ADEOS 2 (primary payload) for NASDA, an Australian satellite called FedSat 1, NASDA's MicroLabSat, and WEOS, operated by the Chiba Institute of Technology in Japan. FedSat 1 is Australia's first indigenously developed satellite in 30 years.

### CHINA

China has not conducted any commercial launches since 1999. However, China conducted five non-commercial launches, returning to a frequency typical during the 1998-2000 period. A Long March 4B vehicle was used to send a meteorological satellite, Fengyun 1, and a remote sensing satellite, Haiyang 1, to LEO during the spring. Another Long March 4B was used later in the year to launch the Ziyuan 2B remote sensing satellite into orbit. China also introduced a new vehicle, the Kaituozhe 1, a small-class vehicle fueled by solid propellant. The launch of this vehicle, which was carrying Tsinghua 2, failed for undisclosed reasons during an autumn launch attempt. Finally, China conducted two launches in a series of unpiloted tests that began in 1999 involving the Long March 2F-Shenzhou crew capsule combina-

tion. Testing of the Long March 2F and the Shenzhou, a crew-rated system composed of an orbital module, a descent module, and a service module, has apparently concluded. The Chinese government announced that the next flight, scheduled to take place in 2003, will be crewed by at least one *yuhangyuan*, the Chinese equivalent of an astronaut or cosmonaut. This crewed flight, if successful, will make China the third country capable of launching humans into space, along with the United States and Soviet Union/Russia. The United States and Soviet Union both began launching humans into space in 1961.

### INDIA

The Indian Space Research Organization (ISRO) performed one launch in 2002. A Polar Space Launch Vehicle (PSLV) was launched from the newly renamed Professor Satish Dhawan Space Center (formerly Sriharikota Space Center) for its first GEO mission. The payload, Metsat 1, is a meteorological satellite operated by ISRO's Master Control Facility in Hassan. Metsat is the first dedicated meteorological platform developed by ISRO. Previously, Indian meteorological instruments were combined with telecommunications transponders aboard Insat satellites.

### ISRAEL

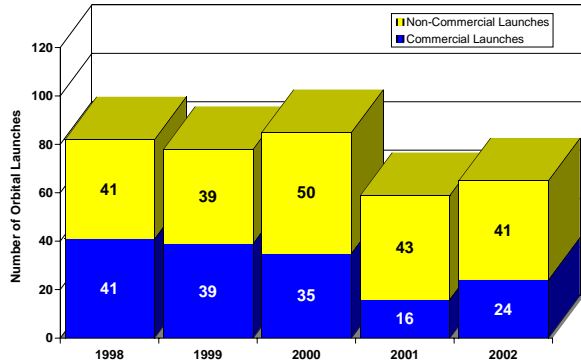
Israel launched an Ofeq remote sensing satellite in 2002, four years after the unsuccessful launch of Ofeq 4. Ofeq 5, launched aboard the indigenously developed Shavit vehicle from Palmachim Air Force Base by Israel Aircraft Industries (IAI) MLM Systems Division, is a military intelligence satellite.

FIVE-YEAR WORLDWIDE SPACE TRANSPORTATION TRENDS

OVERVIEW

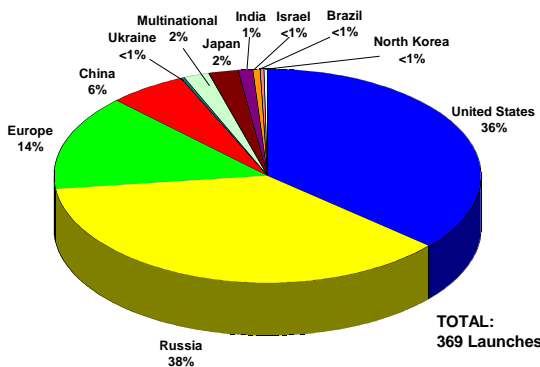
Between 1998 and 2000, there was an annual average of 82 total orbital launches worldwide, while the period 2001-2002 was much different, with 59 and 65 launches, respectively (see Figure 9).

