

Commercial Space Transportation

QUARTERLY LAUNCH REPORT

Featuring the launch results from the previous quarter and forecasts for the next two quarters.



3rd Quarter 1997

United States Department of Transportation • Federal Aviation Administration
Associate Administrator for Commercial Space Transportation

**3RD QUARTER
1997 R EPORT**

Objectives

This report summarizes recent and scheduled worldwide commercial, civil, and military orbital space launch events. Scheduled launches listed in this report are vehicle/payload combinations that have been identified in open sources, including industry references, company manifests, periodicals, and government documents. Note that such dates are subject to change.

This report highlights commercial launch activities, classifying commercial launches as one or more of the following:

- *Internationally competed launch events (i.e., launch opportunities considered available in principle to competitors in the international launch services market),*
- *Any launches licensed by the Office of the Associate Administrator for Commercial Space Transportation of the Federal Aviation Administration under U.S. Code Title 49, Section 701, Subsection 9 (previously known as the Commercial Space Launch Act), and*
- *Certain European launches of post, telegraph and telecommunications payloads on Ariane vehicles.*

Photo credit: McDonnell Douglas (1997). Image is of the Delta 2 7920 launch on May 5, 1997, from Vandenberg Air Force Base. It successfully orbited the first five Iridium communication satellites for Iridium Inc.

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This document was prepared by Futron Corporation and was released on July 25, 1997.

SUMMARY

**Second
Quarter 1997
Launch Events**

- The United States made seven launches in the second quarter of 1997. Four of the launches were non-commercial (an Atlas, a Titan 2, and two Shuttles) and three were commercial (two Deltas and a Pegasus). All of these launches were successful with the Delta vehicle returning to flight after a four month hiatus.
- The Russian Republic/CIS launched nine times with seven non-commercial and two commercial launches. The non-commercial launches were on a Proton, a Cosmos, two Soyuz, two Molniya, and one Zenit (the only failed launch this quarter). Two commercial Proton launches were successful.
- Europe's Ariane 4 launched five commercial communication satellites in three successful attempts.
- China launched one national communication and one national meteorological satellite for two successful non-commercial launches.

**Third and Fourth
Quarter 1997
Scheduled Launch
Events**

-
- United States launch vehicles are slated to make 25 launches in the last two quarters of 1997. Thirteen of these launches will be commercial and 12 will be non-commercial. The commercial launches will include four Atlas, five Delta, two LMLV, one Taurus, and one Pegasus. The non-commercial launches will consist of one Atlas, four Delta, one LMLV, one Pegasus, four Shuttle, and one Titan 4.
 - The Russian Republic/CIS will conduct 15 launches of which seven will be commercial and eight non-commercial. Commercial launches will include six Proton launches and one on the START small launch vehicle. Non-commercial launches will include two Cosmos, one Molniya, three Soyuz, one Zenit and one Rokot.
 - Europe will launch six Ariane 4s with ten satellites and will conduct one non-commercial developmental launch of the Ariane 5.
 - China plans six launches with its Long March vehicles of which three are commercial and three are not.
 - Japan intends to make two non-commercial launches on the H2 carrying three satellites.
 - Brazil will debut its VLS small launch vehicle with the non-commercial launch of a communication payload, SCD 2A.

SUMMARY

Commercial Products and Services

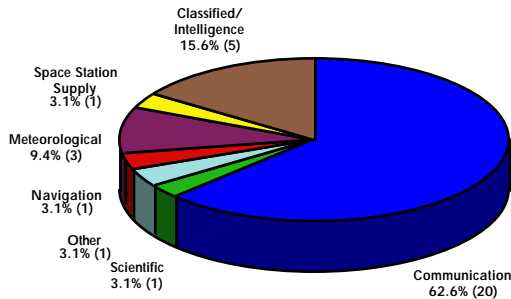
Third and Fourth Quarter 1997

Celestis I and II

A new service that has begun making commercial use of space is the "burial" of cremated remains. This service is the result of an effort begun in the mid-1980s by Celestis Group Inc. of Melbourne, FL. Although this effort failed (amongst other problems the state of Florida required that Celestis build a 15 acre cemetery in space to comply with Florida funeral industry regulations), the reborn Celestis Inc. of Houston, TX has successfully launched one two-pound funeral spacecraft Celestis I, with Minisat-01 on April 21 and plans to launch a second, Celestis II, with the Geosat Follow-On later in the year. The cost to loft seven grams of ashes is \$4,800.

Payload Use Analysis

Second Quarter 1997



There were 32 payloads launched in the Second Quarter of 1997. These payloads were divided between communication (62.6 percent), intelligence/early warning (15.6 percent), navigation (3.1 percent), scientific (3.1 percent), space station supply (3.1 percent), meteorological (9.4 percent) and other (Celestis with 3.1 percent).

Communication payloads constituted 90 percent of the 21 commercially-launched payloads with two other payloads one scientific and one other (Celestis) at five percent each.

LAUNCH SCHEDULE

**Scheduled Launch
Events**

Vehicle	Payload	Site
JULY 1997		
Atlas 2AS Delta 2 7920	Superbird C1 Iridium 13 Iridium 14 Iridium 15 Iridium 16 Iridium 17	CCAS VAFB
Delta 2 7925 Long March 3B Proton SL-12 Shuttle Columbia Soyuz SL-4 Zenit 2 SL-16	Navstar GPS 2-28 Agila 2 PAS 5 STS 83R/94 Progress M-35 FASat-Bravo Gurwin 2 Resurs-O1 N4 SAFIR 2 TMSAT 1	CCAS Xichang Tyuratam KSC Tyuratam Tyuratam
AUGUST 1997		
Ariane 4-TBA	Hot Bird Plus 3 Meteosat 7	Kourou
Ariane 44P Atlas 2AS Delta 2 7920	PAS 6 GE 3 Iridium 18 Iridium 19 Iridium 20 Iridium 21 Iridium 22	Kourou CCAS VAFB
Delta 2 7925 H 2 LMLV 1 Long March 3B Long March 3B Pegasus XL Pegasus XL Shuttle Discovery	ACE COMETS 1 Lewis Sinosat 1 APStar 2R Seastar FORTE P94-1 STS 85 CRISTA SPAS 2 SEDSat 1	CCAS Tanegashima VAFB Xichang Xichang VAFB VAFB KSC
Soyuz SL-4	Soyuz TM-26	Tyuratam

LAUNCH SCHEDULE

**Scheduled Launch
Events**

(Continued)

Vehicle	Payload	Site
SEPTEMBER 1997		
Ariane 44P	Intelsat 8 F3	Kourou
Ariane 5	Phase 3D	Kourou
Atlas 2AS	EchoStar 3	CCAS
LMLV 2	Lunar Prospector	CCAS
Proton SL-12	Iridium 27	Tyuratam
	Iridium 28	
	Iridium 29	
	Iridium 30	
	Iridium 31	
	Iridium 32	
	Iridium 33	
Proton SL-12	Sky 1	Tyuratam
Shuttle Atlantis	STS 86	KSC
START 1	EarlyBird 1	Svobodny
OCTOBER 1997		
Ariane 44L	Sirius 2	Kourou
	IndoStar 1	
Atlas 2	DSCS III 3-10	CCAS
H 2	ETS 7	Tanegashima
	TRMM	
Proton SL-12	Astra 1G	Tyuratam
Titan 4B/Centaur	Cassini	CCAS
	Huygens	

LAUNCH SCHEDULE

Scheduled Launch Events

(Continued)

Vehicle	Payload	Site
NOVEMBER 1997		
Ariane 44P	JCSAT 5 Equator-S	Kourou
Atlas 2AS	Galaxy 8I	CCAS
Delta 2 7920	Iridium 34 Iridium 35 Iridium 36 Iridium 37 Iridium 38	VAFB
Delta 2 7925	Navstar GPS 2R- 3	CCAS
Proton SL-12	Asiasat 3	Tyuratam
PSLV	IRS P4	Sriharikota
Shuttle Columbia	STS 87 Spartan 201-04 USMP 4	KSC
Taurus 1	Geosat Follow-On 1 Celestis 2	VAFB
DECEMBER 1997		
Ariane 4-TBA	BSAT 1 B Hot Bird Plus 4	Kourou
Delta 2 7925	Globalstar 1 Globalstar 2 Globalstar 3 Globalstar 4	CCAS
Delta 2 7920	Iridium 39 Iridium 40 Iridium 41 Iridium 42 Iridium 43	VAFB
Delta 2 7925	Navstar GPS 2R- 2	CCAS
LMLV 2	IKONOS 1	VAFB
Long March 3B	ChinaStar 1A	Xichang
Long March 4	CBERS/Ziyuan 1 SACI 1	Taiyuan
Proton SL-12	Astra 2A	Tyuratam

