

## Commercial Space Transportation

# QUARTERLY LAUNCH REPORT

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



### 4th Quarter 1997

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

## 4TH QUARTER 1997 REPORT

### 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:** Orbital Sciences Corporation (1997). Image is of the Pegasus XL that launched August 1, 1997. It successfully orbited the OrbView 2 (Seastar) remote sensing satellite.

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**SUMMARY**

**Third Quarter 1997  
Launch Events**

- There were 13 United States launches in the third quarter of 1997. Six were non-commercial (a Pegasus, two Delta, and three Shuttle) and seven were commercial (two Atlas, three Delta, a Pegasus, and an Athena 1). All of these launches were successful with the Athena 1 (formerly the LMLV 1) vehicle returning to flight after its initial launch failure.
- Russian Republic/CIS launches totaled seven. Five were non-commercial and two were commercial. The non-commercial launches were on a Proton, a Cosmos, two Soyuz, and a Molniya. The two commercial launches were on Proton. All of the Russian launches were successful.
- Europe lofted three commercial comsats and a non-commercial meteorological satellite on three commercial launches of the Ariane 4.
- China successfully launched two Iridium test articles and a commercial communication satellite (returning the Long March 3B to flight status).
- India's PSLV was partially successful in launching a non-commercial remote sensing satellite.

**Fourth Quarter 1997  
First Quarter 1998  
Scheduled Launch Events**

- United States launch vehicles will attempt 34 launches in the next two quarters (17 launches will be commercial and 17 non-commercial). Commercial launches will include five Atlas, six Delta, two Athena (an Athena 1 and an Athena 2), a Taurus, and three Pegasus. The non-commercial launches will consist of two Atlas, three Delta, one Athena, and three Pegasus launches as well as two Shuttle, one Taurus, one Titan 2, and four Titan 4 launches.
- The Russian Republic/CIS will conduct 11 launches. Six are to be commercial and five non-commercial. Five commercial launches are projected for Proton and one for START-1. Non-commercial launches will include four Soyuz, and one Zenit.
- Europe plans six commercial Ariane 4 launches with ten satellites (one payload is not commercial) and one Ariane 5 non-commercial development flight.
- China intends to make six launches with its Long March vehicles (four commercial and two non-commercial).
- Japan intends to make two non-commercial launches on the H 2 carrying three non-commercial 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

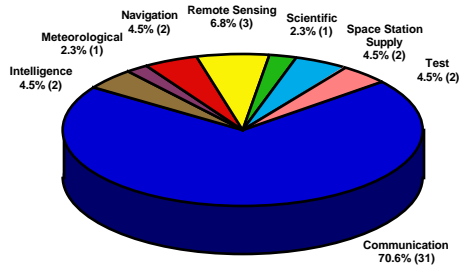
Fourth Quarter 1997  
First Quarter 1998

Florida Spaceport and Lunar Prospector

The planned launch of NASA's Lunar Prospector spacecraft this fourth quarter represents growth in commercial space operations. As a member of NASA's low cost Discovery Class scientific program, Lunar Prospector was designed by a contractor with a minimum of NASA input in a short time and on a tight budget. It will be the first payload launched on Lockheed Martin's Athena 2 intermediate class launch vehicle. Athena (formerly Lockheed Martin Launch Vehicle, or LMLV) is a commercially developed family of launch vehicles. Finally, the Lunar Prospector will be the first payload launched from a US-licensed commercial launch facility, the Florida Spaceport.

Payload Use Analysis

Third Quarter 1997



Forty-four payloads were launched in the Third Quarter of 1997. These payloads were divided between communication (70.6 percent), intelligence (4.5 percent), navigation (4.5 percent), test (4.5 percent), scientific (2.3 percent), space station supply (4.5 percent), meteorological (2.3 percent) and remote sensing (6.8 percent).

Communication payloads constituted all of the 29 internationally competed payloads on commercial launches.

LAUNCH SCHEDULE

Scheduled Launch Events

Vehicle	Payload	Site
<b>OCTOBER 1997</b>		
Atlas 2	DSCS III 3-10	CCAS
Atlas 2AS	EchoStar 3	CCAS
Delta 2 7925	Navstar GPS 2R-2	CCAS
Long March 3B	APStar 2R	Xichang
Long March 3B	Sinosat 1	Xichang
Soyuz SL-4	Progress M-36	Tyuratam
Soyuz SL-4	Foton N-11	Tyuratam
	Mirka	
START 1	Earlybird 1	Svobodny
Titan 4	USA 1997-10	VAFB
Titan 4B/Centaur	Cassini	CCAS
	Huygens	
<b>NOVEMBER 1997</b>		
Ariane 44L	IndoStar 1	Kourou
	Sirius 2	
Ariane 44P	JCSAT 5	Kourou
	Equator-S	
Athena 2	Lunar Prospector	CCAS
Atlas 2AS	Galaxy 8I	CCAS
Delta 2 7920	Iridium 39	VAFB
	Iridium 40	
	Iridium 41	
	Iridium 42	
	Iridium 43	
Delta 2 7925	Navstar GPS 2R-3	CCAS
H 2	ETS 7	Tanegashima
	TRMM	
Proton SL-12	Asiasat 3	Tyuratam
Proton SL-12	Astra 1G	Tyuratam
Shuttle Columbia	STS 87	KSC
	Spartan 201-04	
	USMP 4	
Titan 4/Centaur	USA 1997-11	CCAS

**LAUNCH SCHEDULE**

**Scheduled Launch Events**

(Continued)

<b>Vehicle</b>	<b>Payload</b>	<b>Site</b>
<b>DECEMBER 1997</b>		
Ariane 44P	Intelsat 8 F4	Kourou
Athena 2	IKONOS 1	VAFB
Atlas 2A	DSCS III 3-11	CCAS
Delta 2 7920	Iridium 44	VAFB
	Iridium 45	
	Iridium 46	
	Iridium 47	
	Iridium 48	
Delta 2 7925	Globalstar 1	CCAS
	Globalstar 2	
	Globalstar 3	
	Globalstar 4	
Delta 2 7925	Navstar GPS 2R- 4	CCAS
Long March 2C	Iridium 25	VAFB
	Iridium 26	
Long March 3B	ChinaStar 1A	Xichang
Proton SL-12	Astra 2A	Tyuratam
Soyuz SL-4	Progress M-37	Tyuratam
<b>JANUARY 1998</b>		
Ariane 4-TBA	Inmarsat 3 F5	Kourou
	Brazilsat B3	
Atlas 2	GBS 8	CCAS
Atlas 2A	Eutelsat 3 F 1	CCAS
Delta 2 7920	Argos	VAFB
	Oersted	
	Sunsat	
Delta 2 7920	Iridium 49	VAFB
	Iridium 50	
	Iridium 51	
	Iridium 52	
	Iridium 53	
Delta 2 7925	Skynet 4D	CCAS
Proton SL-12	EchoStar 4	Tyuratam
Shuttle Discovery	STS 89	KSC
Soyuz SL-4	Soyuz TM-27	Tyuratam

**LAUNCH SCHEDULE**

**Scheduled Launch Events**

(Continued)

<b>Vehicle</b>	<b>Payload</b>	<b>Site</b>
<b>FEBRUARY 1998</b>		
Ariane 4-TBA	BSAT 1 B Hot Bird Plus 4	Kourou
Delta 2 7925	Globalstar 5 Globalstar 6 Globalstar 7 Globalstar 8	CCAS
Titan 2	NOAA K	VAFB
<b>MARCH 1998</b>		
Atlas 2AS	Sky 2	CCAS
Titan 4B/Centaur	USA 1998-03	CCAS



LAUNCH SCHEDULE

For the Third Quarter 1997 and  
First Quarter 1998

Additional Launch Events to be  
Announced<sup>†</sup>

Vehicle	Payload	Site
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**FOURTH QUARTER OF 1997**

Ariane 5	Maqsat H Teamsat 1	Kourou
Pegasus XL	Orbcomm 05 Orbcomm 06 Orbcomm 07 Orbcomm 08 Orbcomm 09 Orbcomm 10 Orbcomm 11 Orbcomm 12	VAFB
Pegasus XL	SNOE	VAFB
Pegasus XL	BATSAT	Wallops
Rokot	STEP 4 Kosmos 97RokotTBA	Svobodny
Taurus 1	UoSat 12 Celestis 2 Geosat Follow-On 1 Orbcomm 03 Orbcomm 04	VAFB
Taurus 1	STEX	VAFB
VLS	SCD 2A	Alcantara
Zenit 2 SL-16	FASat-Bravo Gurwin 2 Resurs-O1 N4 SAFIR 2 TMSAT 1	Tyuratam