Figure 9. Five-Year Summary (1998-2002) of Commercial and Non-commercial Launch Events



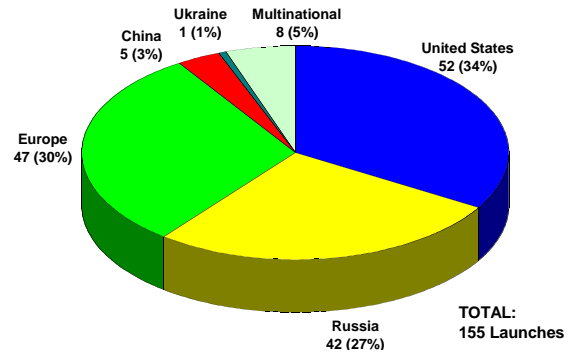
While the number of commercial launches declined slightly from 1998 to 2001, the number of non-commercial launches remained steady. Over the past five years, the United States and Russia have conducted the most total launches worldwide (Figure 10).

Figure 10. Five-Year Worldwide Total Orbital Commercial and Non-commercial Launch Industry Share (1998-2002)



There were 155 commercial orbital launches during the same five-year period, with a high of 41 in 1998 and a low of 16 in 2001. Since 1998, the United States carried out 52 commercial launches. Europe followed closely with 47 commercial launches, while Russia conducted 42 (Figure 11).

Figure 11. Five-Year Worldwide Commercial Orbital Launch Market Share (1998-2002)



In 2002 the number of commercial launches increased by 50 percent from the previous year to 24. Since 1998, the number of commercial launches to GEO per year has remained essentially level, with the exception being the year 2001, when only 12 were accomplished. Commercial launches to NGSO have declined steadily each year over the

Figure 12. Five-Year Worldwide Commercial GEO and NGSO Launch Events (1998-2002)

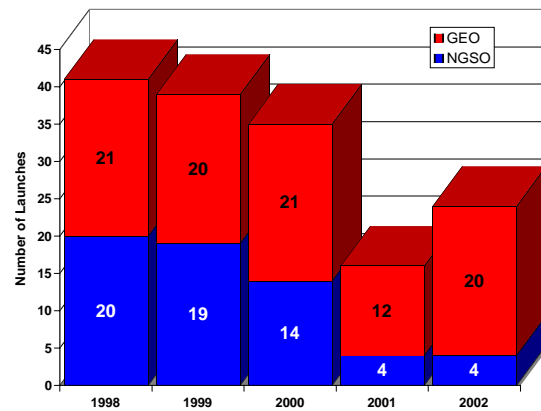
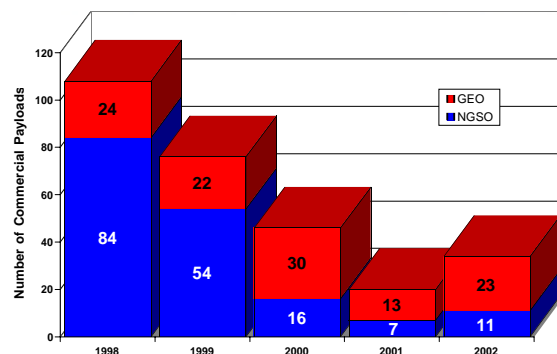


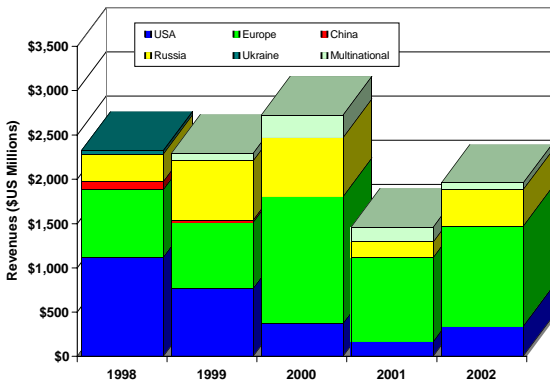
Figure 13. Five-Year Summary of Commercial Payloads Launched by Orbit (1998-2002)



past five years (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 1998 has not changed significantly, the number of commercial NGSO satellites has decreased substantially. In 2002 the number of NGSO satellites launched commercially increased a bit due to replenishment of the Iridium constellation and a host of multimanifested international scientific satellites.

