



*Associate Administrator for
Commercial Space Transportation (AST)*

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COMMERCIAL SPACE TRANSPORTATION: 1999 YEAR IN REVIEW



Cover Photo Credits (from left):

Sea Launch (1999). Image is of the Zenit 3SL launch on October 9, 1999, from the Odyssey Sea Launch Platform. It successfully deployed the DirecTV 1R satellite.

International Launch Services (1999). Image is of the Atlas 2AS launch on April 12, 1999, from Cape Canaveral Air Station. It successfully orbited the Eutelsat W3 communications satellite for Eutelsat.

Boeing Corporation (1999). Image is of the Delta 2 7420 launch on July 10, 1999, Cape Canaveral Air Station. It successfully orbited four Globalstar communications satellites for Globalstar, Inc.

Lockheed Martin Corporation (1999). Image is of the Athena 2 awaiting launch from Vandenberg Air Force Base on September 24, 1999. It successfully orbited the IKONOS 2 commercial remote sensing satellite for Space Imaging Inc.

INTRODUCTION

In 1999, U.S. launch service providers conducted 17 launches licensed by the Federal Aviation Administration (FAA) for revenue that totaled about \$851 million. U.S. launch service providers captured a 36-percent share of the 36 total commercial launches worldwide, conducting 13 launches for commercial or international customers. U.S. launch providers also conducted 2 launches for U.S. government customers and the international Sea Launch venture conducted 2 launches licensed by the FAA. Several events in 1999 resulted in fewer launches and lower revenues than expected. Launch failures caused delays in multiple vehicle programs and prompted governmental and internal program reviews. Delays in certain satellite programs also depressed the anticipated launch rate.

In 1999, the Sea Launch venture successfully conducted its first launch of the Zenit 3SL vehicle from a sea-based platform near the Equator in the Pacific Ocean. The first launch, which deployed a test payload, was followed by Sea Launch's second launch, deploying its first commercial payload, the DirecTV 1-R direct broadcasting satellite. This was the first time an FAA-licensed

launch was conducted outside the borders of the United States without the use of U.S. range assets. The first wave of low earth orbit (LEO) constellation deployments was completed in 1999: Globalstar deployed 40 satellites on four Delta 2 and six Soyuz vehicles. Orbcomm deployed an additional seven payloads on one Pegasus vehicle, and Iridium deployed two payloads on one Long March 2C vehicle. In total, there were 78 orbital launches in 1999, 36 were commercial. Half of these launches, 18, were to LEO. The remaining 18 launches deployed 19 geosynchronous (GEO) satellites for commercial and government customers.

Commercial Space Transportation: 1999 Year in Review summarizes U.S. and international launch activities for calendar year 1999 and provides a historical look at the past five years of commercial launch activities. This report has three parts:

- 1999 FAA-Licensed Commercial Activity
- 1999 Worldwide Launch Activity
- Five-Year Space Transportation Trends

ABOUT THE ASSOCIATE ADMINISTRATOR FOR COMMERCIAL SPACE TRANSPORTATION (AST)

The Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (AST) licenses and regulates U.S. commercial space launch activity as authorized by Executive Order 12465, *Commercial Expendable Launch Vehicle Activities*, and the *Commercial Space Launch Act of 1984*, as amended. AST's mission is to license and regulate commercial launch operations to ensure public health and safety and the safety of property, and to protect

national security and foreign policy interests of the United States during launch operations. The *Commercial Space Launch Act of 1984* and the *1996 National Space Policy* also directs the Federal Aviation Administration to encourage, facilitate, and promote commercial launches.

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

1999 FAA-LICENSED LAUNCH SUMMARY

In 1999, U.S. launch providers conducted 17 launches licensed by the Federal Aviation Administration's (FAA) Office of the Associate Administrator for Commercial Space Transportation (AST). Of the 17 FAA-licensed launches, 13 were conducted for commercial or international customers and two were conducted for U.S. Government agencies, all from U.S. launch ranges.¹ The remaining two launches were conducted by the international Sea Launch joint venture. FAA-licensed launches are listed in Table 1. The 17 FAA-licensed launches were valued at approximately \$851 million including:

- 13 launches for commercial clients, worth \$672 million
- 2 launches for the U.S. Government, worth \$94 million
- 1 operational launch by Sea Launch, worth approximately \$85 million (no revenues were received for the test launch)

Launch Activity in Detail

Several U.S. launch vehicle programs experienced a stand down in 1999 resulting from launch failures. A total of four launch attempts involving U.S. vehicles failed in 1999; two failures of a Titan 4, one failure of a Delta 3, and one failure of an Athena 2. Concern about the RL-10 engine used in the Delta 3 upper stage, and the failure of three consecutive Titan 4 launches resulted in an in-depth review of U.S. launch programs by the Department of Defense and the companies involved. There were no further flights of the Delta 3 in 1999, and the Atlas 2 experienced a hiatus in launch activities because it also uses RL-10 engines in its Centaur upper stage. As a result, the number of FAA-

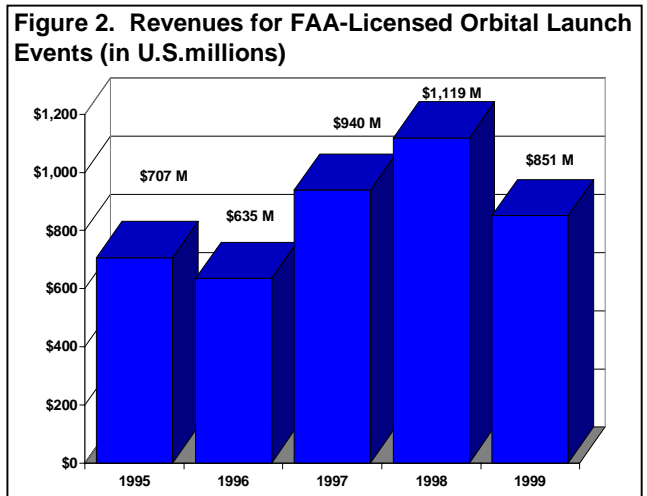
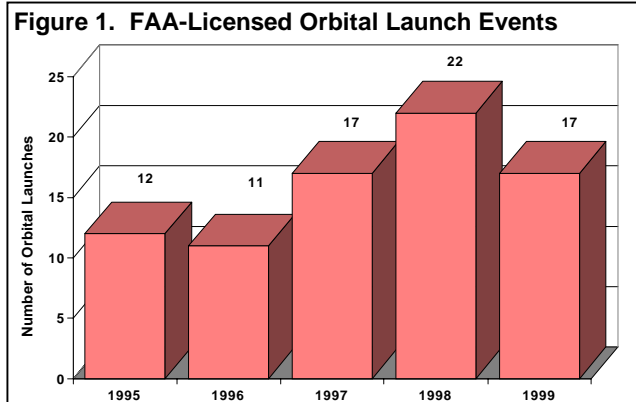