**FIRST QUARTER OF 1998**

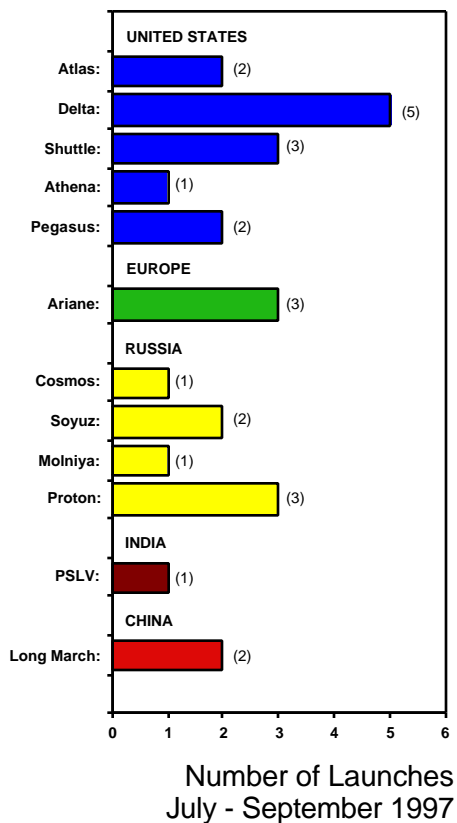
Ariane 4-TBA	PAS 7	Kourou
Athena 1	Clark	VAFB
H 2	COMETS	Tanegashima
Long March 2C	Iridium 54 Iridium 55	Taiyuan
Long March 3B	APMT 1	Xichang
Pegasus XL	Orbcomm 13 Orbcomm 14 Orbcomm 15 Orbcomm 16 Orbcomm 17 Orbcomm 18 Orbcomm 19 Orbcomm 20	VAFB
Pegasus XL	SCD 2	VAFB
Pegasus XL	TRACE	VAFB
Proton SL-12	Tempo 1	Tyuratam

<sup>†</sup> 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

Third Quarter 1997



In the third quarter of 1997, the United States conducted half of the 26 launches that occurred worldwide. Of these 13 launch events, seven were commercial, three were on Delta with Iridium payloads (three sets of five satellites), two on Atlas with GEO communications satellites, and one on Pegasus with a remote sensing payload. Another remote sensing payload, NASA's Lewis, was launched on the second (the first successful) Athena 1 (formerly the LMLV 1). Unfortunately, Lewis began to spin out of control and was destroyed six days after launch after re-entering the atmosphere. The six United States non-commercial launches included three Shuttle missions, two Delta (carrying navigation and scientific satellites) and a Pegasus with an intelligence payload.

There were seven Russian Republic/CIS launches. Two of these launches were commercial Protons, one carrying seven Iridium satellites and the other a GEO communications satellite. The five non-commercial launches were a Soyuz and a Progress Mir mission on Soyuz boosters, a navigation satellite and Faisat 2V on a Cosmos booster, a Proton with an intelligence payload, and a communication satellite launched on a Molniya.

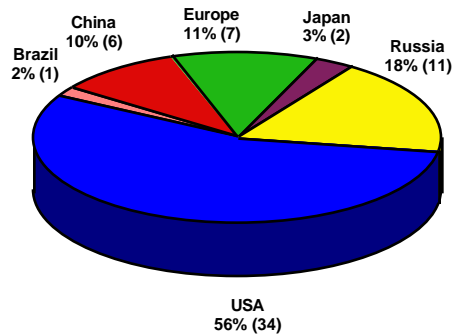
Europe's Ariane 4 launch vehicle made three launches putting three commercial communication satellites in GEO along with the non-commercial Meteosat 7 meteorological satellite.

China returned the Long March 3B to flight with a successful launch of a commercial communications satellite and conducted a successful test launch of a Long March 2C with Iridium test articles.

LAUNCH REPORT

Scheduled Launch Events

Fourth Quarter 1997 and First Quarter 1998



Scheduled Launch Events, by Region  
October 1997 - March 1998

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

In the Fourth Quarter of 1997 and the first Quarter of 1998, 61 launch events are planned. Of these, the United States will conduct 34, Russia 11, and Europe seven. Brazil's VLS will conduct one launch, Japan's H 2 two, and China's Long March six.

The United States will conduct 34 launches in this period. Seven launches will be on Atlas vehicles, all with communication payloads. Nine are on Delta with six communication, two navigation, and one scientific payload. An Athena 1 will launch a remote sensing satellite and two Athena 2 flights will carry a remote sensing and a scientific payload. Pegasus will launch six times with three communication, two scientific, and one development payload. Taurus will be used twice launching a development payload and another multiple payload launch with an intelligence, two communication, and an funerary payload. There will also be two shuttle missions, one Titan 2 with a meteorological satellite and four Titan 4s, one with the Cassini planetary probe and three with classified payloads.

The Russian Republic/CIS plans 11 launches with five Proton launches of communication satellites, one crewed and two supply flights to Mir on Soyuz vehicle as well as a fourth Soyuz micro gravity flight. A Zenit will launch multiple smallsats as well as a Resurs remote sensing satellite. A START 1 will also launch a remote sensing payload.

Europe's Ariane 5 will return to flight with a number of test payloads and there will be six Ariane 4 launches with nine communication and one scientific satellite.

China intends to launch six Long March vehicles with communication payloads.

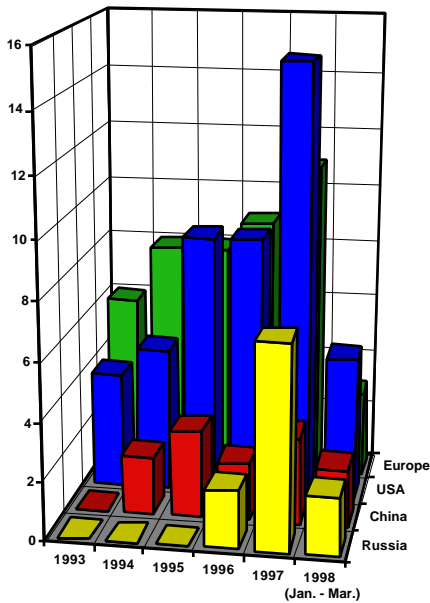
Japan will launch a scientific, a remote sensing, and a technology development payload on two H 2 launch vehicles.

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

LAUNCH REPORT

Scheduled Commercial Launch Events

Forth Quarter 1997 and First Quarter 1998



Commercial Launch Events  
January 1993 - March 1998  
(Small Vehicles Excluded)

Of the 61 worldwide launches expected in the next two quarters, 33 will be commercial. The United States will have half of these with 17 commercial launches. Two of these commercial launches will be remote sensing satellites on Athena launch vehicles (an Athena 1 and an Athena 2). Delta vehicles will launch six times with communication payloads (five launches will carry multiple communication satellite payloads to LEO orbits). Five Atlas launches will carry GEO communication satellites and three Pegasus vehicles will be launched with communication payloads. Finally, a Taurus will launch an intelligence, two LEO communications and a funerary satellite.

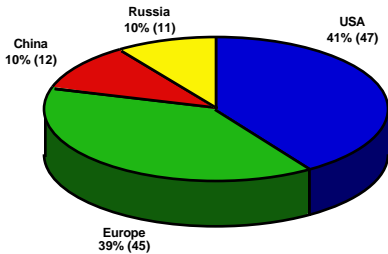
Europe anticipates six commercial launches of the Ariane 4, placing nine communication satellites in GEO and also launching a science satellite as a secondary payload.

The Russian Republic/CIS intends to conduct six commercial launches. On one of these launches, a START launch vehicle will loft the EarlyBird remote sensing satellite. The remaining five launches are all on Proton launch vehicles with GEO communication satellites as payloads.

China's four commercial launches will be split evenly between GEO and LEO payloads with two launches of GEO communication satellites and two launches with two Iridium LEO communication satellites each.

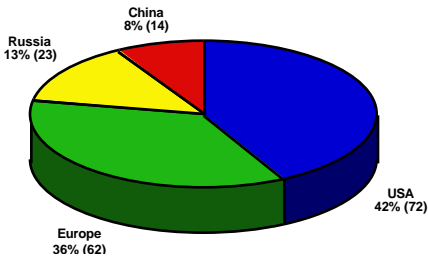
LAUNCH REPORT

Commercial Launch Trends



Commercial Launch Market Trend  
January 1993 - March 1998

(Small Vehicles Excluded)



Internationally Competed Payloads  
Market Trend  
January 1993 - March 1998

(Small Vehicles Excluded)

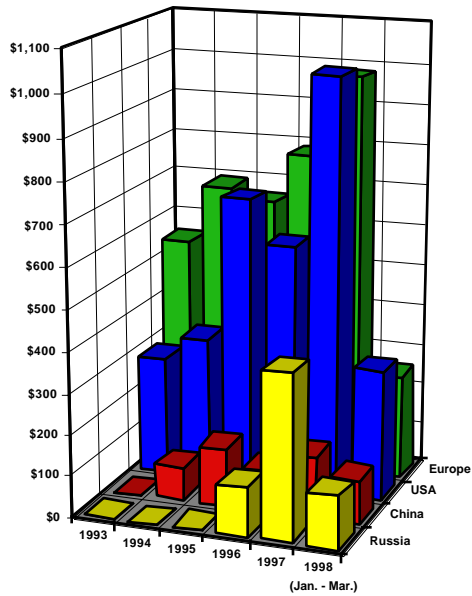
Between January 1993 and March of 1998, 117 commercial launch events (excluding small launch vehicles) are projected. The United States share of these is 41 percent (or 47 launches). In internationally competed payloads, the United States will have launched 72 of 171 for a 42 percent share.