Revenues during the period, highlighted in Figure 14 and Table 8, show a significant drop in 2001 with an increase in annual averages in 2002.

**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)**

	1998	1999	2000	2001	2002
United States	1,120	766	370	167	338
Europe	763	750	1,433	948	1,133
Russia	313	670	671	178	412
China	90	23	0	0	0
Ukraine	40	0	0	0	0
Multinational	0	85	255	170	75
<b>TOTAL</b>	<b>2,326</b>	<b>2,294</b>	<b>2,729</b>	<b>1,463</b>	<b>1,958</b>

While the decrease in demand for commercial launches is apparent in the period 1998 to 2002, it should be noted that both commercial and non-commercial launches have shown a gradual decreasing trend since the end of the Cold War in 1991. Over the past few years the telecommunications industry has had to scale back on future plans. This was due in large part to the rapid build-out of fiber optic cables and a lower-than-anticipated demand for certain types of broadband services

in industrialized countries. Compounding this problem was the diminished demand for additional NGSO constellations.

**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 and, to a lesser extent, NGSO payloads. 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 trends show more demand will be generated by remote sensing and international science payloads in the near future, while NGSO telecommunications constellations represented a major driver of commercial launches a few years ago.

These satellite industry trends will be augmented by continued international competition to provide launch services by Europe, Russia, Ukraine, and China. Possible new entrants into the international launch services market include India, Japan, and Brazil.

**INTERNATIONALLY COMPETED LAUNCHES**

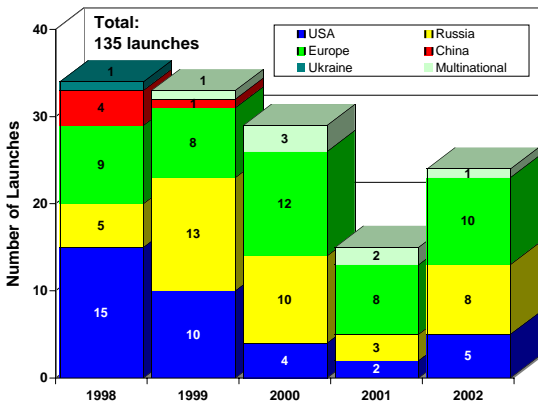
As commercial space business increases and replaces various forms of traditionally government-operated activities, the definitions of “commercial payload” and “commercial launch” become more complex and open to interpretation. Figure 15 shows trends for each country with launch providers competing in the international marketplace. The chart reflects only launch service providers competing in the international marketplace for open bid launch service contracts.



From 1998 to 2002, 267 payloads had launch contracts that were internationally competed. Due to multimanifesting, this translates to 135 internationally competed launch events. In contrast, 51 payloads launched on commercial launches were not internationally competed and are considered captive payloads. Because of multimanifesting, this equates to 20 launches.

The chart also shows that Europe has gained a greater share of internationally competed launches over the course of the past five years. While the share of internationally competed launches by the United States and Russia both dropped from 1998 to 2001, an increase occurred in 2002.

**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 country or launch service company), test payloads, dummy payloads, or small secondary payloads.