LAUNCH SCHEDULE

**Additional Launch
Events to be
Announced** †

**For the Third and Fourth
Quarter 1997**

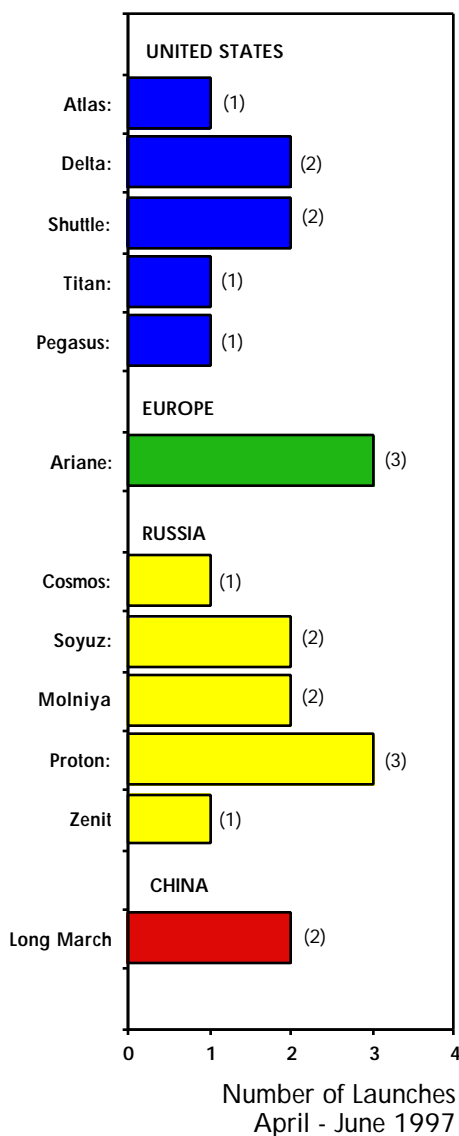
Vehicle	Payload	Site
THIRD QUARTER OF 1997		
Cosmos SL-8	Kosmos 97-3Q TBA Tubsat C-DLR	Plesetsk
Long March 2C	Iridium 25 Iridium 26	Taiyuan
VLS	SCD 2A	Alcantara
FOURTH QUARTER OF 1997		
Cosmos SL-8	Astrid 2 Faisat 02V Kosmos 97-4Q TBA	Plesetsk
Molniya SL-6 Rokot	Molniya 3-49 Kosmos 97-4Q TBA	Plesetsk Svobodny
Soyuz SL-4	UoSat 12 Progress M-36	Tyuratam

† This section summarizes launches and payloads that are expected to occur during the next two quarters. Exact launch dates were not available prior to publication of this report

LAUNCH REPORT

Launch Events

Second Quarter
1997



The United States conducted seven of 21 launches occurring in the second quarter of 1997. Three of these were commercial: two Deltas carrying the Iridium 1 through 5 and Thor 2 communication payloads and a Pegasus with a scientific satellite (Microsat-01) and a funerary micro satellite (Celestis 1). The remaining four non-commercial launches were divided between two Shuttle missions, and an Atlas and a Titan 2 both launching the meteorological satellites GOES 10 and a military DMSP satellite respectively.

The Russian Republic/CIS launched nine times with two of these launches commercial Protons carrying Iridium 6 through 12 and Telstar 5. The seven non-commercial launches included a supply mission to Mir launched on a Soyuz booster, a navigation satellite on a Cosmos booster, and five intelligence satellites launched on two Molnias, a Proton, a Soyuz, and a Zenit. The Zenit launch on May 20 was the only launch failure in the second quarter.

During this period, on June 25, the Progress resupply spacecraft collided with the Spektr module of the Russian Mir Space Station during practice docking operations. The collision with Spektr caused a loss of pressure and power aboard the station. The crew shut Spektr's hatch and repressurized the remaining modules on Mir and worked to reestablish gyrodyne attitude control and to fully charge the batteries. Full repairs will be conducted by the next Mir crew in August 1997.

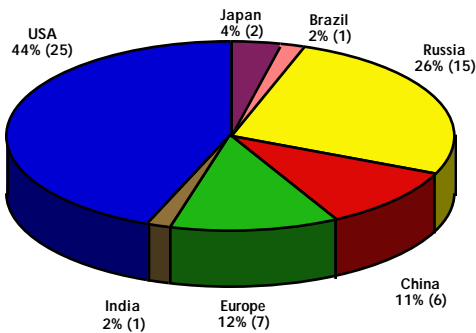
Europe's Ariane 4 launch vehicle made three launches putting five commercial communication satellites in orbit. These were BSAT 1, Thaicom 3, Inmarsat 3 F4, Insat 2D, and Intelsat 8 F2.

China successfully used the troubled Long March vehicle to put a national communication satellite and a national meteorological satellite into orbit.

LAUNCH REPORT

Scheduled Launch Events

Third and Fourth Quarter 1997



Scheduled Launch Events, by Region
July - December 1997

(includes small launch vehicles, excludes sub-orbital launch events)

In the Third and Fourth Quarters of 1997, seven nations will conduct 57 orbital launches.

The United States will launch 25 times. Small vehicle launches during this period will include three LMLVs and one Taurus. They will carry a mix of remote sensing, intelligence, science payloads and the funerary satellite Celestis 2. Of the nine Deltas scheduled, five will carry communication payloads, three navigation, and one science. Atlas will launch five times with communication satellites. Pegasus will have two launches with a remote sensing and an intelligence payload. There will also be four shuttle missions and one Titan 4, which will carry the Cassini planetary probe.

The Russian Republic/CIS will attempt 15 launches some with multiple payloads. These payloads will include four remote sensing and 15 communication satellites. Also one crewed and two supply flights to Mir and two each in the technology and science payload categories are scheduled. Three additional Kosmos payloads are scheduled but their purpose is yet to be determined.

Europe's Ariane 5 will return to flight with a science payload. There will be six Ariane 4 launches with eight communication, one scientific, and meteorological satellite.

China expects to launch six Long Marches carrying six communications and two remote sensing satellites.

Japan will launch a scientific, a remote sensing, and a technology development payload on two H2 vehicles.

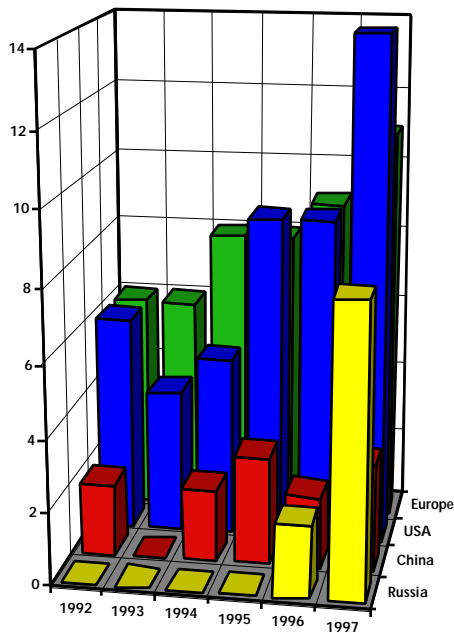
Brazil will launch an SCD 3 data relay satellite on its first VLS launcher.

India will launch a single communication satellite on its PSLV launch vehicle.

LAUNCH REPORT

Scheduled Commercial Launch Events

Third and Forth Quarter 1997



Commercial Launch Events
January 1992 - December 1997
(Small Vehicles Excluded)

Of the 57 launches expected in the next two quarters, 29 (more than half) will be commercial. These launches will be conducted by the United States, The Russian Republic/CIS, Europe, and China.

The United States will have almost half of these commercial launches with 13 out of the 29 total. Two of these commercial launches will be remote sensing satellites on LMLVs. Delta vehicles will launch five times with communication payloads, all of which will be multiple satellite deployments to LEO. Four Atlas launches will carry GEO communication satellites and one Pegasus vehicle will be launched with a remote sensing payload. Finally, a Taurus will launch an intelligence and a funerary satellite.

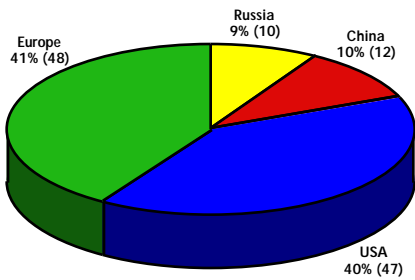
Europe intends to conduct six commercial launches of the Ariane 4, placing eight communication satellites in GEO.

The Russian Republic/CIS intends to conduct seven commercial launches. One of these launches will loft the EarlyBird remote sensing satellite on a START launch vehicle. The remaining six launches are all on Proton launch vehicles with five launches of GEO communication satellites and one launch carrying seven Iridium LEO communication satellites.

China's three commercial launches will be split between GEO and LEO payloads with two launches of GEO communication satellites and one launch with two Iridium LEO communication satellites.