Europe's portion is 45 launches for a 39 percent share, and 62 payloads or 36 percent of the total. China is expected to launch 12 times with 14 payloads for an eight percent share of internationally competed payloads and a ten percent share of launches. The Russian Republic/CIS should have conducted 11 commercial launches for a ten percent share and deployed 23 internationally competed payloads (13 percent of the total).

In the period covered by this report, July 1997 through March 1998, there are expected to be 38 commercial launches (excluding small vehicles) with 80 internationally competed payloads (on commercial, but not small, launchers). Forty-five percent of these launches (17) and 60 percent of payloads (48) are to be launched by the United States. Europe plans 9 launches (24 percent) and 12 payloads (15 percent). China's share is five launches (13 percent) and seven payloads (nine percent) while Russia's plans include 13 payloads on seven vehicles for 16 percent of payloads and 18 percent of launches.

LAUNCH REPORT

Commercial Launch Revenues



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

January 1993 - March 1998

\* 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 \$2,551.5 million worldwide. Revenues for the first quarter of 1998 are projected to be \$811.5 million.

The United States will have a 39-percent share of revenues between January 1993 and March 1998 with \$2,998 million and Europe will have 44-percent with \$3,383 million. The Russian Republic/CIS holds an estimated 9-percent share with \$651 million and China will have a six-percent share with \$582 million.

United States revenues remain stable over the past two years and into the first quarter of 1998 at approximately 40 percent. China and Russia's revenues have increased over this period at the expense of Europe's Arianespace.

## TRENDS IN SATELLITE MASS AND HEAVY LIFT LAUNCH VEHICLES

### Growth Trends in Commercial Satellite Mass

The size of commercial GEO satellites has steadily grown as a result of the telecommunications market demanding more satellites with higher power and more transponders. Many analysts within the satellite manufacturing and launch industries see this trend continuing.

In 1996, the Commercial Space Transportation Advisory Committee (COMSTAC) was split among two possible scenarios for the growth in satellite mass over the next decade: either satellite mass growth would plateau or it would continue to rise.

By 1997, COMSTAC concluded that commercial GEO satellites would likely continue to grow in size and mass and that heavy commercial GEO satellites would comprise a larger proportion of the market than had initially been predicted. Satellites heavier than 9,000 pounds to GTO are expected to increase from about 10 percent of the market today to approximately 50 percent by 2010 (see Figure 1). This trend, according to COMSTAC, will result in a corresponding percentage reduction in the intermediate market segment (satellites weighing 4,000 to 9,000 pounds).

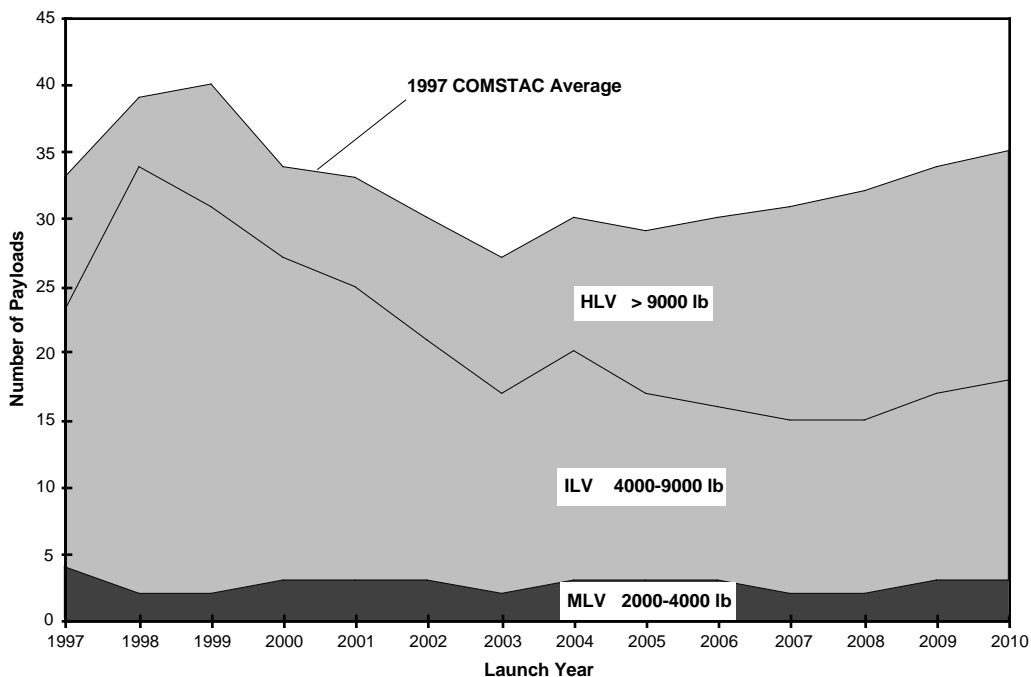


Figure 1. Forecast Trends in Annual GTO Payload Mass Distribution (1997 - 2010)<sup>1</sup>

<sup>1</sup> Commercial Space Transportation Advisory Committee, *Commercial Spacecraft Mission Model Update*, May 1997, p. 6.

The heaviest of the “heavy” commercial GEO satellites could weigh as much as 11,000 pounds from 1998-2000, and may exceed 15,000 pounds in the future.

In another analysis conducted by The Aerospace Corporation, the top 25 percent of satellites are projected to have GTO weights close to 10,000 pounds by the year 2000, and may reach 13,000 to 14,000 pounds by 2010

(see Figure 2). This represents a payload mass trend that is more or less consistent with historical growth rates.

There are a number of factors favoring continued mass growth. Satellites with larger numbers of transponders tend to be more cost effective. Also, increased power needed for multiple spot beams or phased array antennas increases the mass of batteries and other supporting systems. However, satellite growth may be constrained if satellite operators deem the risks associated with the premature loss of a high-cost satellite (due to a launch failure or in-orbit failure) to be too high. Another limiting factor is that satellite manufacturers typically compete to meet the customer requirements at the lowest cost, often with a smaller satellite mass.

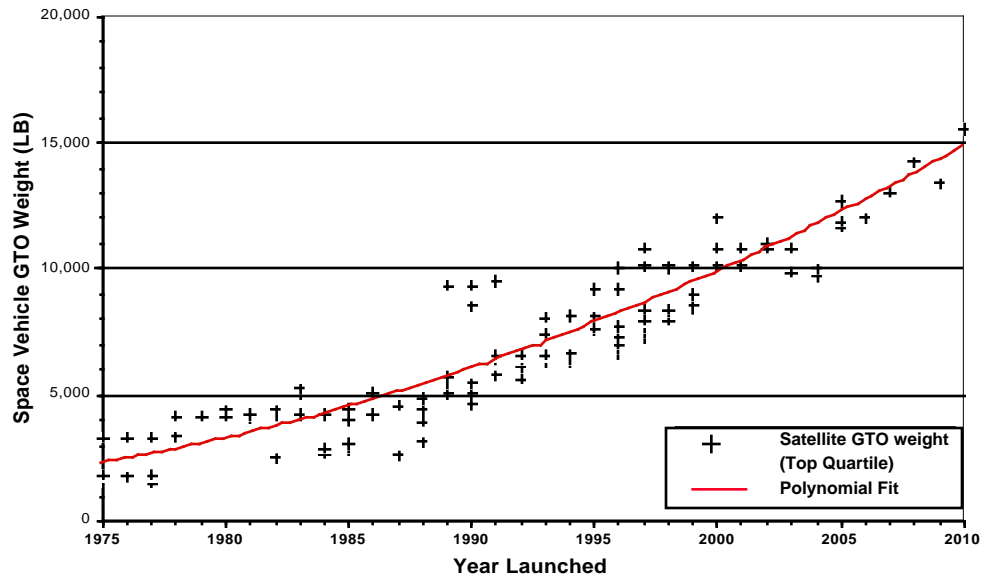


Figure 2. GTO Communications Satellite Weight Growth Trend<sup>2</sup>

## Launch Service Providers Increasing Lift Capacity

The world’s launch service providers are planning increased lift capacity into their range of services to enable the growth of the heavy-lift commercial market. However, as Table 1 shows (below), the majority of the proposed near term vehicle upgrades (particularly those of the United States) do not sufficiently address the full range of heavy satellite masses identified in this year's COMSTAC report.