Table 1. 1999 FAA-Licensed Orbital Launch Events

Date	Vehicle	Payload	Govt/Coml	Launch Outcome	Orbit
Jan. 26	Athena 1	Formosat-1	Coml	Success	LEO
Feb. 16	Atlas 2AS	JCSAT 6	Coml	Success	GEO
Mar. 27	Zenit 3SL	DemoSat†	Test	Success	GEO
Apr. 12	Atlas 2AS	Eutelsat W3	Coml	Success	GEO
Apr. 27	Athena 2	IKONOS 1	Coml	Failure	LEO
May 4	Delta 3	Orion F3	Coml	Failure	GEO
May 17	Pegasus	TERRIERS * MUBLCOM	Govt	Success	LEO
June 10	Delta 2	Globalstars 25,47,49,52	Coml	Success	LEO
July 10	Delta 2	Globalstars 30,32,35,51	Coml	Success	LEO
July 25	Delta 2	Globalstars 26,28,43,48	Coml	Success	LEO
Aug. 17	Delta 2	Globalstars 24,27,53,54	Coml	Success	LEO
Sept. 23	Atlas 2AS	Echostar 5	Coml	Success	GEO
Sept. 24	Athena 2	IKONOS 2	Coml	Success	LEO
Oct. 9	Zenit 3SL	DirecTV 1R	Coml	Success	GEO
Nov. 22	Atlas 2A	GBS 10*	Govt	Success	GEO
Dec. 4	Pegasus	Orbcomms 30-36	Coml	Success	LEO
Dec. 21	Taurus	Kompsat ACRIMSAT Celestis 3	Coml	Success	LEO

* U.S. Government payload; launch services not internationally competed.

† Test launch; not counted in commercial totals.

¹ As part of its licensing of commercial launches, the FAA licenses launches commercially procured by the U.S. Government. For purposes of this report, however, a launch is commercial if it was competed on the commercial launch services market, not captive to a national launch system, and is not a test launch deploying a dummy satellite. U.S. Government launches procured commercially are considered to be government launches.

licensed launches was lower than anticipated, but matches the 1997 figure of 17. FAA-licensed launches are up 41 percent from 12 in 1995.

Sea Launch Deploys Successfully

On March 27, Sea Launch conducted its first successful test launch of the Zenit 3SL deploying the Demosat test satellite from a sea-based platform near the Equator in the Pacific Ocean. This was the first time an FAA-licensed launch occurred outside the borders of the United States without the use of U.S. launch range assets. The system's first commercial payload, the DirecTV 1-R direct broadcasting satellite, was launched October 9. Established in 1995, Sea Launch is a partnership between U.S.-based Boeing (40%); RSC-Energia of Moscow, Russia (25%); Kvaerner Maritime a.s. of Oslo, Norway (20%); and KB Yuzhnoye/PO Yuzhmash of Dnepropetrovsk, Ukraine (15%).

Initial LEO Deployments Complete

Of the 13 commercial launches in the U.S. in 1999, nine were to low earth orbit (LEO), or about 69 percent. Globalstar deployed 16 satellites on four Delta 2 vehicles, and Orbcomm deployed seven payloads on one Pegasus launch. The remaining commercial LEO launches were all small vehicles: three flights of Lockheed Martin's Athena launched Formosat for Taiwan and two IKONOS satellites for Space Imaging Incorporated. The first IKONOS launch failed when the payload fairing did not separate. One Taurus vehicle successfully deployed the Kompsat satellite for South Korea.

Commercial Geosynchronous Launches

Three Atlas vehicles successfully deployed three communications satellites. Boeing's Delta 3 failed to deploy the Orion F3 satellite, its second failure in both attempts to launch the new vehicle.

Table 2. FAA-Licensed Launch Vehicle Performance in 1999

	United States										International (Sea Launch)
Vehicle	Pegasus	Taurus	Athena 1	Athena 2	Titan 2	Delta 2	Delta 3	Atlas 2	Shuttle	Titan 4	Zenit 3SL
1999 Total Launches	3	1	1	2	2	10	1	5	3	3	2
Licensed Launches	2	1	1	2	0	4	1	4	0	0	2
Reliability	3/3	1/1	1/1	1/2	2/2	10/10	0/1	5/5	3/3	1/3	2/2
1999	(100%)	(100%)	(100%)	(50%)	(100%)	(100%)	(0%)	(100%)	(100%)	(33.3%)	(100%)
Last 10 Years	25/28	4/4	2/3	2/3	7/7	81/82	0/2	53/55	65/65	23/27	2/2
	(89.3%)	(100%)	(66.7%)	(66.7%)	(100%)	(98.8%)	(0%)	(96.4%)	(100%)	(85.2%)	(100%)
First Launch	1990	1994	1995	1998	1964	1989	1998	1991	1981	1989	1999
Launch Sites	VAFB, Wallops	VAFB	CCAS, VAFB	CCAS, VAFB	VAFB	CCAS, VAFB	CCAS	CCAS, VAFB	KSC	CCAS, VAFB	Odyssey
LEO (lb./28.5/100 nm)	1,015	3,300	1,755	4,350	7,900	11,220	18,280	19,050	47,300	47,800	35,000
GTO (lb.)	--	1,290	--	--	--	4,060	8,400	8,200	13,000	19,000	11,050

1999 WORLDWIDE LAUNCH ACTIVITY

Thirty-six commercial launches were conducted in 1999 by launch providers in four countries and the international Sea Launch partnership. The United States captured 36 percent of the commercial launch services market with 13 launches. Russia also captured 36 percent of the market with 13 launches and Europe's Arianespace conducted eight commercial launches for a 22 percent share. Sea Launch and the China Great Wall Industry Corporation each had a three percent market share with one launch each. A total of 78 orbital launches were conducted worldwide in 1999 for commercial, civil, and military purposes (see Appendix). A detailed list of non-U.S. commercial launches appears on the next page.

Commercial LEO Launches Strong in 1999

Half of the 36 commercial launches worldwide deployed payloads to LEO in 1999. Prior to 1997, only one to two LEO launches were conducted each year. Four Delta vehicles deployed 16 Globalstar satellites and 24 more Globalstar satellites were deployed by six Soyuz vehicles. Two Iridium payloads were launched on one Long March 2C vehicle from Jiquan in China, and the Dnepr and Cosmos small launch vehicles launched commercially from Russia's Baikonur launch site in Kazakhstan. This wave of commercial LEO launch activity began with the first Iridium launch in May 1997. However, Iridium's failure to attract customers and subsequent bankruptcy in August 1999 has cast a shadow over plans to launch other LEO systems. ICO, which filed for bankruptcy shortly after Iridium, later attracted financing from investors including Teledesic's Craig McCaw and is expected to launch its constellation of 12 medium Earth orbit satellites beginning in 2000.