## APPENDIX: 2002 WORLDWIDE ORBITAL LAUNCH EVENTS

Date	Vehicle	Site	Payload(s)	Operator	Manufacturer	Use	Comml Price	L	M
1/15/2002	Titan 4B/Centaur	CCAFS	Milstar F5	United States Air Force (USAF)	Lockheed Martin Corp.	Communications		S	S
1/24/2002	✓ Ariane 42L	Kourou	* Insat 3C	Indian Space Research Organization (ISRO)	ISRO	Communications	\$75-90M	S	S
2/4/2002	H 2A 202	Tanegashima	MDS 1	National Space Development Agency (NASDA)	NEC Corp.	Development		S	S
			DASH	Institute of Space and Astronautical Science (ISAS)	NASDA/ISAS	Development			S
			Vehicle Evaluation Payload 3	NASDA	NASDA	Test			S
2/5/2002	Pegasus XL	CCAFS	HESSI	National Aeronautics and Space Administration (NASA)	Spectrum Astro, Inc.	Scientific		S	S
2/11/2002	✓ Delta 2 7920	VAFB	* Iridium 90, 91, 94, 95, 96	Iridium Satellite, LLC	Motorola, Inc.	Communications	\$45-55M	S	S
2/21/2002	✓ Atlas 3B	CCAFS	* EchoStar 7	Echostar Communications Corporation	Lockheed Martin	Communications	\$65-75M	S	S
2/23/2002	✓ Ariane 44L	Kourou	* Intelsat 904	Intelsat	Space Systems/Loral	Communications	\$85-125M	S	S
2/25/2002	Soyuz	Plesetsk	Kosmos 2387	TsSKB Progress	TsSKB Progress	Intelligence		S	S
2/28/2002	Ariane 5G	Kourou	ENVISAT 1	European Space Agency (ESA)	Astrium	Remote Sensing		S	S
3/1/2002	Shuttle Columbia	KSC	STS 109 Hubble Servicing Mission 3B	NASA NASA	Rockwell International Ball Aerospace and Technologies Corp.	Crewed Other		S S	S S
3/8/2002	Atlas 2A	CCAFS	TDRS I	NASA	Boeing	Communications		S	S
3/17/2002	✓ Rockot	Plesetsk	GRACE 1 GRACE 2	NASA/Astrium GmbH NASA/Astrium GmbH	NASA/Astrium GmbH NASA/Astrium GmbH	Scientific Scientific	\$12-15M	S S	S S
3/21/2002	Soyuz	Baikonur	Progress ISS 7P	ISS Partner Nations	S. P. Korolev Rocket and Space Corporation Energia	Supply		S	S
3/25/2002	Long March 2F	Jiuquan	Shenzhou 3	China National Space Administration (CNSA)	China Research Institute of Carrier Rocket Technology	Development		S	S
3/28/2002	✓ Ariane 44L	Kourou	* Astra 3A * JCSAT 8	SES Astra Japan Satellite Systems	Boeing Boeing	Communications Communications	\$85-125M	S S	S S
3/30/2002	✓ Proton K	Baikonur	* Intelsat 903	Intelsat	Space Systems/Loral	Communications	\$60-85M	S	S
4/2/2002	Molniya	Plesetsk	Kosmos 2388	Russian Ministry of Defense	NPO Lavotchkin	Intelligence		S	S
4/8/2002	Shuttle Atlantis	KSC	STS 110 ISS 8A	NASA ISS Partner Nations	Rockwell International Boeing	Crewed Space Station		S S	S S
4/16/2002	✓ Ariane 44L	Kourou	* NSS 7	New Skies Satellites N.V.	Lockheed Martin Corp.	Communications	\$85-125M	S	S
4/25/2002	Soyuz	Baikonur	Soyuz ISS 4S	ISS Partner Nations	S. P. Korolev Rocket and Space Corporation Energia	Crewed		S	S
5/3/2002	Ariane 42P	Kourou	* SPOT 5 Idefix	SPOT Image AmSat France	Astrium AmSat France	Remote Sensing Other		S	S
5/4/2002	Delta 2 7920	VAFB	Aqua	NASA	TRW	Remote Sensing		S	S
5/7/2002	✓ Proton K	Baikonur	* DirecTV 5	DirecTV, Inc.	Space Systems/Loral	Communications	\$60-85M	S	S
5/15/2002	Long March 4B	Taiyuan	Fengyun 1D Haiyang 1	China Meteorological Administration China Meteorological Administration	Shanghai Institute of Satellite Engineering China Academy of Space Technology (CAST)	Meteorological Remote Sensing		S S	S S

✓ 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.  
 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