In the long term, alternative technologies such as reusable orbital transfer vehicles may also be available to augment the performance of comparatively smaller launch vehicles by ferrying payloads from low earth orbit. The plans for adding capacity to the various GEO-capable launch systems are outlined below.

<sup>2</sup> The Aerospace Corporation, *Future Spacelift Requirements Study*, 1997



# Special Report

## Atlas

Lockheed Martin's International Launch Services is planning increased capacity into its next upgrade of the Atlas launch vehicle, the Atlas 2AR. With a new first stage utilizing the Russian-designed RD-180 engine, Atlas 2AR will be able to lift close to 8,900 pounds. When strap-on solid boosters are added, the capacity increases to nearly 9,500 pounds. The capacity of the standard Atlas 2AR configuration represents an increase over the initial estimated capacity of just over 8,400 pounds, since capacity held in reserve for launch system components during the vehicle's early development stage was not needed.

The most powerful active version of the Atlas launch vehicle, the Atlas 2AS, can currently lift up to 7,950 pounds to GTO. Although the current and proposed Atlas vehicles may not be able to address all of the future heavy-class payloads discussed above, Lockheed Martin is planning a new family of launch vehicles for the Air Force's Evolved Expendable Launch Vehicle (EELV) competition. This vehicle, if developed, will also use the new RD-180 engine.

## Delta

The decision to build the Delta 3 launch vehicle was initiated specifically to address the growing demand in the intermediate launch market, and

**Table 1. GEO-Capable Launch Vehicles in Use and Under Development**

Vehicle Family	Designation	Intro. Year	Maximum GTO Capacity (lbs.)
<b>UNITED STATES</b>			
Atlas 2	Atlas 2 AS	1993	7,950
Atlas 2	Atlas 2 AR	1998	8,900
Atlas 2	Atlas 2 ARS	2000	9,500
Lockheed Martin EELV	EELV (intermediate)	2003/2005	10,000*
Lockheed Martin EELV	EELV (heavy)	2003/2005	33,000*
Delta 2	Delta 2 7925	1990	4,060
Delta 3	Delta 3	1998	8,400
Delta 4/EELV	EELV (small)	2003/2005	4,800
Delta 4/EELV	EELV (intermediate)	2003/2005	10,000
Delta 4/EELV	EELV (heavy)	2003/2005	33,000
Shuttle		1981	13,000
Venturestar	Venturestar	2003/2004	14,850
<b>EUROPE (ESA)</b>			
Ariane 4	Ariane 44L	1989	9,965
Ariane 5	Ariane 5 (initial version)	1996	13,000
Ariane 5	Ariane 5 (planned 2005 upgrade)	2005	17,600
<b>RUSSIA</b>			
Proton	Proton/Block DM	1967	9,870
Proton	Proton M/Breeze	1998	12,125
<b>UKRAINE</b>			
Zenit	Zenit 3 (w/ Block DM)	1998	13,000
<b>CHINA</b>			
Long March	Long March 3	1984	3,100
Long March	Long March 2E	1990	7,430
Long March	Long March 3B	1996	9,900
<b>JAPAN</b>			
H 2	H 2	1994	8,800
H 2	H 2A (w/liquid booster strap-ons)	2001	13,200

\* Estimated based on EELV requirements

# Special Report

SR-4

will be capable of delivering about 8,400 pounds to GTO. This new Delta vehicle will effectively have twice the launch capacity of the Delta 2, already in operation.

## Ariane

Arianespace is already planning upgrades to the Ariane 5 launch vehicle, which is designed to carry a total of 13,000 to GTO for dual payloads. A number of upgrades are planned to increase the capacity of the Ariane 5 so that it can still conduct dual payload launches with heavier satellites. Capabilities of about 15,400 pounds are planned for 2000, and 16,280 pounds by 2002. Arianespace has announced more recently that it plans capacities of up to 17,600 pounds for dual payloads by 2005.<sup>3</sup> By comparison, the most powerful version of the Ariane 4 currently available, the Ariane 44L, can deliver 9,965 pounds to GTO.

## Proton

Russia's Proton launch vehicle is currently capable of delivering 9,870 pounds to GTO with its Block DM upper stage. The planned Proton M launch vehicle will be capable of delivering 12,125 pounds to GTO using the Breeze upper stage. The Proton M is scheduled to make its first flight in mid-1998, with commercial flights to follow.

## Long March

The Chinese Long March family of vehicles are currently capable of delivering payloads of a variety of sizes into GTO. The largest booster, the Long March 3B, is designed to place 9,900

pounds into that orbit. As of late 1996, trade press reports indicated that China was considering an oxygen-hydrogen propulsion system for a new Ariane 5-class vehicle, as well as a kerosene-oxygen propulsion system based upon technology purchased from Russia. No timetable for these programs was available.<sup>4</sup>

## H 2

Japan's H 2 launch vehicle is currently capable of delivering 8,800 pounds to GTO. The first upgrade to the H 2, the H 2A, will not add capacity but is, instead, intended to lower the cost of the booster and make it more commercially competitive. Further upgrades to the H 2A include a liquid strap-on booster system that would increase the GTO capacity to 13,200 pounds. The first H 2A is expected to launch in 2000, and the upgraded H 2A is expected around 2001.<sup>5</sup>

## Sea Launch

The Boeing-led partnership to launch the Ukrainian built Zenit launcher from an off-shore platform is expected to enter into service in late 1998. From its equatorial launch site in the Pacific Ocean, the Zenit booster with the Block DM upper stage (also used on the Proton) will be able to loft 13,000 pounds to GTO.

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<sup>3</sup> "Arianespace Looks Ahead," *Aviation Week & Space Technology*, August 25, 1997, p. 65.

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<sup>4</sup> "Chinese Manned Flight Set for 1999 Liftoff," *Aviation Week & Space Technology*, October 21, 1996, p. 22.

<sup>5</sup> NASDA

## Options for the Future

### *Old and New Boosters*

In addition to the current family of launchers and their planned evolutions, there are still more alternatives for delivering payloads to geosynchronous orbit. While it is currently not authorized to carry commercial satellites, the Space Shuttle could, in principle, be used to launch commercial satellites, possibly as a privatized launch system during the next decade. The Shuttle is capable of deploying about 13,000 pounds to GTO. The X-33/Venturestar program plans to be able to launch roughly 14,850 pounds to GTO by 2003 or 2004.

### *Advanced Orbit Transfer Techniques*

Another possible solution to the problem of getting large spacecraft into geosynchronous orbit would be to use a launcher only large enough to deliver the payload into low earth orbit and then rely on *reusable orbit transfer vehicles* to ferry payloads from low earth orbit into the higher geosynchronous orbit. The payload could then be launched into LEO on a small launch vehicle and for a lower cost.

Phillips Laboratory and NASA are developing solar thermal propulsion technologies which could lead to an operational orbital transfer vehicle. Solar thermal propulsion uses deployable mirrors which focus sunlight to heat the propellant, rather than using combustion. Other non-conventional orbit transfer techniques such as those involving tethers could be used. A system using a payload attached to a platform in low earth orbit by a tether could transfer momentum from the platform to the payload. A series of such

devices could deliver a payload to GEO without having to use the payload's onboard propellant. These systems have the potential to reduce the cost of GEO launches if they can be developed successfully and economically.