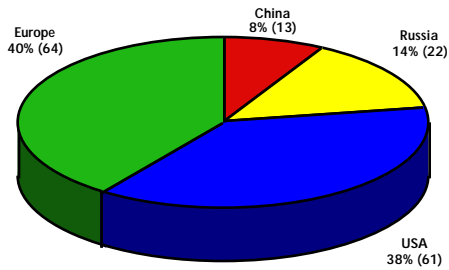
LAUNCH REPORT

Commercial Launch Trends



Commercial Launch Market Trend
January 1992 - December 1997

(Small Vehicles Excluded)



Internationally Competed Payloads
Market Trend
January 1992 - December 1997

(Small Vehicles Excluded)

Between January 1992 and the end of 1997, projections indicate that there will have been a total of 117 commercial launch events (excluding small launch vehicles). Of these, the United States share will be 40 percent or 47 launches. In terms of internationally competed payloads, the United States will have launched 61 of 160 for a 38 percent share.

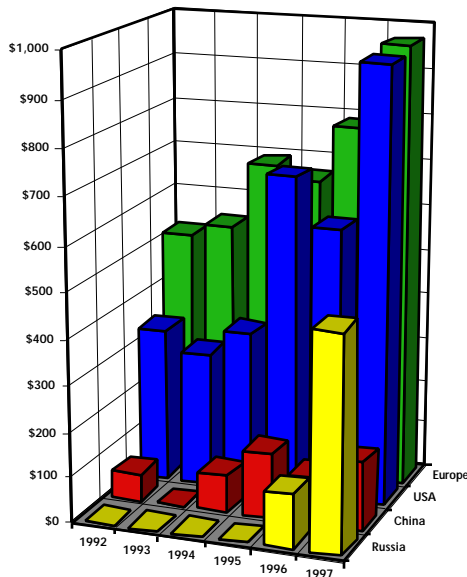
Europe's Arianespace will have launched 48 times for a 41-percent share, lofting 64 payloads or 40 percent of the total. China will have launched 12 times with 13 payloads for an eight-percent share of internationally competed payloads, and a ten-percent share of launches. The Russian Republic/CIS will have conducted ten commercial launches for a nine-percent share and will deploy 14 percent or 22 internationally competed payloads.

Arianespace's payload share continues to decline largely due to the fact that the United States, Russia, and China are all launching multiple sets of satellites for LEO communication constellations. The United States' Delta will have launched five sets of five Iridium satellites and a set of four Globalstar LEO communication satellites. Russia will have launched Iridiums twice with seven at a time on the Proton booster and China will use the Long March 2C to launch a pair of Iridium satellites as well.

In the period covered by this report, April 1997 through December 1997, there will be 32 commercial launches with 72 internationally competed payloads. These figures are even more strongly affected by this year's multiple-payload LEO launches than the long-term numbers. The United States will hold 38 percent of launches (12 launches) and 49 percent of payloads (35 payloads). Europe will have nine launches (28 percent) and 13 payloads (18 percent of payloads). China's share will be three launches (nine percent) and four payloads (six percent). Russia will have launched 20 payloads on eight vehicles for 28 percent of payloads and 25 percent of launches. Note that these projections are subject to change.

LAUNCH REPORT

Commercial Launch Revenues



Commercial Launch Revenues by Region (in US \$ Millions)*

January 1992 - December 1997

* Graph reflects approximate revenues based on actual price quotes and historical price averages. Launch vehicle pricing data is currently being verified for historical accuracy, which may affect figures shown in future quarterly launch reports. Figures here are shown in constant 1994 dollars. Includes small vehicles.

In 1997, revenues for commercial launch events are expected to total \$2,545 million. The United States will have a 38-percent share of these revenues with \$956 million and Europe will have 38-percent with \$970 million. The Russian Republic/CIS holds an estimated 18-percent share with \$471 million and China will have a six-percent share with \$148 million.

Russia and China have a smaller percentage of total revenues than reported during the last quarter while the United States has gained and Europe has lost market share. In 1997, the United States is projected to equal Arianespace's percentage of market share in terms of total revenue.

Special Report

SR-1

Bulk-Buy Practices by Satellite Operators Foster Further Commercialization of Launch Services Industry

INTRODUCTION

The satellite launch industry has steadily grown and matured to take on the features of a truly commercial industry. This year, commercial launches outnumber government launches for the first time. New launch systems, such as the Delta 3, Sea Launch, and H2A, are in development, supported almost entirely by commercial launch demand. An emerging development in the launch services business is the commercial bulk buy of launch vehicle services (that is, the commercial purchase of several launch opportunities through a single procurement, even when specific payloads may not have been selected for those launches). In the past, launch services were arranged for one or two satellites at a time, sometimes with options for more launches to be provided to the satellite operator at a later date.

The practice of buying launch services in bulk has emerged in the GEO launch market for three main reasons:

- First, the existing fleets of GEO-capable launchers have largely been booked through 1998 and part of 1999. The practice of bulk buying creates sufficient quantities of demand to allow existing or emerging launch service providers to begin development of new launch systems to increase supply
- Second, by fostering the development of new launch systems, launch customers are stimulating competition and are able to diversify the available supply of launch vehicles
- Third, bulk purchases typically involve volume discounts and therefore allow for a reduction in the price per launch. This practice is also true of the emerging big LEO markets, which will involve large constellation deployments during the next ten years.

Table 1. Recent Bulk Buys of Launch Services

Launcher	Customer	Number of Launches	Date of Contract	Date of Launches
Delta 2	Iridium	8	April 1994	1997-1998
	Globalstar	up to 6	March 1995	1997-1999
Delta 3	Hughes	10	May 1995	1998-2002
H2A	Hughes	10	September 1996	2000-2005
	Loral	10	September 1996	2000-2005
	Loral	5	February 1997	1999-2001
Proton	Hughes	4	April 1995	1997-1998
	Loral	5	September 1993	through 1998
	SES	4	March 1994	1996-1998
Sea Launch	Hughes	10	December 1995	through 2002
	Loral	10	July 1996	through 2002
Eclipse	Iridium	10 with options	October 1996	1999
K-1	Loral	10	January 1997	1999

Special Report

SR-2

Since the existing fleets of GTO-capable launchers were rapidly becoming over-booked, it was evident that new launchers would, at some point, have to be introduced. Satellite manufacturers and operators have, in part, been financing the development of these systems through bulk buys, effectively minimizing some of the risks associated with the development of entirely new launch systems.

This support has been provided much in the same way that the development of new commercial airliners is supported by customers that promise to buy a significant number of the new planes. In short, commercial launch vehicles are being bought in bulk providing the "guarantee" for the new launch systems.

Satellite manufacturers also have strong incentives to encourage a diversity of launch service providers. Greater supply helps ensure that at least one launch vehicle will be available to launch a particular satellite in a timely manner, and more market players force competition for the most attractive price. Also, in the event of a launch failure, other launchers can continue to fly while the faulty system remains grounded through the investigation.

Large satellite organizations, such as Intelsat and Inmarsat, typically contract directly with a launch service provider. Many commercial telecommunications and PTT organizations, on the other hand, are contracting directly with the satellite manufacturers to arrange for launch services as part of the conditions of sale. Two to three years ago, the US major satellite manufacturers, Hughes and Space Systems/Loral, began to buy as many as ten launches at a time, even before any specific payloads were chosen for the launches. This practice ensured that enough vehicles would be available to launch the satellites being produced by the manufacturers.

DELTA 3

The significance of the decision to develop Delta 3 lies in that it was entirely a commercial business decision, and no government money was needed. This demonstrates that the demand for commercial satellite services was large enough to stimulate the development of a new launch system.

The purchase of launch services in bulk also allows the launch customer to pay less per launch. At the time the agreement between Hughes and McDonnell Douglas was announced, it was stated that Hughes would pay less for launches on Delta 3 than it had been paying for previous launch services on similar vehicles.¹ This has allowed the manufacturers to sell more satellites as well. Steven Dorfman, president of Hughes Telecommunications and Space said at the time of the announcement, "Communications is an elastic marketplace – the lower we can get our costs the more [satellites] we can sell."² The first Delta 3 is expected to fly in 1998 and will carry the Hughes Galaxy 10 satellite.

SEA LAUNCH

The Sea Launch venture, also set to fly for the first time in 1998, is the result of a partnership led by Boeing to launch Ukrainian built Zenit rockets from an off-shore platform. Hughes's decision to buy ten launches on this new system in December 1995 was seen to be an extension of Hughes's approach with Delta 3, described above. Hughes spokesman Richard Dore said at the time of the announcement, "We're starting to build a stable of launch vehicles that we have access to. We think this is critical."³

¹ "McDonnell Douglas Announces Delta Upgrade/ Hughes Deal for 10 Launches Provides Delta 3 Strong Start," *Space News*, May 15, 1995, p.1.

² Ibid.

³ "Sea Launch Lands Hughes Contract/ ten-launch Deal Makes Boeing Instant Player in a Crowded Market," *Space News*, December 18, 1995.