## 2002 WORLDWIDE ORBITAL LAUNCH EVENTS (CONTINUED)

Date	Vehicle	Site	Payload(s)	Operator	Manufacturer	Use	Comm Price	L	M
5/28/2002	Shavit 1	Palmachim AFB	Ofeq 5	Israel Space Agency	Israel Aircraft Industries	Intelligence		S	S
5/28/2002	Cosmos	Plesetsk	Kosmos 2389	Russian Ministry of Defense	TsSKB Progress	Intelligence		S	S
6/5/2002	✓ Ariane 44L	Kourou	* Intelsat 905	Intelsat	Space Systems/Loral	Communications	\$85-125M	S	S
6/5/2002	Shuttle Endeavour	KSC	STS 111 ISS UF-2	NASA ISS Partner Nations	Rockwell International Boeing	Crewed Supply		S	S
6/10/2002	Proton K	Baikonur	* Express A1R	Russian Satellite Communication Co.	Alcatel Espace	Communications		S	S
6/15/2002	✓ Zenit 3SL	Odyssey Launch Platform	* Galaxy 3C	Pan American Satellite Corp.	Boeing	Communications	\$65-85M	S	S
6/20/2002	✓ Rocket	Plesetsk	* Iridium 97, 98	Iridium Satellite LLC	Motorola, Inc.	Communications	\$12-15M	S	S
6/24/2002	Titan 2	VAFB	NOAA 17	National Oceanic and Atmospheric Administration (NOAA)	Lockheed Martin Corp.	Meteorological		S	S
6/26/2002	Soyuz	Baikonur	Progress ISS 8P	ISS Partner Nations	S. P. Korolev Rocket and Space Corporation Energia	Supply		S	S
7/3/2002	Delta 2 7425-10	CCAFS	Contour	NASA	Applied Physics Laboratory	Scientific		S	F
7/5/2002	✓ Ariane 5G	Kourou	* Atlantic Bird 3 * N-Star C	France Telecom NTT DoCoMo	Alcatel Espace Lockheed Martin Corp.	Communications Communications	\$125-155M	S	S
7/8/2002	Cosmos	Plesetsk	Kosmos 2390-2391	Russian Ministry of Defense	NPO PM	Communications		S	S
7/25/2002	Proton K	Baikonur	Kosmos 2392	Russian Ministry of Defense	NPO Lavotchkin	Intelligence		S	S
8/21/2002	✓ Atlas 5 401	CCAFS	* Hot Bird 6	Eutelsat	Alcatel Espace	Communications	\$65-75M	S	S
8/22/2002	✓ Proton K	Baikonur	* EchoStar 8	Echostar Communications Corporation	Space Systems/Loral	Communications	\$60-85M	S	S
8/28/2002	✓ Ariane 5G	Kourou	* Atlantic Bird 1 MSG 1	Eutelsat Eumetsat	Alenia Spazio Alcatel Espace	Communications Meteorological	\$125-155M	S	S
9/6/2002	✓ Ariane 44L	Kourou	* Intelsat 906	Intelsat	Space Systems/Loral	Communications	\$85-125M	S	S
9/10/2002	H 2A 202	Tanegashima	DRTS W USERS Recovery Module USERS Service Module	National Space Development Agency Institute for Unmanned Space Experiment Free Flyer (IUSEFF) IUSEFF	Mitsubishi Electric Corp. IHI Aerospace Mitsubishi/NEC	Communications Development Development		S	S
9/12/2002	PSLV	Professor Satish Dhawan Space Center	Metsat	ISRO	ISRO	Meteorological		S	S
9/15/2002	Kaituoze 1	Taiyuan	Tsinghua 2	Tsinghua University (Beijing)	Tsinghua University (Beijing)	Development		F	F
9/18/2002	✓ Atlas 2AS	CCAFS	* Hispasat 1D	Hispasat	Alcatel Espace	Communications	\$65-75M	S	S
9/25/2002	Soyuz	Baikonur	Progress ISS 9P	ISS Partner Nations	S. P. Korolev Rocket and Space Corporation Energia	Supply		S	S
9/26/2002	Cosmos	Plesetsk	Nadezhda M 2	Russian Ministry of Defense	NPO Yuzhnoye	Navigation		S	S
10/7/2002	Shuttle Atlantis	KSC	STS 112 ISS 9A	NASA ISS Partner Nations	Rockwell International Boeing	Crewed Space Station		S	S
10/15/2002	Soyuz	Plesetsk	Foton 13	Russian Ministry of Defense	TsSKB Progress	Microgravity		F	F
10/17/2002	Proton K	Baikonur	INTEGRAL	ESA	Alenia Spazio	Scientific		S	S