Worldwide Commercial Launch Revenues

Revenues from the 36 commercial launches conducted globally in 1999 reached an estimated

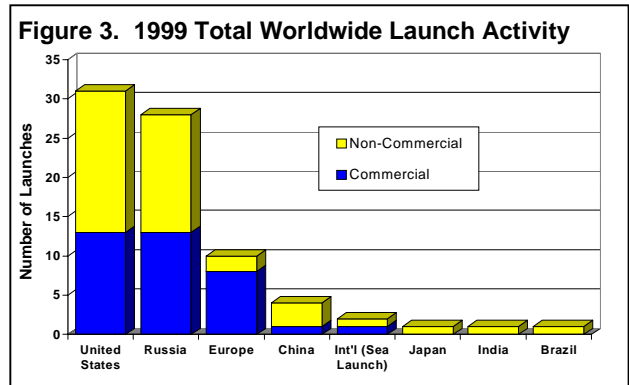


Table 3. 1999 Orbital Launch Events

	Commercial Launches	Non-Commercial Launches	TOTAL Launches
United States	13	18	31
Russia	13	15	28
Europe	8	2	10
China	1	3	4
Int'l (Sea Launch)	1	1	2
Japan	0	1	1
India	0	1	1
Brazil	0	1	1
TOTAL	36	42	78

Figure 4. 1999 Worldwide Commercial Market Share

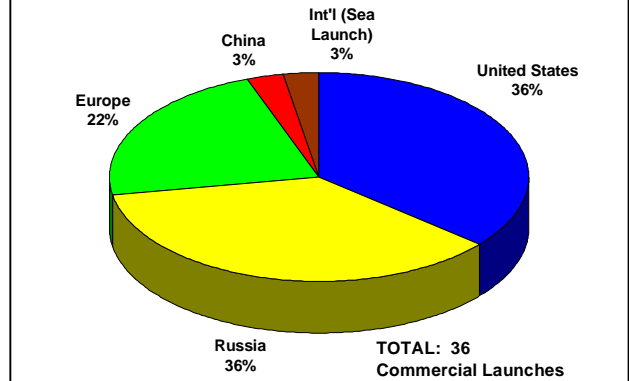
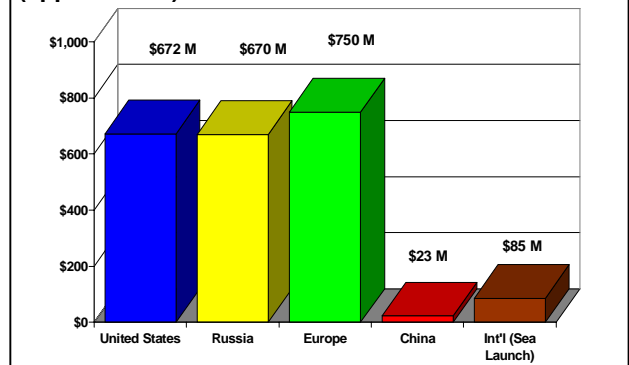


Figure 5. 1999 Commercial Launch Revenues (approximate)



\$2.2 billion.² U.S. commercial launch revenues were \$672 million; Russian revenues were \$670 million; European revenues were \$750 million; Chinese revenues were \$23 million; and the international Sea Launch venture had revenues of about \$85 million (Figure 5).

Revenues are attributed to the country in which the primary vehicle manufacturer is based, with the exception of the international Sea Launch venture. In the past, this method has worked well because most launch vehicles were manufactured, sold, and launched by the same organization which resided entirely in one country or Europe.

With the rise of multinational launch service corporations, however, a clean division of revenue for particular launches among countries 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. International Launch Services (ILS) markets launches of the Russian Proton vehicle, and Starsem conducts launches of Soyuz. Also, Sea Launch represents a partnership among organizations in four countries and uses its own launch facility outside national borders. As a result, revenues actually accrued to each country may in fact be higher or lower than presented due to participation in launch programs attributed to other countries.

Failures Afflict Launch Providers Worldwide

There were a total of eight launch failures worldwide in 1999. Of these, four were of U.S. vehicles including two Titan 4s, one Delta 3, and one Athena 2. Two Russian Proton rockets also failed, followed by one Japanese H-2, and Brazil's VLS. The Titan failures carrying high-value national security satellites followed an earlier Titan 4 failure in 1998, prompting several reviews of manufacturing and operations procedures.

The Delta 3 mishap was its second consecutive failure, following its destruction in its debut flight in August 1998. The Delta failure delayed launches of the Atlas 2 and the inaugural flight of the Atlas 3 because they both utilize versions of the RL-10 engine on their upper stages as does Delta 3. Russia's Proton failures also delayed several commercial launches as well as the launch of the Zvezda space station module. The failure of Brazil's VLS did not impact the commercial market, but kept Brazil from becoming the twelfth country to successfully launch a satellite.

Table 4. 1999 Non-U.S. Commercial Launch Events

Date	Vehicle	Payload	Launch Outcome	Orbit
Feb. 9	Soyuz	Globalstars 23,36,38,40	Success	LEO
Feb. 15	Proton	Telstar 6	Success	GEO
Feb. 26	Ariane 44L	Arabsat 3A Skynet 4E	Success	GEO
Mar. 15	Soyuz	Globalstars 22,37,41,46	Success	LEO
Mar. 21	Proton	AsiaSat 3S	Success	GEO
Apr. 2	Ariane 42P	Insat 2E	Success	GEO
Apr. 15	Soyuz	Globalstars 19,42,44,45	Success	LEO
Apr. 21	Dnepr 1	UoSat 12	Success	LEO
Apr. 29	Cosmos	Abrixis MegSat 0	Success	LEO
May 21	Proton	Nimiq 1	Success	GEO
June 11	Long March 2C	Iridium 14A Iridium 21A	Success	LEO
June 18	Proton	Astra 1H	Success	GEO
Aug. 12	Ariane 42P	Telkom 1	Success	GEO
Sept. 4	Ariane 42P	KoreaSat 3	Success	GEO
Sept. 22	Soyuz	Globalstars 33,50,55,58	Success	LEO
Sept. 25	Ariane 44LP	Telstar 7	Success	GEO
Sept. 26	Proton	LMI 1	Success	GEO
Oct. 18	Soyuz	Globalstars 31,56,57,59	Success	LEO
Oct. 19	Ariane 44LP	Telstar 12	Success	GEO
Nov. 13	Ariane 44LP	GE 4	Success	GEO
Nov. 22	Soyuz	Globalstars 29,34,39,61	Success	LEO
Dec. 21	Ariane 44L	Galaxy 11	Success	GEO

² Revenues for both U.S. and foreign commercial launches are based on open source information and estimates by AST and are approximations only.