Special Report

SR-3

Since the December 1995 announcement, Hughes has exercised three more options on top of the original ten launches, and Space Systems/Loral announced its own ten-launch buy in July 1996. The first launch of the Zenit Sea Launch is expected in late 1998, and will carry the Hughes Galaxy 11 satellite.

H 2A

Japan's H2 launcher has flown successfully all four times since its introduction in 1994, but was deemed to be prohibitively expensive to compete in the commercial launch market. Determined to control costs, NASDA decided in September 1995 to develop the lower-cost H2A and make it available for commercial launches beginning in 2000. In July 1996, early reports of a pending deal between Hughes and Rocket System Corp. (RSC), the marketing agency for H2A, indicated that Hughes would buy five launches for an average price of \$78 million each. A deal was finally reached for ten launches, although the price terms were not disclosed. An RSC official quoted in *Space News* acknowledged that the planned cost reduction of the new H2A was enabled by the bulk purchase: "The cost reductions have been achieved not only because of streamlining of the rocket systems, but also because of foreign procurement."⁴ Space Systems/Loral also secured ten launches for the H2A in September 1996.

PROTON

Russia's Proton also has a multiple launch contract through Hughes, Space Systems/Loral, and SES of Luxembourg. International Launch Services, the partnership to market both the Atlas and Proton launch vehicles, is working to

expand capacity for its Proton business, which is nearly booked through 1999.⁵

LEO SYSTEMS

The new LEO communication systems have also bought their launches in bulk. To deploy a constellation, a large number of satellites needs to be deployed in a short period of time. Large launch vehicles like the ones used to launch GEO satellites tend to offer greater cost efficiency per pound to orbit and can deploy many satellites at once. Once the constellation is deployed, a mixture of small and large launch vehicles can be used to replenish the system.

Eclipse – In October 1996, Motorola announced it would buy 10 launches for its Iridium satellites aboard the Eclipse reusable small launcher being developed by Kelly Space & Technology. Eclipse Astroliner will use a modified F-106 aircraft that would be towed behind a Boeing 747. The vehicle will be released and then rocketed on a suborbital trajectory to a very high altitude where the payload and an upper stage are deployed. In this way, about 3,500 pounds could be delivered to low earth orbit. Eclipse would be used to replenish Iridium satellites on an as-needed basis.

For the initial deployment of the Iridium constellation, larger expendable launchers are being used to deploy several satellites at a time. McDonnell Douglas's Delta 2 will launch 40 of the satellites five at a time over eight launches. Russia's Proton will conduct three launches of seven satellites at a time through a special arrangement with Proton manufacturer Khrunichev. China's Long March 2C will launch six times carrying two satellites each. McDonnell Douglas also will launch three more sets of five to replenish the

⁴ "Hughes Nears H2A Deal," *Space News*, July 8, 1996, p. 18.

⁵ Various sources, including "Rocket Shortage Impacts Hughes, But Lockheed Finds Launchers," *Space Business News*, April 2, 1997.

Special Report

SR-4

constellation. To date, two Deltas and one Proton have already placed 17 Iridium satellites into orbit.

K-1 – Kistler Aerospace, another developer of a small reusable launch vehicle, signed a deal with Space Systems/Loral (the manufacturer of the Globalstar satellites) in January 1997 for ten launches on their two-stage K-1 launch vehicle. The payloads have not yet been identified, but a K-1 could lift three Globalstar-class satellites at once. The K-1 is designed to deliver 3,600 kg to low earth orbit, giving the K-1 roughly similar capabilities to the McDonnell Douglas Delta 2 launch vehicle. The first and second stages would be powered by the Russian designed NK-33 engine, the same engine used on the N-1 rocket in the 1970's as part of Russia's former manned lunar program. Both stages would be recovered after use through a system of parachutes and airbags. The first orbital test flight of the K-1 is now set for 1998.

Globalstar also has multiple launch agreements with McDonnell Douglas as well as with Starsem and Yuzhnoye to launch on the Russian Soyuz and Ukrainian Zenit launch vehicles.

If the new generation of commercially developed small launchers can deploy LEO satellites reliably and cost effectively, they may be able to capture a significant portion of the LEO replenishment market as well.

GLOSSARY

For proper interpretation of the data in this report, the following definitions should be understood:

Commercial Launch Events: A commercial launch event is an internationally competed launch event, as defined below, and/or any launch licensed by the Department of Transportation/Office of Commercial Space Transportation (DoT/OCST), under the Commercial Space Launch Act (CSLA), or certain Post, Telegraph and Telecommunications launches.

Commercial Launch Revenue: Commercial launch revenues are generated from launch services provided by private and government licensed entities. It is understood that commercial launch providers of different countries operate within different economic, policy, and procedural contexts which affect the respective prices for a launch contract, however, this report does not attempt to adjust its data for these factors.

Geosynchronous Orbit (GEO): An orbit approximately 22,300 miles above the equator in which a payload completes one orbit around the Earth every 24 hours.

Geosynchronous Transfer Orbit (GTO): A temporary orbit used to later place payloads in a geosynchronous orbit.

Internationally-Competed Launch Events: An internationally competed launch event results from a launch opportunity which is available in principle to competitors in the international launch services market.

Low Earth Orbit (LEO): An orbit range on the order of 100-1000 nautical miles.

Market Share: That segment of a commercial market which is captured by a specified entity.

Microgravity: An environment in which gravitational forces are essentially nonexistent. Microgravity is used for materials processing, life-sciences, and other experiments. Suborbital flights generally are conducted to expose experimental payloads to a brief microgravity environment. Microgravity is also utilized for orbiting payloads.

Orbital Insertion: The point of a launch event at which a payload has attained planned orbital velocity and finally separates from its launch vehicle.

Payload: Cargo to be jettisoned or released which may include attached kick motors.

Payload Mass Class: Payloads are categorized in the following mass classes:

Microsat	0 - 200 lbs	Small	201 - 2,000 lbs
Medium	2,001 - 5,000 lbs	Intermediate	5,001 - 10,000 lbs
Large	10,001 - 20,000 lbs	Heavy	over 20,000 lbs

Scheduled Launch Events: Future launch events associated with specific dates as reported in open sources.

Secondary Payload: A payload of lesser dimensions and weight than the primary payload(s). These payloads are launched along with primary payload(s) due to excess launch capacity.

Suborbital: A term used to describe a launch event or payload that does not achieve a full earth orbit.

ACRONYMS

ACE	Advanced Composition Explorer	INTELSAT	- International Telecommunications Satellite Organization
APT	Asia Pacific Telecommunications Satellite	IRS	Indian Resource Satellite
BSAT	Broadcast Satellite System Corp.	ISAS	Institute of Space and Astronautical Science
CAST	Chinese Academy of Space Technology	ISRO	Indian Space Research Organization
CBERS	China Brazil Earth Resources Satellite	Jawsat	Joint Academy-Weber State Satellite
CCAS	Cape Canaveral Air Station	JCSAT	Japan Communications Satellite Co. Satellite
COMETS	- Communications and Broadcasting and Tech Satellite	JPL	Jet Propulsion Laboratory
CRISTA	SPAS - Cryogenic Infrared Spectrometer telescope for Atmosphere-Space Pallet Satellite	JSAT	Japan Satellite Systems, Inc.
CIS	Commonwealth of Independent States	KB	Design Bureau
DARA	German Space Agency	KSC	Kennedy Space Center
DASA	Deutsche Aerospace	LEO	Low Earth Orbit
DFH	Dong Fang Hong	LMLV	Lockheed Martin Launch Vehicle
DMSP	Defense Meteorological Support Program	MEO	Medium Earth Orbit
DoD	Department of Defense	MoD	Ministry of Defense
DoT	Department of Transportation	NASA	National Aeronautics and Space Administration
DSCS	Defense Satellite Communications System	NASDA	National Space Development Agency (Japan)
DSP	Defense Support Program	NEC	Nippon Electric Corp.
ELI	Elliptical	nMI	Nautical Mile
ELINTS	Electronic intelligence satellites	NOAA	National Oceanic and Atmospheric Administration
ESA	European Space Agency	NPO	Scientific Production Organization
ETS	Engineering Test Satellite	OCST	Office of Commercial Space Transportation
EXT	Extra-Orbital	OSC	Orbital Sciences Corporation
FAA	Federal Aviation Administration	PAS	Pan American Satellite
FORTE	Fast On-Orbit Recording of Transient Events	PSLV	Polar Satellite Launch Vehicle
FSW	Fanhui Shi Weixing	PTT	Post Telegraph and Telecommunications
FY	Feng Yun	RKK Energia	- Rocket and Space Company Energia
GE	General Electric	SACI	Satellite Cientifico
GEO	Geosynchronous Orbit	SAFIR	Satellite for Information Relay
GOES	Geostationary Operational Environmental Satellite	SCD	Satellite de Coleta de Dados
GTO	Geosynchronous Transfer Orbit	SES	Societe Europeene des Satellites
INMARSAT	- International Maritime Satellite Organization	SLV	Satellite Launch vehicle
INTA	Instituto Nacional de Tecnica Aeroespacial	SSTI	Small Spacecraft Technology Initiative

ACRONYMS CONTINUED...