## 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
APMT.....	Asia Pacific Mobile Telecommunications
APT.....	Asia Pacific Telecommunications
BSAT.....	Broadcast Satellite System Corp. Satellite
CAST.....	Chinese Academy of Space Technology
CBERS.....	China Brazil Earth Resources Satellite
CCAS.....	Cape Canaveral Air Station
CRISTA SPAS.....	Cryogenic Infrared Spectrometer telescope for Atmosphere-Space Pallet Satellite
CIS.....	Commonwealth of Independent States
DARA.....	German Space Agency
DASA.....	Deutsche Aerospace
DMSP.....	Defense Meteorological Support Program
DoD.....	Department of Defense
DoT.....	Department of Transportation
DSCS.....	Defense Satellite Communications System
DSP.....	Defense Support Program
ELI.....	Elliptical
ELINTS.....	Electronic intelligence satellites
ESA.....	European Space Agency
ETS.....	Engineering Test Satellite
EXT.....	Extra-Orbital
FAA.....	Federal Aviation Administration
FORTE.....	Fast On-Orbit Recording of Transient Events
FY.....	Feng Yun
GBS.....	Global Broadcast Service
GE.....	General Electric
GEO.....	Geosynchronous Orbit
GPS.....	Global Positioning System
GTO.....	Geosynchronous Transfer Orbit
IAE.....	Instituto de Aeronautica e Espacio
ISAS.....	Institute of Space and Astronautical Science
INTELSAT.....	International Telecommunications Satellite Organization
INMARSAT.....	International Maritime Satellite Organization
INPE.....	National Institute for Space Research
INTA.....	Instituto Nacional de Tecnica Aeroespacial
IRS.....	Indian Resource Satellite
ISRO.....	Indian Space Research Organization
Jawsat.....	Joint Academy-Weber State Satellite
JCSAT.....	Japan Communications Satellite Co. Satellite
JPL.....	Jet Propulsion Laboratory
JSAT.....	Japan Satellite Systems, Inc.
KB.....	Design Bureau
KSC.....	Kennedy Space Center
LEO.....	Low Earth Orbit
LMLV.....	Lockheed Martin Launch Vehicle
MBB.....	Messerschmitt - Bolkow - Blohm

## ACRONYMS continued...

MEO.....Middle Earth Orbit  
MFS .....Iridium Mass Frequency Simulator  
MTCR.....Missile Technology Control Regime  
MoD.....Ministry of Defense  
NASA.....National Aeronautics and Space Administration  
NASDA.....National Space Development Agency (Japan)  
NEC.....Nippon Electric Corp.  
nMI.....Nautical Mile  
NOAA.....National Oceanic and Atmospheric Administration  
NPO.....Scientific Production Organization  
OCST.....Office of Commercial Space Transportation  
OSC.....Orbital Sciences Corporation  
PAS.....Pan American Satellite  
PSLV.....Polar Satellite Launch Vehicle  
PTT.....Post Telegraph and Telecommunications  
RKK Energia.....Rocket and Space Company Energia  
SACI.....Satellite Cientifico  
SAFIR.....Satellite for Information Relay  
SCD.....Satellite de Coleta de Dados  
SEDSat.....Small Expendable-tether Deployer System Satellite  
SES.....Societe Europeene des Satellites  
SLV.....Satellite Launch vehicle  
SNOE.....Student Nitric Oxide Explorer  
SSTL.....Small Spacecraft Technology Initiative  
STEP.....Space Test Program  
STS.....Space Transportation System  
TERRIERS.....Tomographic Experiment using Radiative Recombinitive Ionospheric  
EUV and Radio Sources  
TRACE.....Transition region and Coronal Explorer  
TMSAT.....Thai Micro-Satellite  
TRMM.....Tropical Rainfall Measuring Mission  
Tubsat.....Technical University of Berlin Satellite  
TsSKB.....Central Specialized Design Bureau  
UoSat.....University of Surrey Satellite  
USAF.....United States Air Force  
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
<b>Heavy</b>							
Ariane 5	0/1 0%	39600 lbs 18000 kg	15000 lbs 6800 kg	N/A	N/A	\$ 115-143 M	Kourou
Long March 3B	1/2 50%	29900 lbs 13600 kg	9900 lbs 4500 kg	4950 lbs 2250 kg	N/A	\$ 60-70 M	Xichang
Proton SL-12	194/216 89.8%	46297 lbs 21000 kg	12100 lbs 5500 kg	4850 lbs 2200 kg	N/A	\$ 50-70 M	Tyuratam
Shuttle Atlantis	19/19 100%	47300 lbs 21455 kg	13007 lbs 5900 kg	5203 lbs 2360 kg	N/A	\$ 161-215 M	KSC
Shuttle Columbia	23/23 100%	47300 lbs 21455 kg	13007 lbs 5900 kg	5203 lbs 2360 kg	N/A	\$ 161-215 M	KSC
Shuttle Discovery	24/24 100%	47300 lbs 21455 kg	13007 lbs 5900 kg	5203 lbs 2360 kg	N/A	\$ 161-215 M	KSC
Titan 4	10/11 90.9%	39100 lbs 17736 kg	14000 lbs 6350 kg	N/A	N/A	\$ 160-180 M	CCAS, VAFB
Titan 4/Centaur	7/7 100%	39100 lbs 17736 kg	14000 lbs 6350 kg	10200 lbs 4627 kg	N/A	\$ 240-270 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	\$ 25-40 M	Tyuratam
<b>Intermediate</b>							
Ariane 4-TBA	N/A	N/A	N/A	N/A	N/A	\$ 85 M	Kourou
Ariane 44L	24/25 96%	21100 lbs 9600 kg	9965 lbs 4520 kg	N/A	N/A	\$ 90-110 M	Kourou
Ariane 44P	10/10 100%	15200 lbs 6900 kg	7320 lbs 3320 kg	N/A	N/A	\$ 75-90 M	Kourou
Atlas 2	9/9 100%	14500 lbs 6580 kg	6200 lbs 2810 kg	3086 lbs 1400 kg	N/A	\$ 60-70 M	CCAS
Atlas 2A	11/11 100%	16050 lbs 7280 kg	6700 lbs 3039 kg	3307 lbs 1500 kg	N/A	\$ 65-80 M	CCAS
Atlas 2AS	10/10 100%	19050 lbs 8640 kg	7950 lbs 3606 kg	4604 lbs 2090 kg	N/A	\$ 90-100 M	CCAS, VAFB
H 2	4/4 100%	23000 lbs 10500 kg	8800 lbs 4000 kg	4800 lbs 2200 kg	N/A	\$ 182-201 M	Tanegashima
Soyuz SL-4	939/946 99.3%	15400 lbs 7000 kg	N/A	N/A	N/A	\$ 12-25 M	Plesetsk, Tyuratam
<b>Medium</b>							
Delta 2 7920	8/8 100%	11109 lbs 5039 kg	2800 lbs 1270 kg	N/A	N/A	\$ 45-50 M	CCAS, VAFB
Delta 2 7925	36/37 97.3%	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	\$ 19-21 M	CCAS, VAFB
Long March 2C	15/15 100%	7040 lbs 3200 kg	2200 lbs 1000 kg	860 lbs 390 kg	N/A	\$ 15-20 M	Jiuquan
Molniya SL-6	292/307 95.1%	3970 lbs 1805 kg	N/A	N/A	N/A	N/A	Tyuratam, Plesetsk
PSLV	3/4 75%	6400 lbs 2900 kg	990 lbs 450 kg	N/A	N/A	N/A	Sriharikota
Titan 2	18/18 100%	7900 lbs 3583 kg	N/A	N/A	N/A	\$ 41-47 M	VAFB
<b>Small</b>							
Cosmos SL-8	407/411 99%	3100 lbs 1400 kg	N/A	N/A	N/A	\$ 10 M	Kapustin Yar, Plesetsk, Tyuratam
LMLV 1	1/2 50%	1755 lbs 800 kg	N/A	N/A	N/A	\$ 14-16 M	CCAS, VAFB
Pegasus XL	6/9 66.7%	943 lbs 428 kg	322 lbs 146 kg	181 lbs 82 kg	N/A	\$ 12-14 M	VAFB, Wallops Island
START 1	2/2 100%	790 lbs 359 kg	N/A	N/A	N/A	\$ 5-10 M	Plesetsk, Svobodny
Taurus 1	1/1 100%	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
<b>Classified</b>										
USA 1997-10	Classified	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
USA 1997-11	Classified	N/A	GEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
USA 1998-03	Classified	N/A	GEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>Communications</b>										
Agila 2	Communications	N/A	GEO 144 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 / 3700kg	N/A	15 Ku1, 1 Ku2	N/A	N/A
Asiasat 3	Communications	N/A	GEO 105.5 E	N/A	N/A	7656 lbs / 3480kg	N/A	16 Ku1, 28 C1	N/A	N/A
Astra 1G	Communications	N/A	GEO 19.2 E	19305 nMi	19305 nMi	7260 lbs / 3300kg	N/A	32 Ku1	3-axis	N/A
Astra 2A	Communications	N/A	GEO 28.2 E	N/A	N/A	7260 lbs / 3300kg	N/A	32 Ku1	N/A	N/A
Brazilsat B3	Communications	N/A	GEO 293 E	1933N/A	19305 nMi	3850 lbs / 1750kg	N/A	27 C1, 1 C2,	Spin	N/A
BSAT 1 B	Communications	N/A	GEO 110 E	1933N/A	19305 nMi	2750 lbs / 1250kg	N/A	4 Ku1	Spin	N/A
ChinaStar 1A	Communications	\$ 87 M	GEO 87.5 E	N/A	N/A	6600 lbs / 3000kg	N/A	16 Ku1, 4 Ku2	N/A	N/A
DSCS III 3-10	Communications	N/A	GEO	19326 nMi	19323 nMi	2475 lbs / 1125kg	N/A	6 SHF	3-axis	1240 W
DSCS III 3-11	Communications	N/A	GEO	19326 nMi	19323 nMi	2475 lbs / 1125kg	N/A	6 SHF	3-axis	1240 W
EchoStar 3	Communications	N/A	GEO 298.5 E	N/A	N/A	6600 lbs / 3000kg	N/A	16 Ku	3-axis	N/A
EchoStar 4	Communications	N/A	GEO 185 E	N/A	N/A	6600 lbs / 3000kg	N/A	16 Ku	3-axis	N/A
Eutelsat 3 F 1	Communications	N/A	GEO 10 E	19332 nMi	19305 nMi	6599 lbs / 3000kg	N/A	24 Ku1	N/A	N/A
Faisat 02V	Communications	N/A	LEO	432 nMi	432 nMi	251 lbs / 114kg	N/A	N/A	N/A	17 W
Galaxy 8I	Communications	N/A	GEO 265 E	1933N/A	19322 nMi	6572 lbs / 2987kg	N/A	24 Ku1, 24 C1	N/A	N/A
GBS 8	Communications	N/A	GEO	N/A	N/A	6305 lbs / 2866kg	N/A	EHF, UHF	N/A	2500 W
GE 3	Communications	N/A	GEO 273 E	19375 nMi	N/A	5687 lbs / 2585kg	N/A	24 Ku1, 24 C1	N/A	N/A
Globalstar 1	Communications	N/A	LEO	764 nMi	764 nMi	988 lbs / 449kg	N/A	1 L1	N/A	875 W
Globalstar 2	Communications	N/A	LEO	764 nMi	764 nMi	988 lbs / 449kg	N/A	1 L1	N/A	875 W
Globalstar 3	Communications	N/A	LEO	764 nMi	764 nMi	988 lbs / 449kg	N/A	1 L1	N/A	875 W
Globalstar 4	Communications	N/A	LEO	764 nMi	764 nMi	988 lbs / 449kg	N/A	1 L1	N/A	875 W
Hot Bird Plus 3	Communications	N/A	GEO 13 E	N/A	N/A	6380 lbs / 2900kg	N/A	20 Ku1	N/A	N/A
Hot Bird Plus 4	Communications	N/A	GEO 13 E	N/A	N/A	6380 lbs / 2900kg	N/A	17 Ku1, 2 Ku2	N/A	N/A
IndoStar 1	Communications	N/A	GEO 106.1 E	N/A	N/A	2442 lbs / 1110kg	N/A	5 S1	N/A	N/A
Inmarsat 3 F5	Communications	N/A	GEO	N/A	N/A	4352 lbs / 1978kg	N/A	2 C1, 1 L1,	N/A	N/A
Intelsat 8 F3	Communications	N/A	GEO 64 E	N/A	N/A	8122 lbs / 3692kg	N/A	6 Ku1, 18 C1,	N/A	N/A
Intelsat 8 F4	Communications	N/A	GEO 338.5 E	N/A	N/A	8122 lbs / 3692kg	N/A	6 Ku1, 18 C1,	N/A	N/A
Iridium 13	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 14	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 15	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 16	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 17	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 18	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 19	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 20	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 21	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A