Worldwide Payload Summary

A total of 128 spacecraft were launched on 78 launches in 1999. Of these 128, 76 were for commercial purposes and 52 were for governmental or scientific purposes.³ Three commercial payloads and five government payloads were lost to launch failures. A total of 22 commercially-owned payloads were launched to GEO, including Sea Launch's test payload. Three commercial payloads, Express A1, Yamal 101 and 102, were launched on two Russian Proton vehicles not procured commercially.

Commercial LEO Payloads Dominate

The deployment of LEO telecommunications constellations continued to dominate commercial payloads in 1999, with 54 out of the 76 commercial payloads launched going to LEO, including 49 spacecraft for the Iridium, Globalstar, and Orbcomm systems. Other commercial payloads launched to LEO include the UoSAT-12 satellite for Surrey Satellite Technology, Ltd. of the United Kingdom, two IKONOS satellites for U.S.-based Space Imaging, the MegSat 0 technology demonstrator and store-and-forward satellite for Meggorin of Italy, and the Celestis 3 space burial capsule for Celestis of the U.S.

Launch Activities by Country

Russia – In 1999, Russia played a substantial role in the commercial LEO market with six launches of Soyuz deploying 24 satellites for Globalstar. These represented the first for the joint French-Russian Starsem venture. Starsem is owned by Arianespace, the Ariane vehicle service provider, Aerospatiale Matra, the Russian Space Agency,

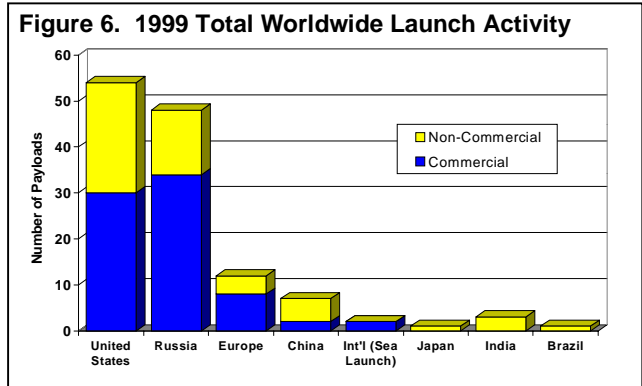


Table 5. Payloads Launched in 1999

	Commercial Payloads	Non-Commercial Payloads	TOTAL Payloads
United States	30	24	54
Russia	34	14	48
Europe	8	4	12
China	2	5	7
Int'l (Sea Launch)	2	0	2
Japan	0	1	1
India	0	3	3
Brazil	0	1	1
TOTAL	76	52	128

Figure 7. Total Payloads Launched by Country 1999

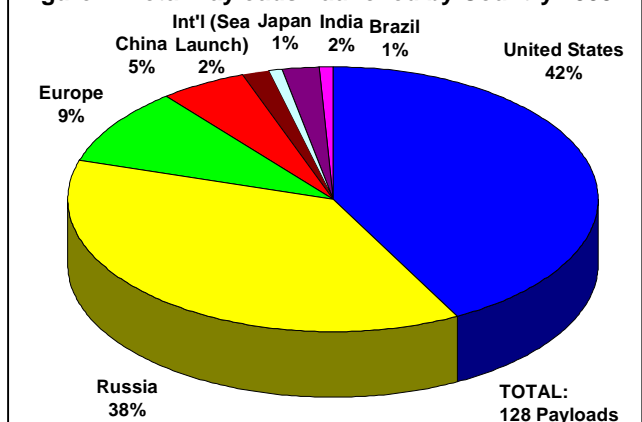
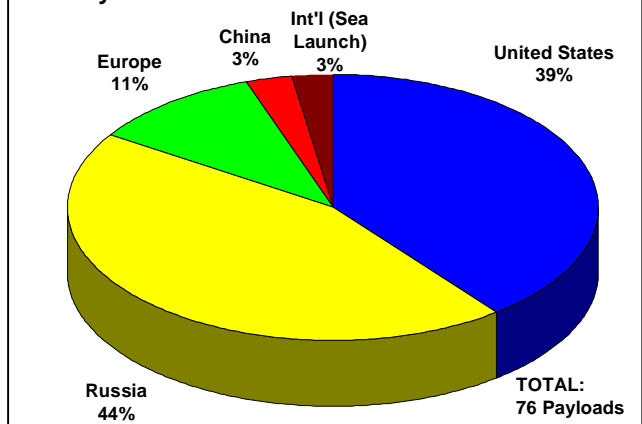


Figure 8. Commercial Payloads Launched by Country 1999



³ The term “commercial payload” refers to a spacecraft which serves a commercial function or is operated by a commercial entity, without regard to how it was launched. For this report, communications satellites launched for international consortia such as Intelsat are considered commercial. Satellites for government communications purposes may or may not be considered commercial, depending on the percent of capacity leased to commercial operators.

and the Soyuz manufacturer, the Samara Space Center (TsKB Progress). Two failures of the Proton vehicle on non-commercial launches disrupted the GEO launch schedule, and only five commercial launches were conducted on behalf of International Launch Services (ILS), the partnership between U.S.-based Lockheed Martin and Russia's Khrunichev and Energia.

Russia conducted two commercial launches of small vehicles in 1999. The first was the Ukrainian-built Dnepr launch vehicle, a converted SS-18 ballistic missile, which made its first orbital flight and successfully deployed the UoSAT-12 satellite for Surrey Satellite Technology of the United Kingdom. The second small Russian commercial launch was of a Cosmos vehicle which successfully deployed the Abraxis satellite for DLR of Germany and the MegSat 0 satellite for Megjorin of Italy.

Europe – Europe's Arianespace conducted eight commercial launches of the Ariane 4 and deployed nine geosynchronous satellites. Only one Ariane 4 vehicle deployed two GEO

payloads; an Ariane 44L deployed Arabsat 3A and Skynet 4E on February 26. One non-commercial launch of an Ariane 40 deployed the Helios 1B and Clementine spacecrafts. One launch of the Ariane 5 successfully deployed the XMM telescope to conduct observations in the X-ray spectrum. This was the first non-developmental launch of the Ariane 5 vehicle following three previous test launches. The first test launch in 1996 ended in failure, and the second launch in 1997 was a partial success with the payload ending up in a lower than intended orbit. One final qualification flight in 1998 successfully deployed a test satellite. Arianespace also conducted its first LEO commercial deployment on Soyuz vehicles through its Starsem venture with Russia.