STEP	Space Test Program
STS	Space Transportation System
SNOE	Student Nitric Oxide Explorer
TERRIERS	Tomographic Experiment using Radiative Recombinitive Ionospheric EUV and Radio Sources
TRACE	Transition region and Coronal Explorer
TRMM	Tropical Rainfall Measuring Mission
Tubsat	Technical University of Berlin Satellite
TsSKB	Central Specialized Design Bureau
UoSat	University of Surrey Satellite
USMP	United States Microgravity Payload
VAFB	Vandenberg Air Force Base
VLS	Veiculo Lancador de Satellites
XL	Extra Long

Characteristics of Cited Vehicles

Vehicle Designation	(Success + Partial) / Attempts	LEO 28 Degrees	GTO	GEO	Suborbital	Price per Launch (Approx.)	Launch Sites
Heavy							
Ariane 5	0/1 0%	39600lbs 18000kg	15000 lbs 6800 kg	N/A	N/A	\$130 M	Kourou
Long March 3B	0/1 0%	29900 lbs 13600 kg	9900 lbs 4500 kg	4950 lbs 2240 kg	N/A	\$50-70 M	Xichang
Proton SL-12	191/213 89.7%	46297lbs 21000 kg	12100 lbs 5500 kg	4850 lbs 2200 kg	N/A	\$50-70 M	Tyuratam
Shuttle Atlantis	18/18 100.0%	47300 lbs 21455 kg	13007 lbs 5900 kg	5202 lbs 2360 kg	N/A	\$161-215 M	KSC
Shuttle Columbia	22/22 100.0%	47300 lbs 21455 kg	13007 lbs 5900 kg	5202 lbs 2360 kg	N/A	\$161-215 M	KSC
Shuttle Discovery	23/23 100.0%	47300 lbs 21455 kg	13007 lbs 5900 kg	5202 lbs 2360 kg	N/A	\$161-215 M	KSC
Titan 4	10/11 90.0%	39100 lbs 17736 kg	14000 lbs 6350 kg	N/A	N/A	\$160-180 M	CCAS, VAFB
Titan 4/Centaur	7/7 100.0%	39100 lbs 17736 kg	14000 lbs 6350 kg	10200 lbs 4627 kg	N/A	\$255 M	CCAS
Titan 4B/Centaur	N/A	N/A	N/A	N/A	N/A	N/A	CCAS, VAFB
Zenit 2 SL-16	23/28 82.1%	30300 lbs 13740 kg	N/A	N/A	N/A	\$30-35 M	Tyuratam
Intermediate							
Ariane 44L	23/24 95.8%	21100 lbs 9600 kg	9965 lbs 4520 kg	N/A	N/A	\$90-110 M	Kourou
Ariane 44LP	15/16 93.8%	18300 lbs 8300 kg	8950 lbs 4060 kg	N/A	N/A	\$80-95 M	Kourou
Ariane 44P	8/8 100.0%	15200 lbs 6900 kg	7320 lbs 3320 kg	N/A	N/A	\$80-95 M	Kourou
Ariane 4-TBA	N/A	N/A	N/A	N/A	N/A	\$85 M	Kourou
Atlas 1	9/11 81.9%	12569 lbs 5700kg	4970lbs 2255 kg	2511 lbs 1140 kg	N/A	\$65-75 M	CCAS
Atlas 2	9/9 100.0%	14500 lbs 6580 kg	6200 lbs 2810 kg	3086 lbs 1400 kg	N/A	\$60-70 M	CCAS
Atlas 2AS	8/8 100.0%	19050 lbs 8640 kg	7950 lbs 3606 kg	4604 lbs 2090 kg	N/A	\$95-105 M	CCAS, VAFB
H 2	4/4 100.0%	23000 lbs 10500 kg	8800 lbs 4000kg	4800 lbs 2200 kg	N/A	\$170-190 M	Tanegashima
Long March 3A	3/3 100.0%	15800 lbs 7200 kg	5500 lbs 2500 kg	2700 lbs 1230 kg	N/A	\$40-45 M	Xichang
Soyuz SL-4	937/944 99.3%	15400 lbs 7000 kg	N/A	N/A	N/A	\$20-25 M	Plesetsk, Tyuratam
Medium							
Delta 2 7920	4/4 100.0%	11109 lbs 5039kg	2800 lbs 1270kg	N/A	N/A	\$45-50 M	CCAS, VAFB
Delta 2 7925	35/36 97.2%	11220 lbs 5089 kg	4060 lbs 1840 kg	2000 lbs 907 kg	N/A	\$45-50 M	CCAS, VAFB
LMLV 2	N/A	4390 lbs 1990 kg	N/A	N/A	N/A	\$20 M	CCAS, VAFB
Long March 2C	14/14 100.0%	7040 lbs 3200 kg	2200 lbs 1000 kg	860 lbs 390 kg	N/A	\$15-20 M	Jiuquan
Long March 3	11/12 91.7%	11023 lbs 5000 kg	3100 lbs 1400 kg	1600 lbs 730 kg	N/A	\$35-40 M	Xichang

Characteristics of Cited Vehicles

Vehicle Designation	(Success + Partial) / Attempts	LEO 28 Degrees	GTO	GEO	Suborbital	Price per Launch (Approx.)	Launch Sites
Medium continued...							
Long March 4	2/2 100.0%	8818 lbs 4000 kg	2430 lbs 1100 kg	1220 lbs 500 kg	N/A	\$20-30 M	Taiyuan
PSLV	2/3 66.7%	6400 lbs 2900 kg	990 lbs 450 kg	N/A	N/A	N/A	Sriharikota
Titan 2	6/6 100.0%	7900 lbs 3583 kg	N/A	N/A	N/A	\$41-46 M	VAFB
Small							
Cosmos SL-8	406/410 99.0%	3100 lbs 1400 kg	N/A	N/A	N/A	\$10-14 M	Kapustin Yar, Plesetsk, Tyuratam
LMLV 1	0/1 0.0%	1755 lbs 800kg	N/A	N/A	N/A	\$16 M	CCAS,VAFB
Molniya SL-6	291/306 95.1%	3970 lbs 1800 kg	N/A	N/A	N/A	\$19 M	Plesetsk, Tyuratam
Pegasus XL	4/7 57.1%	943 lbs 428 kg	322 lbs 146 kg	181 lbs 82 kg	N/A	\$12-14 M	VAFB, Wallops Island
Rokot	1/1 100.0%	4100 lbs 1850 kg	N/A	N/A	N/A	\$54-75 M	Plesetsk, Tyuratam
START 1	3/3 100.0%	360 lbs 790 kg	N/A	N/A	N/A	\$5-10 M	Plesetsk
Taurus 1	1/1 100.0%	3100 lbs 1400 kg	990 lbs 450 kg	N/A	N/A	\$17-25 M	VAFB
VLS	N/A	440 lbs 200 kg	N/A	N/A	N/A	N/A	Alcantara