## Characteristics of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in orbit	Freq. Bands & trans.	Stab.	Power
<b>Communications</b>										
Iridium 22	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 25	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 26	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 27	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 28	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 29	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 30	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 31	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 32	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 33	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 34	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 35	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 36	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 37	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 38	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 39	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 40	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 41	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 42	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 43	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 44	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 45	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 46	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 47	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
Iridium 48	Communications	N/A	LEO	419 nMi	419 nMi	1496 lbs / 680kg	N/A	1 L1, 1 Ka1	N/A	N/A
JCSAT 5	Communications	N/A	GEO	N/A	N/A	6820 lbs / 3100kg	N/A	N/A	N/A	N/A
Molniya 3-49	Communications	N/A	ELI	20917 nMi	24N/A	3850 lbs / 1750kg	N/A	2 C1	N/A	1000 W
Orbcomm 03	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 04	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 05	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 06	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 07	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 08	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 09	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 10	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 11	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 12	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 13	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 14	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 15	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A



## Characteristics of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in orbit	Freq. Bands & trans.	Stab.	Power
<b>Communications</b>										
Orbcomm 16	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 17	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 18	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 19	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
Orbcomm 20	Communications	N/A	LEO	419 nMi	411 nMi	87 lbs / 40kg	N/A	N/A	N/A	N/A
PAS 5	Communications	N/A	GEO 302 E	N/A	N/A	8184 lbs / 3720kg	N/A	24 Ku1, 24 C1	N/A	N/A
PAS 6	Communications	N/A	GEO 317 E	N/A	N/A	6644 lbs / 3020kg	N/A	36 Ku1	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	N/A	N/A	7683 lbs / 3492kg	N/A	14 Ku1, 24 C1	N/A	N/A
Sirius 2	Communications	N/A	GEO 5.2 E	N/A	N/A	6354 lbs / 2888kg	N/A	26 Ku1, 8 Ku2	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
Sky 2	Communications	N/A	GEO	N/A	N/A	7683 lbs / 3492kg	N/A	32 Ku1	N/A	N/A
Skyнет 4D	Communications	N/A	GEO 326 E	N/A	N/A	3152 lbs / 1433kg	N/A	3 X1	3-axis	N/A
Superbird C1	Communications	N/A	GEO 144 E	N/A	N/A	5938 lbs / 2699kg	N/A	4 Ku1, 4 Ku2,	N/A	N/A
<b>Crewed</b>										
Soyuz TM-26	Crewed	N/A	LEO	221 nMi	213 nMi	15587 lbs / 7070kg	14969 lbs / 6790 kg	N/A	N/A	N/A
Soyuz TM-27	Crewed	N/A	LEO	221 nMi	213 nMi	15587 lbs / 7070kg	14969 lbs / 6790 kg	N/A	N/A	N/A
<b>Development</b>										
Argos	Development	N/A	LEO	45N/A	45N/A	N/A	N/A	N/A	N/A	N/A
ETS 7	Development	\$ 37 M	LEO	297 nMi	297 nMi	6101 lbs / 2773kg	N/A	N/A	3-axis	N/A
STEP 4	Development	N/A	LEO	324 nMi	324 nMi	396 lbs / 180kg	N/A	N/A	N/A	N/A
<b>Experimental</b>										
Gurwin 2	Experimental	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Maqsat H	Experimental	N/A	ELI	N/A	N/A	5060 lbs / 2300kg	N/A	N/A	N/A	N/A
<b>Intelligence</b>										
FORTE P94-1	Intelligence	\$ 27 M	LEO	432 nMi	432 nMi	141 lbs / 64kg	N/A	N/A	N/A	N/A
Geosat Follow-On 1	Intelligence	N/A	LEO	432 nMi	422 nMi	748 lbs / 340kg	N/A	N/A	N/A	N/A
Kosmos 2345	Intelligence	N/A	GEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
USA 1997-07	Intelligence	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>Meteorological</b>										
Meteosat 7	Meteorological	\$ 102 M	GEO 10 E	N/A	N/A	1584 lbs / 720kg	N/A	N/A	N/A	N/A
NOAA K	Meteorological	N/A	LEO	473 nMi	459 nMi	4915 lbs / 2234kg	3205 lbs / 1454 kg	N/A	N/A	1400 W
<b>Microgravity</b>										
Wake Shield Facility 4	Microgravity	N/A	LEO	N/A	N/A	3748 lbs / 1700kg	N/A	N/A	N/A	N/A
<b>Navigation</b>										
Kosmos 2346	Navigation	N/A	LEO	54N/A	54N/A	N/A	N/A	N/A	N/A	N/A
Navstar GPS 2-28	Navigation	N/A	MEO	10899 nMi	10899 nMi	4138 lbs / 1881kg	N/A	1 L1	N/A	N/A
Navstar GPS 2R- 2	Navigation	N/A	MEO	10899 nMi	10899 nMi	4470 lbs / 2032kg	N/A	1 L1	N/A	N/A
Navstar GPS 2R- 3	Navigation	N/A	MEO	10899 nMi	10899 nMi	4470 lbs / 2032kg	N/A	1 L1	N/A	N/A