China – China conducted four launches in 1999, one of them commercial. China's most notable launch was the successful test of the Shenzhou space capsule launched on the new Long March 2F vehicle. Shenzhou, designed to carry Chinese astronauts into space, was launched without a crew and completed 14 orbits of the Earth before

Table 6. Russian and Ukrainian Launch Vehicle Performance in 1999

	Russia & Ukraine						
Vehicle	Cosmos	Cyclone 2	Dnepr	Molniya	Soyuz	Zenit 2	Proton
1999 Total Launches	2	1	1	2	12	1	9
Reliability 1999	2/2 (100%)	1/1 (100%)	1/1 (100%)	2/2 (100%)	12/12 (100%)	1/1 (100%)	7/9 (77.8%)
Last 10 Years	54/55 (98.2%)	15/15 (100%)	1/1 (100%)	51/51 (100%)	158/161 (98.1%)	14/19 (73.7%)	80/87 (92%)
First Launch	1964	1966	1999	1961	1963	1985	1967
Launch Sites	Plesetsk	Baikonur	Baikonur	Baikonur, Plesetsk	Baikonur, Plesetsk	Baikonur	Baikonur
LEO (lb.)	3,100	8,820	9,700	3,970 (polar)	15,400	30,300	44,200
GTO (lb.)	--	--	--	--	--	--	10,150





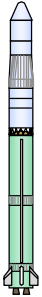
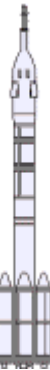



being recovered at a landing site in Inner Mongolia. More test launches are expected before the first astronauts are launched into space. The single commercial launch was of a Long March 2C that deployed two LEO satellites for Iridium. Also in 1999, a Long March 4 vehicle deployed a Fen Yung meteorological satellite and the Shi Jian-5 scientific satellite. A Long March 4B deployed the CBERS/Ziyuan 1 satellite, an Earth resources satellite developed in cooperation with Brazil. Brazil's SACI 1 experimental satellite was deployed during the same launch.

India - There was one launch of India's PSLV launch vehicle this year, on May 26. The vehicle successfully deployed Oceansat 1, a remote sensing payload also known as IRS P4. Also on board were two small payloads whose launches were the first commercially procured for the PSLV: the Kitsat 3 remote sensing satellite for South Korea, and Tubsat C-DLR for the Technical University of Berlin. This was the fifth launch for India's PSLV.

Japan – Japan's only launch in 1999 was of an H-2 rocket to deploy the MTSat 1 GEO communications satellite for the Japanese Ministry of Transportation. This launch failed and it was the second consecutive failure of the H-2. In 1998, the COMETS experimental GEO communications satellite was stranded in an orbit lower than intended following a failure in the second stage. Since there have been two consecutive failures involving the H-2, Japanese officials have stated that they will not launch the one remaining H-2 vehicle in 2000 as planned, but will instead proceed directly with the new H-2A program.

Brazil - Brazil's second attempt to launch its VLS small launcher ended in failure destroying the SACI-2 experimental meteorological satellite. The first launch of the VLS vehicle occurred in 1997, also ending in failure. Brazil plans additional test launches of its indigenously-built vehicle in 2000 or 2001.

Table 7. European, Chinese, Japanese, Indian, and Brazilian Launch Vehicle Performance in 1999

	Europe		China				Japan	India	Brazil
Vehicle									
1999 Total Launches	9	1	1	1	1	1	1	1	1
Reliability 1999	9/9 (100%)	1/1 (100%)	1/1 (100%)	1/1 (100%)	1/1 (100%)	1/1 (100%)	0/1 (0%)	1/1 (100%)	0/1 (0%)
Last 10 Years	84/87 (96.6%)	3/4 (75%)	10/10 (100%)	2/2 (100%)	1/1 (100%)	1/1 (100%)	5/7 (71.4%)	3/5 (60%)	0/2 (0%)
First Launch	1988	1996	1975	1988	1999	1999	1994	1993	1997
Launch Sites	Kourou	Kourou	Xichang	Taiyuan	Taiyuan	Jiuquan	Tanegashima	Sriharikota	Alcantara
LEO (lb.)	21,100	39,600	7,040	8,818	4,851 (polar)	(unknown)	23,000	6,400	440
GTO (lb.)	10,900	15,000	2,200	2,430	3,315	(unknown)	8,800	990	--

FIVE-YEAR SPACE TRANSPORTATION TRENDS

Over the past five years, commercial launches have doubled as the market for geosynchronous satellites continued to increase and a sizeable market for launches of non-geosynchronous, or LEO, constellations emerged. While there were 18 launches in 1995, there were between 36 and 37 commercial launches worldwide in each of the past three years.

As a proportion of total launches, the number of commercial launches continues to grow relative to government-sponsored launches; commercial launches represented 23 percent of total launches in 1995, 44 percent in 1998, and 46 percent in 1999. The industry also has diversified over the past five years, with the introduction of the Russian Proton and Soyuz and the international Sea Launch vehicles on the international launch services market.

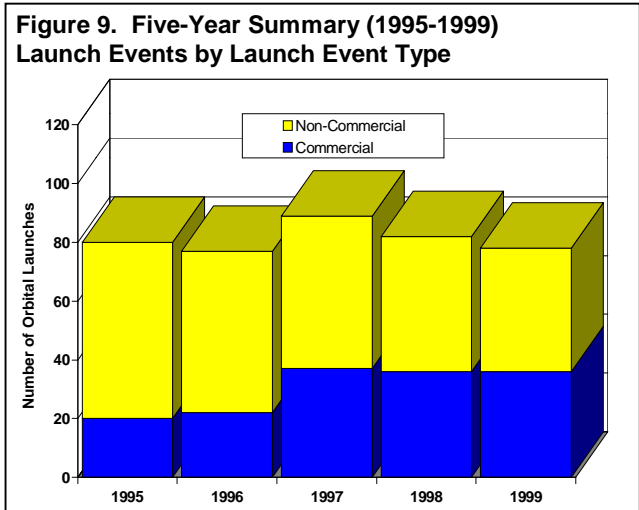


Table 9. Five-Year Summary (1995-1999) Launch Events by Launch Type

	Commercial Launches	Non-Commercial Launches	TOTAL Launches
1995	18	62	80
1996	21	56	77
1997	37	52	89
1998	36	46	82
1999	36	42	78

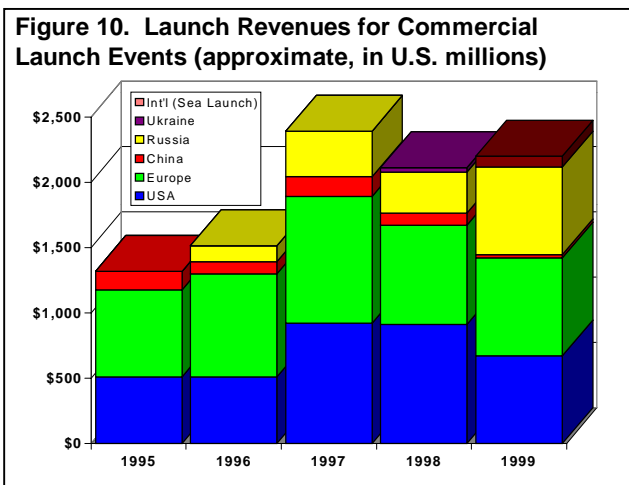


Table 8. Launch Revenues for Commercial Launch Events (approximate, in U.S. millions)