Characteristics of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in orbit	Freq. Bands & trans.	Stab.	Power
Communications										
Agila 2	Communications	N/A	GEO 155 E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
APStar 2R	Communications	N/A	GEO 76.5 E	N/A	N/A	8140 lbs / 3700 kg	N/A	15 Ku, 1 Ku	N/A	N/A
Asiasat 3	Communications	N/A	GEO 105.5 E	N/A	N/A	7656 lbs / 3480 kg	N/A	16 Ku, 28 C	N/A	N/A
Astra 1G	Communications	N/A	GEO 19.2 E	19305 nMi	19305 nMi	7260 lbs / 3300 kg	N/A	32 Ku	3-axis	N/A
Astra 2A	Communications	N/A	GEO 28.2 E	N/A	N/A	7260 lbs / 3300 kg	N/A	32 Ku	N/A	N/A
BSAT 1	Communications	N/A	GEO 110 E	19330 nMi	19305 nMi	2750 lbs / 1250 kg	N/A	4 Ku	Spin	N/A
BSAT 1 B	Communications	N/A	GEO 110 E	19330 nMi	19305 nMi	2750 lbs / 1250 kg	N/A	4 Ku	Spin	N/A
ChinaStar 1A	Communications	\$100 M	GEO 87.5 E	N/A	N/A	6600 lbs / 3000 kg	N/A	16 Ku, 4 Ku	N/A	N/A
DFH 3-2	Communications	N/A	GEO 125 E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DSCS III 3-10	Communications	N/A	GEO TBA	19326 nMi	19323 nMi	2475 lbs / 1125 kg	N/A	6 SHF	3-axis	1240 W
EchoStar 3	Communications	N/A	GEO 298.5 E	N/A	N/A	6600 lbs / 3000 kg	N/A	16 Ku	3-axis	N/A
Faisat 02V	Communications	N/A	LEO	432 nMi	432 nMi	251 lbs / 114 kg	N/A	N/A	N/A	17 W
Galaxy 8I	Communications	N/A	GEO 265 E	19330 nMi	19322 nMi	6572 lbs / 2987 kg	N/A	24 Ku, 24 C	N/A	N/A
GE 3	Communications	N/A	GEO 273 E	19375 nMi	N/A	5687 lbs / 2585 kg	N/A	24 Ku, 24 C	N/A	N/A
Globalstar 1	Communications	N/A	LEO	764 nMi	764 nMi	988 lbs / 449 kg	N/A	1 L	N/A	875 W
Globalstar 2	Communications	N/A	LEO	764 nMi	764 nMi	988 lbs / 449 kg	N/A	1 L	N/A	875 W
Globalstar 3	Communications	N/A	LEO	764 nMi	764 nMi	988 lbs / 449 kg	N/A	1 L	N/A	875 W
Globalstar 4	Communications	N/A	LEO	764 nMi	764 nMi	988 lbs / 449 kg	N/A	1 L	N/A	875 W
Hot Bird Plus 3	Communications	N/A	GEO 13 E	N/A	N/A	6380 lbs / 2900 kg	N/A	20 Ku	N/A	N/A
Hot Bird Plus 4	Communications	N/A	GEO 13 E	N/A	N/A	6380 lbs / 2900 kg	N/A	17 Ku, 2 Ku	N/A	N/A
IndoStar 1	Communications	N/A	GEO 106.1 E	N/A	N/A	2442 lbs / 1110 kg	N/A	5 S	N/A	N/A
Inmarsat 3 F4	Communications	N/A	GEO 306 E	N/A	N/A	4352 lbs / 1978 kg	N/A	2 C, 1 L,	N/A	N/A
Insat 2D	Communications	N/A	GEO 74 E	N/A	N/A	4609 lbs / 2095 kg	N/A	1 Ku, 2 Ku,	N/A	N/A
Intelsat 8 F2	Communications	N/A	GEO 174 E	N/A	N/A	8122 lbs / 3692 kg	N/A	6 Ku, 18 C,	N/A	N/A
Intelsat 8 F3	Communications	N/A	GEO 64 E	N/A	N/A	8122 lbs / 3692 kg	N/A	6 Ku, 18 C,	N/A	N/A
Iridium 1	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 2	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 3	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 4	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 5	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 6	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 7	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 8	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 9	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 10	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 11	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 12	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 13	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 14	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 15	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A

Characteristics of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in orbit	Freq. Bands & trans.	Stab.	Power
Communications										
Iridium 16	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 17	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 18	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 19	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 20	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 21	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 22	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 25	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 26	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 27	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 28	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 29	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 30	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 31	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 32	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 33	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 34	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 35	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 36	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 37	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 38	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 39	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 40	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 41	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 42	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
Iridium 43	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
JCSAT 5	Communications	N/A	GEO TBA	N/A	N/A	6820 lbs / 3100 kg	N/A	N/A	N/A	N/A
Molniya 3-49	Communications	N/A	ELI	20917 nMi	240 nMi	3850 lbs / 1750 kg	N/A	2 C	N/A	1000 W
PANSAT 1	Communications	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PAS 5	Communications	N/A	GEO 302 E	N/A	N/A	8184 lbs / 3720 kg	N/A	24 Ku, 24 C	N/A	N/A
PAS 6	Communications	N/A	GEO 317 E	N/A	N/A	6644 lbs / 3020 kg	N/A	36 Ku	N/A	N/A
SAFIR 2	Communications	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SCD 2A	Communications	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sinosat 1	Communications	N/A	GEO TBA	N/A	N/A	7683 lbs / 3492 kg	N/A	14 Ku, 24 C	N/A	N/A
Sirius 2	Communications	N/A	GEO 5.2 E	N/A	N/A	6354 lbs / 2888 kg	N/A	26 Ku, 8 Ku	N/A	N/A
Sky 1	Communications	N/A	GEO 250 E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Superbird C1	Communications	N/A	GEO 144 E	N/A	N/A	5938 lbs / 2699 kg	N/A	4 Ku, 4 Ku,	N/A	N/A
Telstar 5	Communications	N/A	GEO 267 E	N/A	N/A	7683 lbs / 3492 kg	N/A	4 Ku, 24 Ku	N/A	N/A
Thaicom 3	Communications	N/A	GEO 78.5 E	N/A	N/A	6270 lbs / 2850 kg	N/A	2 Ku, 12 Ku	N/A	N/A
Thor 2	Communications	N/A	GEO 359 E	N/A	N/A	2640 lbs / 1200 kg	N/A	15 Ku	N/A	N/A

Characteristics of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in orbit	Freq. Bands & trans.	Stab.	Power
Crewed										
Soyuz TM-26	Crewed	N/A	LEO	221 nMi	213 nMi	15587 lbs / 7070 kg	14969 lbs / 6790 kg	N/A	N/A	N/A
Development										
ETS 7	Development	\$43 M	LEO	297 nMi	297 nMi	6101 lbs / 2773 kg	N/A	N/A	3-axis	N/A
Experimental										
Gurwin 2	Experimental	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tubsat C-DLR	Experimental	N/A	LEO	540 nMi	540 nMi	N/A	N/A	N/A	N/A	N/A
Intelligence										
FORTE P94-1	Intelligence	\$30 M	LEO	432 nMi	432 nMi	141 lbs / 64 kg	N/A	N/A	N/A	N/A
Geosat Follow-On 1	Intelligence	N/A	LEO	432 nMi	422 nMi	748 lbs / 340 kg	N/A	N/A	N/A	N/A
Kosmos 2340	Intelligence	N/A	ELI	21600 nMi	324 nMi	N/A	N/A	N/A	N/A	N/A
Kosmos 2342	Intelligence	N/A	ELI	21264 nMi	278 nMi	N/A	N/A	N/A	N/A	N/A
Kosmos 2343	Intelligence	N/A	LEO	171 nMi	92 nMi	N/A	N/A	N/A	N/A	N/A
Kosmos 2344	Intelligence	N/A	MEO	1483 nMi	815 nMi	N/A	N/A	N/A	N/A	N/A
Kosmos F1-1997	Intelligence	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Meteorological										
DMSP 5D-2-F14	Meteorological	N/A	LEO	462 nMi	451 nMi	1826 lbs / 830 kg	N/A	N/A	3-axis	1000 W
FY 2-B	Meteorological	\$35 M	GEO 105 E	N/A	N/A	2640 lbs / 1200 kg	1323 lbs / 600 kg	N/A	Spin	N/A
GOES 10	Meteorological	N/A	GEO 255 E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Meteosat 7	Meteorological	\$117 M	GEO 10 E	N/A	N/A	1584 lbs / 720 kg	N/A	N/A	N/A	N/A
Navigation										
Kosmos 2341	Navigation	N/A	LEO	548 nMi	528 nMi	N/A	N/A	N/A	N/A	N/A
Navstar GPS 2-28	Navigation	N/A	MEO	10899 nMi	10899 nMi	4138 lbs / 1881 kg	N/A	1 L	N/A	N/A
Navstar GPS 2R- 2	Navigation	N/A	MEO	10899 nMi	10899 nMi	4470 lbs / 2032 kg	N/A	1 L	N/A	N/A
Navstar GPS 2R- 3	Navigation	N/A	MEO	10899 nMi	10899 nMi	4470 lbs / 2032 kg	N/A	1 L	N/A	N/A
Other										
Celestis 1	Other	N/A	LEO	314 nMi	299 nMi	N/A	N/A	N/A	N/A	N/A
Celestis 2	Other	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Remote Sensing										
CBERS/Ziyuan 1	Remote Sensing	\$75 M	LEO	420 nMi	420 nMi	3190 lbs / 1450 kg	N/A	N/A	3-axis	985 W
Earlybird 1	Remote Sensing	N/A	LEO	254 nMi	254 nMi	682 lbs / 310 kg	N/A	N/A	N/A	N/A
FASat-Bravo	Remote Sensing	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IKONOS 1	Remote Sensing	N/A	LEO	367 nMi	367 nMi	1797 lbs / 817 kg	N/A	N/A	N/A	N/A
IRS P4	Remote Sensing	N/A	LEO	497 nMi	481 nMi	2970 lbs / 1350 kg	N/A	N/A	N/A	N/A
Lewis	Remote Sensing	\$59 M	LEO	282 nMi	282 nMi	803 lbs / 365 kg	N/A	N/A	N/A	N/A
Resurs-O1 N4	Remote Sensing	N/A	LEO	451 nMi	451 nMi	6160 lbs / 2800 kg	N/A	N/A	N/A	N/A
Remote Sensing										
SACI 1	Remote Sensing	N/A	LEO	420 nMi	420 nMi	132 lbs / 60 kg	N/A	N/A	N/A	N/A
Seastar	Remote Sensing	N/A	LEO	432 nMi	432 nMi	603 lbs / 274 kg	N/A	N/A	N/A	N/A
TMSAT 1	Remote Sensing	N/A	LEO	N/A	N/A	110 lbs / 50 kg	N/A	N/A	N/A	N/A
TRMM	Remote Sensing	\$170 M	LEO	189 nMi	189 nMi	7964 lbs / 3620 kg	N/A	N/A	3-axis	N/A