## Characteristics of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in orbit	Freq. Bands & trans.	Stab.	Power
<b>Other</b>										
Celestis 2	Other	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>Remote Sensing</b>										
Earlybird 1	Remote Sensing	N/A	LEO	254 nMi	254 nMi	682 lbs / 310kg	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 / 817kg	N/A	N/A	N/A	N/A
IRS 1D	Remote Sensing	N/A	LEO	449 nMi	432 nMi	2145 lbs / 975kg	N/A	N/A	N/A	N/A
IRS P4	Remote Sensing	N/A	LEO	497 nMi	481 nMi	2970 lbs / 1350kg	N/A	N/A	N/A	N/A
Lewis	Remote Sensing	N/A	LEO	N/A	N/A	848 lbs / 386kg	N/A	N/A	N/A	N/A
Resurs-O1 N4	Remote Sensing	N/A	LEO	451 nMi	451 nMi	6160 lbs / 2800kg	N/A	N/A	N/A	N/A
Seastar	Remote Sensing	N/A	LEO	432 nMi	N/A	603 lbs / 274kg	N/A	N/A	N/A	N/A
TMSAT 1	Remote Sensing	N/A	LEO	N/A	N/A	110 lbs / 50kg	N/A	N/A	N/A	N/A
TRMM	Remote Sensing	\$ 148 M	LEO	189 nMi	189 nMi	7964 lbs / 3620kg	N/A	N/A	3-axis	N/A
<b>Scientific</b>										
ACE	Scientific	N/A	EXT	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cassini	Scientific	\$ 1215 M	EXT	N/A	N/A	12773 lbs / 5806kg	5100 lbs / 2313 kg	X	3-axis	700 W
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	27N/A	550 lbs / 250kg	N/A	N/A	N/A	N/A
Huygens	Scientific	\$ 239 M	EXT	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lunar Prospector	Scientific	N/A	EXT	N/A	N/A	513 lbs / 233kg	N/A	N/A	N/A	N/A
Oersted	Scientific	N/A	LEO	464 nMi	243 nMi	136 lbs / 62kg	N/A	N/A	N/A	44 W
SEDSat 1	Scientific	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SNOE	Scientific	N/A	LEO	297 nMi	297 nMi	220 lbs / 100kg	N/A	N/A	N/A	N/A
Spartan 201-04	Scientific	N/A	LEO	168 nMi	159 nMi	2800 lbs / 1270kg	N/A	N/A	N/A	N/A
Sunsat	Scientific	N/A	LEO	464 nMi	243 nMi	132 lbs / 60kg	N/A	N/A	N/A	N/A
Teamsat 1	Scientific	N/A	ELI	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TRACE	Scientific	N/A	LEO	378 nMi	378 nMi	491 lbs / 223kg	N/A	N/A	N/A	N/A
<b>Supply</b>										
Progress M-35	Supply	N/A	LEO	N/A	N/A	15983 lbs / 7250kg	N/A	N/A	N/A	N/A
Progress M-36	Supply	N/A	LEO	N/A	N/A	15983 lbs / 7250kg	N/A	N/A	N/A	N/A
<b>Test</b>										
Iridium MFS 1	Test	N/A	LEO	342 nMi	336 nMi	1496 lbs / 680kg	N/A	N/A	N/A	N/A
Iridium MFS 2	Test	N/A	LEO	342 nMi	336 nMi	1496 lbs / 680kg	N/A	N/A	N/A	N/A
<b>TBA</b>										
USMP 4	TBA	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A

## Launch Events July - September 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
<b>China</b>								
<b>Long March</b>								
August 19, 1997	Long March 3B	Agila 2	Mabuhay Philippine Satellite Corp.	Space Systems/Loral	Yes	Commercial	Success	Success
September 1, 1997	Long March 2C	Iridium MFS 1	China Aerospace Corp.	Lockheed Martin	No	Non-Commercial	Success	Success
September 1, 1997	Long March 2C	Iridium MFS 2	China Aerospace Corp.	Lockheed Martin	No	Non-Commercial	Success	Success
<b>Europe (ESA)</b>								
<b>Ariane</b>								
August 8, 1997	Ariane 44P	PAS 6	Pan American Satellite Corp.	Space Systems/Loral	Yes	Commercial	Success	Success
September 2, 1997	Ariane 44L	Hot Bird Plus 3 Meteosat 7	Eutelsat Eumetsat	Matra Marconi Aerospatiale	Yes	Commercial	Success	Success
September 23, 1997	Ariane 44P	Intelsat 8 F3	Intelsat	Lockheed Martin Corp.	Yes	Commercial	Success	Success
<b>India</b>								
<b>PSLV</b>								
September 29, 1997	PSLV	IRS 1D	ISRO	ISRO	No	Non-Commercial	Success	Success
<b>Russia/CIS</b>								
<b>Cosmos</b>								
September 23, 1997	Cosmos SL-8	Faisat 02V Kosmos 2346	Final Analysis Inc. Russia/CIS MoD	Final Analysis Inc. AO Polyot	No	Non-Commercial	Success	Success

## Launch Events July - September 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
<b>Russia/CIS</b>								
<b>Molniya</b>								
September 25, 1997	Molniya SL-6	Molniya 3-49	Russia/CIS PTT	NPO Prikladnoi Mekhaniki	No	Non-Commercial	Success	Success
<b>Proton</b>								
August 14, 1997	Proton SL-12	Kosmos 2345	Russia/CIS MoD	Russia/CIS MoD	No	Non-Commercial	Success	Success
August 28, 1997	Proton SL-12	PAS 5	Pan American Satellite Corp.	Hughes	Yes	Commercial	Success	Success
September 14, 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	Commercial	Success	Success
<b>Soyuz</b>								
July 5, 1997	Soyuz SL-4	Progress M-35	RKK Energia	RKK Energia	No	Non-Commercial	Success	Success
August 5, 1997	Soyuz SL-4	Soyuz TM-26	RKK Energia	RKK Energia	No	Non-Commercial	Success	Success
<b>USA</b>								
<b>Atlas</b>								
July 27, 1997	Atlas 2AS	Superbird C1	Space Communications Corp.	Hughes	Yes	Commercial	Success	Success
September 4, 1997	Atlas 2AS	GE 3	GE Americom	Lockheed Martin Corp.	Yes	Commercial	Success	Success

## Launch Events July - September 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
<b>USA</b>								
<b>Delta</b>								
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	Commercial	Success	Success
July 23, 1997	Delta 2 7925	Navstar GPS 2-28	DoD	Rockwell International	No	Non-Commercial	Success	Success
August 20, 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	Commercial	Success	Success
August 25, 1997	Delta 2 7920	ACE	NASA	NASA	No	Non-Commercial	Success	Success
September 26, 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	Commercial	Success	Success
<b>LMLV</b>								
August 22, 1997	LMLV 1	Lewis	NASA	TRW	No	Commercial	Success	Failure
<b>Pegasus</b>								
August 1, 1997	Pegasus XL	Seastar	Orbital Sciences Corp. (OSC)	Orbital Sciences Corp. (OSC)	No	Commercial	Success	Success
August 29, 1997	Pegasus XL	FORTE P94-1	DoD	Los Alamos National Laboratory	No	Non-Commercial	Success	Success

## Launch Events July - September 1997

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
<b>USA</b>								
<b>Shuttle</b>								
July 1, 1997	Shuttle Columbia	STS 83R Wake Shield Facility 4	NASA Space Vacuum Epitaxy Center	Rockwell International Space Industries, Inc.	No	Non-Commercial	Success	Success
August 7, 1997	Shuttle Discovery	STS 85 SEDSat 1 CRISTA SPAS 2	NASA NASA NASA/DARA	Rockwell International University of Alabama in Huntsville MBB Erno	No	Non-Commercial	Success	Success
September 25, 1997	Shuttle Atlantis	STS 86	NASA	Rockwell International	No	Non-Commercial	Success	Success

## Future Launch Events October 1997 - March 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
<b>Brazil</b>							
<b>VLS</b>							
4th Qtr 1997	VLS	SCD 2A	IAE	IAE	No	Non-Commercial	Alcantara
<b>China</b>							
<b>Long March</b>							
October 20, 1997	Long March 3B	APStar 2R	APT Satellite Co., Ltd.	Space Systems/Loral	Yes	Commercial	Xichang
January 25, 1998	Long March 3B	Sinosat 1	SINO-Satellite Communications	EuraSpace	No	Non-Commercial	Xichang
December 1997	Long March 2C	Iridium 25 Iridium 26	Iridium, Inc. Iridium, Inc.	Lockheed Martin Corp. Lockheed Martin Corp.	Yes	Commercial	Taiyuan
December 1997	Long March 3B	ChinaStar 1A	Ministry of Posts & Telecommunications	Lockheed Martin Corp.	No	Non-Commercial	Xichang
1st Qtr 1998	Long March 2C	Iridium 54 Iridium 55	Iridium, Inc. Iridium, Inc.	Lockheed Martin Corp. Lockheed Martin Corp.	Yes	Commercial	Taiyuan
1st Qtr 1998	Long March 3B	APMT 1	APMT	Hughes	Yes	Commercial	Xichang
<b>Europe (ESA)</b>							
<b>Ariane</b>							
4th Qtr 1997	Ariane 5	Maqsat H Teamsat 1	Arianespace ESA	Arianespace ESA	No	Non-Commercial	Kourou
November 7, 1997	Ariane 44L	IndoStar 1 Sirius 2	PT MediaCitra IndoStar Nordiska Satellitaktiebolaget (NSAB)	CTA Space Systems Aerospatiale	Yes	Commercial	Kourou
November 27, 1997	Ariane 44P	JCSAT 5 Equator-S	Japan Satellite Systems (JSAT) NASA/DARA	Hughes Max Planck Institute	Yes	Commercial	Kourou