	1995	1996	1997	1998	1999
USA	\$481	\$510	\$923	\$911	\$672
Europe	\$664	\$788	\$970	\$763	\$750
China	\$142	\$95	\$148	\$90	\$23
Russia		\$120	\$351	\$313	\$670
Ukraine				\$35	
Int'l (Sea Launch)					\$85
TOTAL	\$1,287	\$1,513	\$2,392	\$2,112	\$2,200

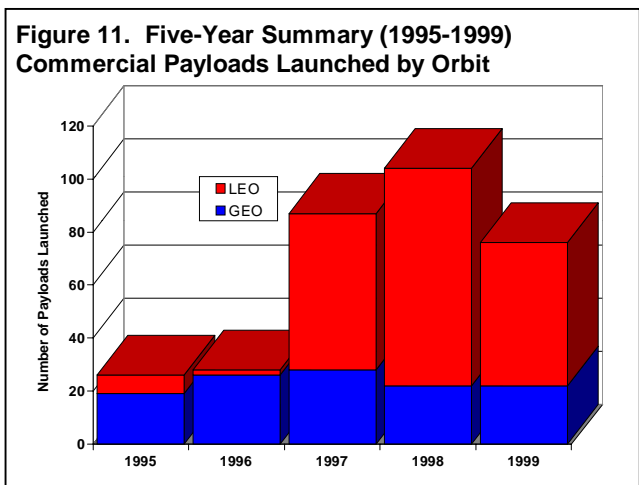


Table 10. Five-Year Summary (1995-1999) Commercial Payloads Launched by Orbit

	GEO Commercial Payloads	LEO Commercial Payloads	TOTAL Commercial Payloads
1995	18	4	22
1996	24	1	25
1997	28	59	87
1998	22	82	104
1999	22	54	76

Annual commercial launch revenues have grown by two-thirds over the period from 1995 to 1999; 1995 revenues were about \$1.3 billion compared to \$2.2 billion in 1999. Revenues in 1999 were up only slightly from \$2.1 billion 1998, and are still lower than a high of \$2.4 billion in 1997 due to fewer GEO launches.

The number of commercial payloads continues to be high due to the deployment of three LEO constellations through the period: Iridium, Globalstar, and Orbcomm. The number of LEO payloads from this first wave of LEO systems has likely peaked in 1999 as these systems enter the operations and maintenance phase, requiring fewer launches.

The United States continues to hold the largest market share of total commercial launches over the period, at 41 percent. Europe's Arianespace has long dominated the GEO launch market, but the large rise in the U.S. share has been due to the arrival of the commercial LEO constellations. Russia has also seen a dramatic rise in its commercial market share, considering it has only been conducting commercial launches since 1996. Russia holds an 18 percent market share for total commercial launches and 35 percent of total payloads over the five-year period.

Over the last five years, two new countries have attempted to launch a satellite using an

Figure 12. Five-Year Worldwide Launch Totals (1995-1999)

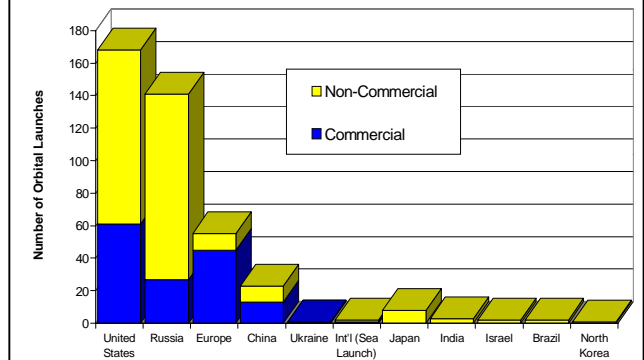


Table 11. Five-year Worldwide Launch Totals (1995-1999)

	Commercial	Non-Commercial	TOTAL
United States	61	107	168
Russia	27	114	141
Europe	45	10	55
China	13	10	23
Ukraine	1	0	1
Int'l (Sea Launch)	1	1	2
Japan	0	8	8
India	0	3	3
Israel	0	2	2
Brazil	0	2	2
North Korea	0	1	1
TOTAL	148	258	406

indigenously-built vehicle. Brazil has made two launch attempts, and North Korea attempted to deploy a satellite in 1998. None were successful. If these launches had been successful, Brazil and North Korea would have been the twelfth and thirteenth countries to launch their own satellites.

Figure 13. Five-Year Worldwide Orbital Launch Share (1995-1999)

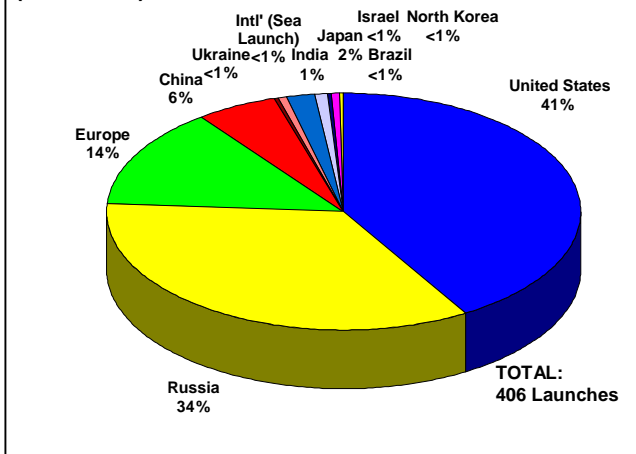
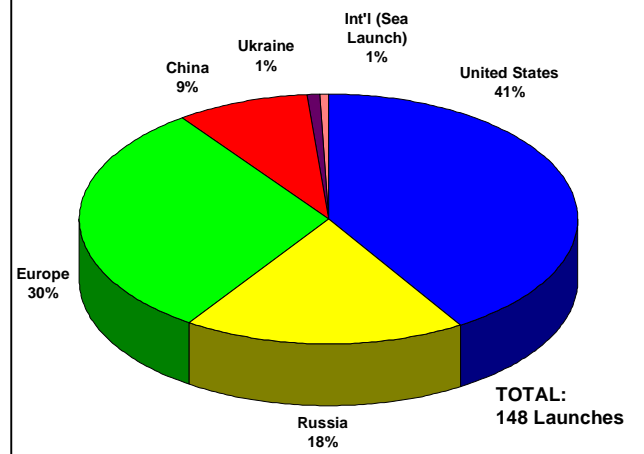


Figure 14. Five-Year Worldwide Commercial Launch Share (1995-1999)