Characteristics of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in orbit	Freq. Bands & trans.	Stab.	Power
Saturn										
Cassini	Saturn	\$1400 M	EXT	N/A	N/A	12773 lbs / 5806 kg	5100 lbs / 2313 kg	X	3-axis	700 W
Scientific										
ACE	Scientific	N/A	EXT	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Astrid 2	Scientific	N/A	LEO	540 nMi	540 nMi	N/A	N/A	N/A	N/A	N/A
COMETS 1	Scientific	N/A	GEO 121 E	N/A	N/A	7583 lbs / 3447 kg	N/A	1 S, 2 Ka	N/A	N/A
CRISTA SPAS 2	Scientific	N/A	LEO	162 nMi	162 nMi	N/A	N/A	N/A	N/A	N/A
Equator-S	Scientific	N/A	ELI	34398 nMi	270 nMi	550 lbs / 250 kg	N/A	N/A	N/A	N/A
Lunar Prospector	Scientific	N/A	EXT	N/A	N/A	513 lbs / 233 kg	N/A	N/A	N/A	N/A
Minisat 01	Scientific	N/A	LEO	314 nMi	303 nMi	442 lbs / 201 kg	N/A	N/A	N/A	N/A
Phase 3D	Scientific	N/A	EXT	25380 nMi	2160 nMi	1100 lbs / 500 kg	N/A	N/A	N/A	N/A
SEDSat 1	Scientific	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spartan 201-04	Scientific	N/A	LEO	168 nMi	159 nMi	2800 lbs / 1270 kg	N/A	N/A	N/A	N/A
UoSat 12	Scientific	N/A	LEO	N/A	N/A	330 lbs / 150 kg	N/A	N/A	N/A	N/A
Supply										
Progress M-34	Supply	N/A	LEO	N/A	N/A	15983 lbs / 7250 kg	N/A	N/A	N/A	N/A
Progress M-35	Supply	N/A	LEO	N/A	N/A	15983 lbs / 7250 kg	N/A	N/A	N/A	N/A
Progress M-36	Supply	N/A	LEO	N/A	N/A	15983 lbs / 7250 kg	N/A	N/A	N/A	N/A
TBA										
Kosmos 97-3Q TBA	TBA	N/A	LEO	540 nMi	540 nMi	N/A	N/A	N/A	N/A	N/A
Kosmos 97-4Q TBA	TBA	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kosmos 97-4Q TBA	TBA	N/A	TBA	N/A	N/A	N/A	N/A	N/A	N/A	N/A
USMP 4	TBA	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Titan										
Huygens	Titan	\$275 M	EXT	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Launch Events April - June 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
China								
Long March								
May 11, 1997	Long March 3A	DFH 3-2	Chinese Broadcasting Satellite Corp.	Chinese Academy of Space Technology	No	Non-Commercial	Success	Success
June 10, 1997	Long March 3	FY 2-B	Chinese Academy of Space Technology	Shanghai Institute of Satellite Engineeri	No	Non-Commercial	Success	Success
Europe (ESA)								
Ariane								
April 16, 1997	Ariane 44LP Ariane 44LP	BSAT 1 Thaicom 3	Telecommunications Advancement Org. Shinawatra Satellite Public Ltd., Co.	Hughes Aerospatiale	Yes Yes	Commercial	Success	Success
June 3, 1997	Ariane 44L Ariane 44L	Inmarsat 3 F4 Insat 2D	Inmarsat ISRO	Lockheed Martin Corp. ISRO	Yes Yes	Commercial	Success	Success
June 25, 1997	Ariane 44P	Intelsat 8 F2	Intelsat	Lockheed Martin Corp.	Yes	Commercial	Success	Success
Russia/CIS								
Cosmos								
April 17, 1997	Cosmos SL-8	Kosmos 2341	Russia/CIS MoD	NPO Prikladnoi Mekhaniki	No	Non-Commercial	Success	Success
Molniya								
April 9, 1997	Molniya SL-6	Kosmos 2340	Russia/CIS MoD	Russia/CIS MoD	No	Non-Commercial	Success	Success
May 14, 1997	Molniya SL-6	Kosmos 2342	Russia/CIS MoD	Russia/CIS MoD	No	Non-Commercial	Success	Success

Launch Events April - June 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
Russia/CIS								
Proton								
May 24, 1997	Proton SL-12	Telstar 5	AT&T	Space Systems/Loral	Yes	Commercial	Success	Success
June 6, 1997	Proton SL-12	Kosmos 2344	Russia/CIS MoD	Russia/CIS MoD	No	Non-Commercial	Success	Success
June 16, 1997	Proton SL-12	Iridium 6 Iridium 7 Iridium 8 Iridium 9 Iridium 10 Iridium 11 Iridium 12	Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc.	Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp.	Yes Yes Yes Yes Yes Yes Yes	Commercial	Success	Success
Soyuz								
April 6, 1997	Soyuz SL-4	Progress M-34	RKK Energia	RKK Energia	No	Non-Commercial	Success	Success
May 15, 1997	Soyuz SL-4	Kosmos 2343	Russia/CIS MoD	TsSKB Progress	No	Non-Commercial	Success	Success
Zenit								
May 20, 1997	Zenit 2 SL-16	Kosmos F1-1997	Russia/CIS	Russia/CIS	No	Non-Commercial	Failure	Failure

Launch Events April - June 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
USA								
Atlas								
April 25, 1997	Atlas 1	GOES 10	NOAA	Space Systems/Loral	No	Non-Commercial	Success	Success
Delta								
May 5, 1997	Delta 2 7920	Iridium 1 Iridium 2 Iridium 3 Iridium 4 Iridium 5	Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc.	Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp.	Yes Yes Yes Yes Yes	Commercial	Success	Success
May 20, 1997	Delta 2 7925	Thor 2	Telenor A.S.	Hughes	Yes	Commercial	Success	Success
Pegasus								
April 21, 1997	Pegasus XL	Celestis 1 Minisat 01	Celestis INTA	Celestis INTA	No Yes	Commercial	Success	Success
Shuttle								
April 4, 1997	Shuttle Columbia	STS 83	NASA	Rockwell International	No	Non-Commercial	Success	Partial
May 15, 1997	Shuttle Atlantis	STS 84	NASA	Rockwell International	No	Non-Commercial	Success	Success
Titan								
April 4, 1997	Titan 2	DMSP 5D-2-F14	DoD	Lockheed Martin	No	Non-Commercial	Success	Success

Future Launch Events July - December 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
Brazil							
VLS							
3rd Qtr 1997	VLS	SCD 2A	IAE	IAE	No	Non-Commercial	Alcantara
China							
Long March							
July 1997	Long March 3B	Agila 2	Mabuhay Philippine Satellite Corp.	Space Systems/Loral	Yes	Commercial	Xichang
August 1997	Long March 3B	Sinosat 1	SINO-Satellite Communications Co. Ltd.	EuraSpace	No	Non-Commercial	Xichang
August 1997	Long March 3B	APStar 2R	APT Satellite Co., Ltd.	Space Systems/Loral	Yes	Commercial	Xichang
3rd Qtr 1997	Long March 2C Long March 2C	Iridium 25 Iridium 26	Iridium, Inc. Iridium, Inc.	Lockheed Martin Corp. Lockheed Martin Corp.	Yes Yes	Commercial	Taiyuan
December 1997	Long March 3B	ChinaStar 1A	Ministry of Posts and Telecom	Lockheed Martin Corp.	No	Non-Commercial	Xichang
December 1997	Long March 4	CBERS/Ziyuan 1 SACI 1	China/Brazil INPE	National Institute for Space Research (INPE) INPE	No No	Non-Commercial Non-Commercial	Taiyuan
Europe (ESA)							
Ariane							
August 7, 1997	Ariane 44P	PAS 6	Pan American Satellite Corp.	Space Systems/Loral	Yes	Commercial	Kourou
August 29, 1997	Ariane 4-TBA	Hot Bird Plus 3 Meteosat 7	Eutelsat Eumetsat	Matra Marconi Aerospatiale	Yes No	Commercial	Kourou
September 18, 1997	Ariane 44P	Intelsat 8 F3	Intelsat	Lockheed Martin Corp.	Yes	Commercial	Kourou
October 1997	Ariane 44L	IndoStar 1 Sirius 2	PT MediaCitra IndoStar Nordiska Satellitaktiebolaget (NSAB)	CTA Space Systems Aerospatiale	Yes Yes	Commercial	Kourou
October 1997	Ariane 5	Phase 3D	Amsat	Amsat DL	No	Non-Commercial	Kourou