✓ 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.  
 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

## 2002 WORLDWIDE ORBITAL LAUNCH EVENTS (CONTINUED)

Date	Vehicle	Site	Payload(s)	Operator	Manufacturer	Use	Comml Price	L	M
10/27/2002	Long March 4B	Taiyuan	Ziyuan 2B	China Aerospace Corporation (CAC)	CAST	Remote Sensing		S	S
10/30/2002	Soyuz	Baikonur	Soyuz ISS 5S	ISS Partner Nations	S .P. Korolev Rocket and Space Corporation Energia	Crewed		S	S
11/20/2002	✓ Delta 4 Medium + (4,2)	CCAFS	* Eutelsat W5	Eutelsat	Alcatel Espace	Communications	\$70-85M	S	S
11/22/2002	Shuttle Endeavour	KSC	STS 113 ISS 11A	NASA ISS Partner Nations	Rockwell International Boeing	Crewed Space Station		S	S
11/26/2002	✓ Proton K	Baikonur	* Astra 1K	SES Astra	Alcatel Espace	Communications	\$60-85M	F	F
11/28/2002	Cosmos	Plesetsk	Mozhayets	La Spienza, University of Rome	NPO PM	Other		S	S
			AlSat 1	National Center for Space Technology (Algeria)	Surrey Satellite Technology Ltd.	Scientific			S
			RUBIN 3-DSI	OHB-System	OHB-System	Development			
12/5/2002	Atlas 2A	CCAFS	TDRS J	NASA	Boeing	Communications		S	S
12/11/2002	✓ Ariane 5 ECA	Kourou	* Hot Bird 7 Stentor	Eutelsat Centre National d'Etudes Spatiales (CNES)/France Telecom	Astrium Astrium GmbH	Communications Communications	\$125-155M	F	F
12/14/2002	H 2A 202	Tanegashima	ADEOS 2 FedSat 1	NASDA Cooperative Research Centre for Satellite Systems (CRCSS)	Mitsubishi/NEC/Toshiba CRCSS	Remote Sensing Communications		S	S
			WEOS	Chiba Institute of Technology	Chiba Institute of Technology	Remote Sensing			S
			MicroLabSat	NASDA	Toshiba	Scientific			S
12/17/2002	✓ Ariane 44L	Kourou	* NSS 6	New Skies Satellites N.V.	Lockheed Martin	Communications	\$85-125M	S	S
12/20/2002	✓ Dnepr 1	Svobodny	* LatinSat 1-2 SaudiSat 2 Unisat 2	Aprize Satellite (Argentina) Riyandh Space Research Institute University of Rome, La Spienza	Surrey Satellite Technology Ltd. Riyandh Space Research Institute University of Rome, La Spienza	Communications Development Development	\$8-11M	S	S
			* RUBIN 2 Trailblazer Structural Test Article	OHB-System TransOrbital	OHB-System TransOrbital	Development Test		S	S
12/24/2002	Molniya	Plesetsk	Kosmos 2393	Russian Ministry of Defense	NPO PM	Communications		S	S
12/25/2002	Proton K	Baikonur	Kosmos 2394-2396 (Glonass M R4-R6)	Russian Ministry of Defense	NPO PM	Navigation		S	S
12/29/2002	✓ Proton M	Baikonur	* Nimiq 2	Telesat Canada	Lockheed Martin Corp.	Communications	\$70-100M	S	S
12/29/2002	Long March 2F	Jiuquan	Shenzhou 4	CNSA	China Research Institute of Carrier Rocket Technology	Development		S	S

✓ 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.  
L and M refer to the outcome of the Launch and Mission: S = success, P = partial success, F = failure