1999 WORLDWIDE ORBITAL LAUNCH EVENTS

Date	Vehicle	Site	Payload	Operator	Manufacturer	Use	Comml Price	L	M
1/3/99	Delta 2 7425	CCAS	Mars Polar Lander	NASA	Lockheed Martin Corp.	Scientific		S	S
1/26/99	✓ + Athena 1	Spaceport Florida	Deep Space 2 Formosat-1	NASA Natl. Space Prog. Office (NSPO)	Jet Propulsion Laboratory TRW	Development Development	\$16-17 M	S	S
2/7/99	Delta 2 7426	CCAS	Stardust	NASA	Lockheed Martin Corp.	Scientific		S	S
2/9/99	✓ Soyuz	Baikonur	* Globalstars 23,36,38,40	Globalstar, Inc.	Space Systems/Loral	Communications	\$35-40 M	S	S
2/15/99	✓ Proton	Baikonur	* Telstar 6	Skynet	Space Systems/Loral	Communications	\$75-95 M	S	S
2/16/99	✓ + Atlas 2AS	CCAS	* JCSAT 6	Japan Satellite Systems	Hughes	Communications	\$90-105 M	S	S
2/20/99	Soyuz	Baikonur	Soyuz TM-29	RKK Energia	RKK Energia	Crewed		S	S
2/23/99	Delta 2 7920	VAFB	Argos	Space Test Prog. Office	Boeing	Development		S	S
2/26/99	✓ Ariane 44L	Kourou	Oersted Sunsat	Danish Space Rsrch. Inst. University of Stellenbosch	Comp. Resources Intl. Stellenbosch University	Scientific Scientific	\$100-125 M	S	S
2/28/99	Proton	Baikonur	* Arabsat 3A	Arabsat	Alcatel Espace	Communications		S	S
3/4/99	Pegasus XL	VAFB	Skynet 4E	British Defense Ministry	Matra Marconi	Communications		S	S
3/15/99	✓ Soyuz	Baikonur	Raduga 34	Russia/CIS PTT	NPO Prikladnoi Mekhaniki	Communications		S	F
3/21/99	✓ Proton	Baikonur	WIRE	NASA	NASA Goddard	Scientific		S	S
3/27/99	+ Sea Launch	Sea Launch Platform	* Globalstars 22,37,41,46	Globalstar, Inc.	Space Systems/Loral	Communications	\$35-40 M	S	S
4/2/99	Soyuz	Baikonur	* AsiaSat 3S	Asiasat	Hughes	Communications	\$75-95 M	S	S
4/2/99	✓ Ariane 42P	Kourou	* DemoSat	Sea Launch	Hughes	Test		S	S
4/9/99	Titan 4B/IUS	CCAS	Progress M-41	RKK Energia	RKK Energia	Mir Re-supply		S	S
4/12/99	✓ + Atlas 2AS	CCAS	* Insat 2E	ISRO	ISRO	Communications	\$65-85 M	S	S
4/15/99	Delta 2 7920	VAFB	DSP 19	DoD	TRW	Intelligence		F	F
4/15/99	✓ Soyuz	Baikonur	* Eutelsat W3	Eutelsat	Aerospatiale	Communications	\$90-105 M	S	S
4/21/99	✓ Dnepr 1	Baikonur	Landsat 7	NASA	Lockheed Martin Corp.	Remote Sensing		S	S
4/27/99	✓ + Athena 2	VAFB	* Globalstars 19,42,44,45	Globalstar, Inc.	Space Systems/Loral	Communications	\$35-40 M	S	S
4/29/99	✓ Cosmos	Kapustin Yar	* UoSat 12	Surrey Satellite Tech. Ltd.	Surrey Satellite Tech. Ltd.	Scientific	\$10-20 M	S	S
4/30/99	Titan 4B/Centaur	CCAS	* IKONOS 1	Space Imaging Inc.	Lockheed Martin Corp.	Remote Sensing	\$22-26 M	F	F
5/4/99	✓ + Delta 3	CCAS	Abrixas	DLR	OHB System	Scientific	\$12-14 M	S	S
5/10/99	Long March 4	Taiyuan	* MegSat 0	Meggiorin	Meggiorin S.p.A.	Communications		F	F
5/17/99	✓ + Pegasus XL	VAFB	Milstar II-F1	DoD/USAF	Lockheed Martin Corp.	Communications		F	F
5/21/99	✓ Proton	Baikonur	* Orion F3	Orion Network Systems	Hughes	Communications	\$75-90 M	F	F
5/22/99	Titan 4B	VAFB	FY-1C	China Meteo. Admin.	Shanghai Inst. of Sat. Eng.	Meteorological		S	S
5/26/99	PSLV	Sriharikota	SJ 5	Chin. Acad. Space Tech.	Chin. Acad. Space Tech.	Scientific		S	S
5/27/99	Shuttle Discovery	KSC	TERRIERS	Boston University/NASA	AeroAstro	Scientific	\$12-15 M	S	F
6/10/99	✓ + Delta 2 7420	CCAS	MUBLCOM	ARPA	Orbital Sciences Corp.	Communications		S	S
6/11/99	✓ Long March 2C	Taiyuan	* Nimiq 1	Telesat Canada	Lockheed Martin Corp.	Communications	\$75-95 M	S	S
6/18/99	✓ Proton	Baikonur	USA 144	NRO	Unknown	Classified		S	S
6/19/99	Titan 2	VAFB	Oceansat 1	ISRO	ISRO	Remote Sensing		S	S
6/24/99	Delta 2 7320	CCAS	Kitsat 3	Korea Advncd. Inst. of Sci.	Surrey Satellite Tech. Ltd.	Remote Sensing		S	S
7/5/99	Proton	Baikonur	Tubsat C-DLR	Technical Univ. of Berlin	Technical Univ. of Berlin	Development		S	S
7/8/99	Molniya	Plesetsk	STS 96	NASA	Rockwell International	Crewed		S	S
7/10/99	✓ + Delta 2 7420	CCAS	Starshine	NASA	Utah State University	Scientific		S	S
7/16/99	Soyuz	Baikonur	* Globalstars 25,47,49,52	Globalstar, Inc.	Space Systems/Loral	Communications	\$45-55 M	S	S
			* Iridium 14A	Iridium, Inc.	Lockheed Martin Corp.	Communications	\$20-25 M	S	S
			* Iridium 21A	Iridium, Inc.	Lockheed Martin Corp.	Communications		S	S
			* Astra 1H	SES	Hughes	Communications	\$75-95 M	S	S
			QuikSCAT	NASA	Ball Aerospace	Scientific		S	S
			FUSE	NASA	Orbital Sciences Corp.	Scientific		S	S
			Raduga 35	Russia/CIS PTT	NPO Prikladnoi Mekhaniki	Communications		F	F
			Molniya 3-50	Russia/CIS PTT	NPO Prikladnoi Mekhaniki	Communications		S	S
			* Globalstars 30,32,35,51	Globalstar, Inc.	Space Systems/Loral	Communications	\$45-55 M	S	S
			Progress M-42	RKK Energia	RKK Energia	Mir Re-supply		S	S

✓ Denotes commercial launch, defined as a launch that is internationally competed or whose primary payload is commercial in nature.