Future Launch Events July - December 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
Europe (ESA)							
Ariane continued...							
November 1997	Ariane 44P	Equator-S JCSAT 5	NASA/DARA Japan Satellite Systems (JSAT)	Max Planck Institute Hughes	No Yes	Commercial	Kourou
December 1997	Ariane 4-TBA	BSAT 1 B Hot Bird Plus 4	Telecommunications Advancement Org. Eutelsat	Hughes Matra Marconi	Yes Yes	Commercial	Kourou
India							
PSLV							
November 1997	PSLV	IRS P4	ISRO	ISRO	No	Non-Commercial	Sriharikota
Japan							
H							
August 17, 1997	H 2	COMETS 1	NASDA	Toshiba	No	Non-Commercial	Tanegashima
October 31, 1997	H 2	ETS 7 TRMM	NASDA NASDA/NASA	Toshiba NASA Goddard Space Flight Center	No No	Non-Commercial	Tanegashima
Russia/CIS							
Cosmos							
3rd Qtr 1997	Cosmos SL-8	Kosmos 97-3Q TBA Tubsat C-DLR	Russia/CIS Technical University of Berlin	Russia/CIS Technical University of Berlin	No Yes	Non-Commercial	Plesetsk
4th Qtr 1997	Cosmos SL-8	Astrid 2 Faisat 02V Kosmos 97-4Q TBA	Swedish National Space Board Final Analysis Inc. Russia/CIS	Swedish Space Corp. Final Analysis Inc. Russia/CIS	No No No	Non-Commercial	Plesetsk
Molniya							
4th Qtr 1997	Molniya SL-6	Molniya 3-49	Russia/CIS PTT	NPO Prikladnoi Mekhaniki	No	Non-Commercial	Plesetsk

Future Launch Events July - December 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
Russia/CIS							
Proton							
July 31, 1997	Proton SL-12	PAS 5	Pan American Satellite Corp.	Hughes	Yes	Commercial	Tyuratam
September 1997	Proton SL-12	Iridium 27 Iridium 28 Iridium 29 Iridium 30 Iridium 31 Iridium 32 Iridium 33	Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc.	Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp.	Yes Yes Yes Yes Yes Yes Yes	Commercial	Tyuratam
September 1997	Proton SL-12	Sky 1	American Sky Broadcasting	Space Systems/Loral	Yes	Commercial	Tyuratam
October 1997	Proton SL-12	Astra 1G	Societe Europeenne des Satellites (SES)	Hughes	Yes	Commercial	Tyuratam
November 1997	Proton SL-12	Asiasat 3	Asia Satellite Telecommunications Co Ltd	Hughes	Yes	Commercial	Tyuratam
December 1997	Proton SL-12	Astra 2A	Societe Europeenne des Satellites (SES)	Hughes	Yes	Commercial	Tyuratam
Rokot							
4th Qtr 1997	Rokot	Kosmos 97-4Q TBA UoSat 12	Russia/CIS Surrey Satellite Technology Ltd.	Russia/CIS Surrey Satellite Technology	No No	Non-Commercial	Svobodny
Soyuz							
July 5, 1997	Soyuz SL-4	Progress M-35	RKK Energia	RKK Energia	No	Non-Commercial	Tyuratam
August 5, 1997	Soyuz SL-4	Soyuz TM-26	RKK Energia	RKK Energia	No	Non-Commercial	Tyuratam
4th Qtr 1997	Soyuz SL-4	Progress M-36	RKK Energia	RKK Energia	No	Non-Commercial	Tyuratam
Start							
September 1997	START 1	Earlybird 1	Earthwatch, Inc.	CTA Space Systems	Yes	Commercial	Svobodny

Future Launch Events July - December 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
Russia/CIS							
Zenit							
July 1997	Zenit 2 SL-16	FASat-Bravo Gurwin 2 Resurs-O1 N4 SAFIR 2 TMSAT 1	Chilean Air Force Asher Space Research Institute Russia/CIS OHB System Thai MicroSatellite Co.	Surrey Satellite Technology Limited Technion Institute of Technology VNI Elektromekhaniki OHB System Surrey Satellite Technology	No No No No Yes	Non-Commercial	Tyuratam
USA							
Atlas							
July 25, 1997	Atlas 2AS	Superbird C1	Space Communications Corp.	Hughes	Yes	Commercial	CCAS
August 27, 1997	Atlas 2AS	GE 3	GE Americom	Lockheed Martin Corp.	Yes	Commercial	CCAS
September 25, 1997	Atlas 2AS	EchoStar 3	EchoStar Satellite Corp.	Lockheed Martin Astro Space	Yes	Commercial	CCAS
October 24, 1997	Atlas 2	DSCS III 3-10	DoD	Lockheed Martin Corp.	No	Non-Commercial	CCAS
November 24, 1997	Atlas 2AS	Galaxy 8I	Hughes Communications Inc.	Hughes	Yes	Commercial	CCAS
Delta							
July 9, 1997	Delta 2 7920	Iridium 13 Iridium 14 Iridium 15 Iridium 16 Iridium 17	Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc.	Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp.	Yes Yes Yes Yes Yes	Commercial	VAFB
July 23, 1997	Delta 2 7925	Navstar GPS 2-28	DoD	Rockwell International	No	Non-Commercial	CCAS
August 19, 1997	Delta 2 7920	Iridium 18 Iridium 19 Iridium 20 Iridium 21 Iridium 22	Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc.	Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp.	Yes Yes Yes Yes Yes	Commercial	VAFB
August 25, 1997	Delta 2 7925	ACE	NASA	NASA	No	Non-Commercial	CCAS

Future Launch Events July - December 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
USA							
Delta continued...							
November 8, 1997	Delta 2 7920	Iridium 34 Iridium 35 Iridium 36 Iridium 37 Iridium 38	Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc.	Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp.	Yes Yes Yes Yes Yes	Commercial	VAFB
November 13, 1997	Delta 2 7925	Navstar GPS 2R- 3	DoD	Lockheed Martin Corp.	No	Non-Commercial	CCAS
December 4, 1997	Delta 2 7925	Globalstar 1 Globalstar 2 Globalstar 3 Globalstar 4	Globalstar, Inc. Globalstar, Inc. Globalstar, Inc. Globalstar, Inc.	Space Systems/Loral Space Systems/Loral Space Systems/Loral Space Systems/Loral	Yes Yes Yes Yes	Commercial	CCAS
December 18, 1997	Delta 2 7920	Iridium 39 Iridium 40 Iridium 41 Iridium 42 Iridium 43	Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc. Iridium, Inc.	Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp. Lockheed Martin Corp.	Yes Yes Yes Yes Yes	Commercial	VAFB
December 22, 1997	Delta 2 7925	Navstar GPS 2R- 2	DoD	Lockheed Martin Corp.	No	Non-Commercial	CCAS
LMLV							
August 7, 1997	LMLV 1	Lewis	NASA	TRW	No	Commercial	VAFB
September 24, 1997	LMLV 2	Lunar Prospector	NASA	Lockheed Martin Corp.	No	Non-Commercial	CCAS
December 1, 1997	LMLV 2	IKONOS 1	Space Imaging Inc.	Locheed Martin	No	Commercial	VAFB
Pegasus							
August 1, 1997	Pegasus XL	Seastar	Orbital Sciences Corp. (OSC)	Orbital Sciences Corp. (OSC)	No	Commercial	VAFB
August 28, 1997	Pegasus XL	FORTE P94-1	DoD	Los Alamos National Laboratory	No	Non-Commercial	VAFB

Future Launch Events July - December 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
USA							
Shuttle							
July 1, 1997	Shuttle Columbia	STS 83R/94	NASA	Rockwell International	No	Non-Commercial	KSC
August 7, 1997	Shuttle Discovery	CRISTA SPAS 2 SEDSat 1 STS 85	NASA/DARA NASA NASA	MBB Erno University of Alabama in Huntsville Rockwell International	No No No	Non-Commercial	KSC
September 18, 1997	Shuttle Atlantis	STS 86	NASA	Rockwell International	No		
November 20, 1997	Shuttle Columbia	STS 87 Spartan 201-04 USMP 4	NASA NASA NASA	Rockwell International NASA NASA	No No No	Non-Commercial	KSC
Taurus							
November 1, 1997	Taurus 1	Celestis 2 Geosat Follow-On 1	Celestis DoD	Celestis Ball Aerospace	Yes No	Commercial	VAFB
Titan							
October 6, 1997	Titan 4B/Centaur	Cassini Huygens	NASA European Space Agency (ESA)	Jet Propulsion Laboratory Aerospatiale	No No	Non-Commercial	CCAS