+ Denotes FAA-licensed launch.

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

L/M refers to the outcome of the launch and mission: S = success, P = partial success, F = failure.

1999 WORLDWIDE ORBITAL LAUNCH EVENTS (CONT.)

Date	Vehicle	Site	Payload	Operator	Manufacturer	Use	Comml Price	L	M
7/17/99	Zenit 2	Baikonur	Okean O1	NSAU	NPO Yuzhnoye	Remote Sensing		S	S
7/23/99	Shuttle Columbia	KSC	STS 93	NASA	Rockwell International	Crewed		S	S
7/25/99	✓ + Delta 2 7420	CCAS	Chandra * Globalstars 26,28,43,48	NASA Globalstar, Inc.	TRW Space Systems/Loral	Scientific Communications	\$45-55 M	S	S
8/12/99	✓ Ariane 42P	Kourou	* Telkom 1	PT Telekom	Lockheed Martin Corp.	Communications	\$65-85 M	S	S
8/17/99	✓ + Delta 2 7420	CCAS	* Globalstars 24,27,53,54	Globalstar, Inc.	Space Systems/Loral	Communications	\$45-55 M	S	S
8/18/99	Soyuz	Plesetsk	Kosmos 2365	Russian MoD	Unknown	Intelligence		S	S
8/26/99	Cosmos	Plesetsk	Kosmos 2366	Russian MoD	Polyot Production Association	Navigation		S	S
9/4/99	✓ Ariane 42P	Kourou	* KoreaSat 3	Korea Telecom	Lockheed Martin Corp.	Communications	\$65-85 M	S	S
9/6/99	Proton	Baikonur	* Yamal 101 * Yamal 102	Gazkom Gazkom	RKK Energia RKK Energia	Communications Communications		S	S
9/9/99	Soyuz	Plesetsk	Foton 12	Space Research Institute	KB Photon	Microgravity		S	S
9/22/99	✓ Soyuz	Baikonur	* Globalstars 33,50,55,58	Globalstar, Inc.	Space Systems/Loral	Communications	\$35-40 M	S	S
9/23/99	✓ + Atlas 2AS	CCAS	* Echostar 5	Echostar	Space Systems/Loral	Communications	\$90-105 M	S	S
9/24/99	✓ + Athena 2	VAFB	* IKONOS 2	Space Imaging Inc.	Lockheed Martin Corp.	Remote Sensing	\$22-26 M	S	S
9/25/99	✓ Ariane 44LP	Kourou	* Telstar 7	Skyнет	Space Systems/Loral	Communications	\$90-110 M	S	S
9/26/99	✓ Proton	Baikonur	* LMI 1	Lockheed Martin Intersputnik	Lockheed Martin Corp.	Communications	\$75-95 M	S	S
9/28/99	Soyuz	Plesetsk	Resurs-F 1M 2	Russian MoD	Central Specialized Design Bureau (TsSKB)	Remote Sensing		S	S
10/7/99	Delta 2 7925	CCAS	Navstar GPS 2R- 3	DoD	Lockheed Martin Corp.	Navigation		S	S
10/9/99	✓ + Sea Launch	Sea Launch Platform	* DirecTV 1R	DirecTV, Inc.	Hughes	Communications	\$75-95 M	S	S
10/14/99	Long March 4B	Taiyuan	CBERS/Ziyuan 1 SACI 1	China/Brazil INPE	Chin. Acad. Space Tech. INPE	Remote Sensing Remote Sensing		S	S
10/18/99	✓ Soyuz	Baikonur	* Globalstars 31,56,57,59	Globalstar, Inc.	Space Systems/Loral	Communications	\$35-40 M	S	S
10/19/99	✓ Ariane 44LP	Kourou	* Telstar 12	Orion Network Services	Space Systems/Loral	Communications	\$90-110 M	S	S
10/27/99	Proton	Baikonur	* Express A 1	Russian Space Com.Corp.	NPO PM	Communications		F	F
11/13/99	✓ Ariane 44LP	Kourou	* GE 4	GE Americom	Lockheed Martin Corp.	Communications	\$90-110 M	S	S
11/15/99	H 2	Tanegashima	MTSat 1	Ministry of Transport	Space Systems/Loral	Navigation		F	F
11/20/99	Long March 2F	Jiuquan	Shenzhou	China National Space Administration	China Rsrch. Inst. of Carrier Rocket Tech.	Test		S	S
11/22/99	+ Atlas 2A	CCAS	GBS 10	DoD	Hughes	Communications	\$75-85 M	S	S
11/22/99	✓ Soyuz	Baikonur	* Globalstars 29,34,39,61	Globalstar, Inc.	Space Systems/Loral	Communications	\$35-40 M	S	S
12/3/99	Ariane 40	Kourou	Helios 1B Clementine	CNES/DGA DGA	Matra Marconi Alcatel Space	Intelligence Development		S	S
12/4/99	+ Pegasus XL/HAPS	Wallops	* Orbcomms 30-36	Orbcomm	Orbital Sciences Corp.	Communications	\$12-15 M	S	S
12/10/99	Ariane 5	Kourou	XMM	European Space Agency	Deutsche Aerospace	Scientific		S	S
12/11/99	VLS	Alcantara	SACI 2	INPE	INPE	Remote Sensing		F	F
12/12/99	Titan 2	VAFB	DMSP 5D-3-F15	DoD	Lockheed Martin Corp.	Meteorological		S	S
12/18/99	Atlas 2AS	VAFB	Terra	NASA	Lockheed Martin Corp.	Remote Sensing		S	S
12/19/99	Shuttle Discovery	KSC	STS 103	NASA	Rockwell International	Crewed		S	S
12/21/99	✓ Ariane 44L	Kourou	* Galaxy 11	PanAmSat	Hughes	Communications	\$100-125 M	S	S
12/21/99	✓ + Taurus 1	VAFB	Kompsat ACRIMSAT * Celestis 3	Korea Aerospace Research Institute NASA Celestis, Inc.	TRW/KARI Orbital Sciences Corp. Celestis, Inc.	Remote Sensing Scientific Other	\$18-20 M	S	S
12/26/99	Cyclone 2	Baikonur	Kosmos 2367	Russian MoD	Unknown	Intelligence		S	S
12/27/99	Molniya	Plesetsk	Kosmos 2368	Russian MoD	Unknown	Intelligence		S	S

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 L/M refers to the outcome of the launch and mission: S = success, P = partial success, F = failure.