## Future Launch Events October 1997 - March 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
<b>Europe (ESA)</b>							
December 18, 1997	Ariane 44P	Intelsat 8 F4	Intelsat	Lockheed Martin Corp.	Yes	Commercial	Kourou
January 22, 1998	Ariane 4-TBA	Inmarsat 3 F5 Brazilsat B3	Inmarsat Embratel	Lockheed Martin Corp. Hughes	Yes	Commercial	Kourou
February 27, 1998	Ariane 4-TBA	BSAT 1 B Hot Bird Plus 4	Telecommunications Advancement Org. Eutelsat	Hughes Matra Marconi	Yes	Commercial	Kourou
1st Qtr 1998	Ariane 4-TBA	PAS 7	Pan American Satellite Corp.	Space Systems/Loral	Yes	Commercial	Kourou
<b>Japan</b>							
<b>H</b>							
November 19, 1997	H 2	ETS 7 TRMM	NASDA NASDA/NASA	Toshiba NASA Goddard Space Flight Center	No	Non-Commercial	Tanegashima
1st Qtr 1998	H 2	COMETS	NASDA	Toshiba	No	Non-Commercial	Tanegashima
<b>Russia/CIS</b>							
<b>Proton</b>							
November 2, 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
January 1998	Proton SL-12	EchoStar 4	EchoStar Satellite Corp.	Lockheed Martin Astro Space	Yes	Commercial	Tyuratam
1st Qtr 1998	Proton SL-12	Tempo 1	Tempo Satellite, Inc.	Space Systems/Loral	Yes	Commercial	Tyuratam



## Future Launch Events October 1997 - March 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
<b>Russia/CIS</b>							
<b>Soyuz</b>							
October 6, 1997	Soyuz SL-4	Progress M-36	RKK Energia	RKK Energia	No	Non-Commercial	Tyuratam
October 9, 1997	Soyuz SL-4	Foton N-11	Space Research Institute (IKI)	KB Photon	No	Non-Commercial	Plesetsk
January 28, 1998	Soyuz SL-4	Soyuz TM-27	RKK Energia	RKK Energia	No	Non-Commercial	Tyuratam
1st Qtr 1998	Soyuz SL-4	Progress M-37	RKK Energia	RKK Energia	No	Non-Commercial	Tyuratam
<b>START</b>							
1st Qtr 1998	START 1	Earlybird 1	Earthwatch, Inc.	CTA Space Systems	Yes	Commercial	Svobodny
<b>Zenit</b>							
4th Qtr 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 VNII Elektromekhaniki OHB System Surrey Satellite Technology	No	Non-Commercial	Tyuratam
<b>USA</b>							
<b>Athena</b>							
November 23, 1997	Athena 2	Lunar Prospector	NASA	Lockheed Martin Corp.	No	Non-Commercial	CCAS
December 1, 1997	Athena 2	IKONOS 1	Space Imaging Inc.	Locheed Martin	No	Commercial	VAFB
1st Qtr 1998	Athena 1	Clark	NASA	CTA Space Systems, Inc.	No	Commercial	VAFB
<b>Atlas</b>							
October 5, 1997	Atlas 2AS	EchoStar 3	EchoStar Satellite Corp.	Lockheed Martin Astro Space	Yes	Commercial	CCAS

## Future Launch Events October 1997 - March 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
<b>USA</b>							
October 24, 1997	Atlas 2	DSCS III 3-10	DoD	Lockheed Martin Corp.	No	Non-Commercial	CCAS
December 1, 1997	Atlas 2AS	Galaxy 8I	Hughes Communications Inc.	Hughes	Yes	Commercial	CCAS
December 13, 1997	Atlas 2A	DSCS III 3-11	DoD	Lockheed Martin Corp.	No	Non-Commercial	CCAS
January 26, 1998	Atlas 2A	Eutelsat 3 F 1	Eutelsat	Aerospatiale	Yes	Commercial	CCAS
February 13, 1998	Atlas 2	GBS 8	DoD	Hughes	No	Commercial	CCAS
March 30, 1998	Atlas 2AS	Sky 2	American Sky Broadcasting	Space Systems/Loral	Yes	Non-Commercial	CCAS
<b>Delta</b>							
October 18, 1997	Delta 2 7925	Navstar GPS 2R-2	DoD	Lockheed Martin Corp.	No	Non-Commercial	CCAS
December 16, 1998	Delta 2 7925	Navstar GPS 2R-3	DoD	Lockheed Martin Corp.	No	Non-Commercial	CCAS
November 8, 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	Commercial	VAFB
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	Commercial	CCAS

## Future Launch Events October 1997 - March 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
<b>USA</b>							
December 16, 1997	Delta 2 7920	Iridium 44 Iridium 45 Iridium 46 Iridium 47 Iridium 48	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	Commercial	VAFB
February 8, 1998	Delta 2 7925	Skynet 4D	British Defense Ministry	Matra Marconi	Yes	Commercial	CCAS
March 8, 1998	Delta 2 7920	Argos Oersted Sunsat	Space Test Program Office, USAF NASA/Danish Space Research Council University of Stellenbosch	TRW University of Copenhagen Stellenbosch University	No	Non-Commercial	VAFB
January 25, 1998	Delta 2 7920	Iridium 49 Iridium 50 Iridium 51 Iridium 52 Iridium 53	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	Commercial	VAFB
February 26, 1998	Delta 2 7925	Globalstar 5 Globalstar 6 Globalstar 7 Globalstar 8	Globalstar, Inc. Globalstar, Inc. Globalstar, Inc. Globalstar, Inc.	Space Systems/Loral Space Systems/Loral Space Systems/Loral Space Systems/Loral	Yes	Commercial	CCAS
<b>Pegasus</b>							
4th Qtr 1997	Pegasus XL	STEP 4	DoD	TRW	No	Non-Commercial	Wallops Flight Facilit
4th Qtr 1997	Pegasus XL	Orbcomm 05 Orbcomm 06 Orbcomm 07 Orbcomm 08 Orbcomm 09 Orbcomm 10 Orbcomm 11 Orbcomm 12	Orbcomm Orbcomm Orbcomm Orbcomm Orbcomm Orbcomm Orbcomm Orbcomm	Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC)	No	Commercial	VAFB

## Future Launch Events October 1997 - March 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
<b>USA</b>							
4th Qtr 1997	Pegasus XL	SNOE BATSAT	University of Colorado/NASA Unknown	University of Colorado Unknown	No	Non-Commercial	VAFB
1st Qtr 1998	Pegasus XL	Orbcomm 13 Orbcomm 14 Orbcomm 15 Orbcomm 16 Orbcomm 17 Orbcomm 18 Orbcomm 19 Orbcomm 20	Orbcomm Orbcomm Orbcomm Orbcomm Orbcomm Orbcomm Orbcomm Orbcomm	Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC)	No	Commercial	VAFB
1st Qtr 1998	Pegasus XL	TRACE	NASA	NASA Goddard	No	Non-Commercial	VAFB
1st Qtr 1998	Pegasus XL	SCD 2	INPE	INPE	Yes	Commercial	CCAS
<b>Shuttle</b>							
November 19, 1997	Shuttle Columbia	STS 87 Spartan 201-04 USMP 4	NASA NASA NASA	Rockwell International NASA NASA	No	Non-Commercial	KSC
January 15, 1998	Shuttle Discovery	STS 89	NASA	Rockwell International	No	Non-Commercial	KSC
<b>Taurus</b>							
4th Qtr 1997	Taurus 1	Celestis 2 Geosat Follow-On 1 Orbcomm 03 Orbcomm 04	Celestis DoD Orbcomm Orbcomm	Celestis Ball Aerospace Orbital Sciences Corp. (OSC) Orbital Sciences Corp. (OSC)	No	Commercial	VAFB
4th Qtr 1997	Taurus 1	STEX	DoD	DoD	No	Non-Commercial	VAFB

## Future Launch Events October 1997 - March 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Site
<b>USA</b>							
<b>Titan</b>							
October 9, 1997	Titan 4	USA 1997-10	DoD	DoD	No	Non-Commercial	VAFB
October 13, 1997	Titan 4B/Centaur	Cassini Huygens	NASA European Space Agency (ESA)	Jet Propulsion Laboratory Aerospatiale	No	Non-Commercial	CCAS
November 1, 1997	Titan 4/Centaur	USA 1997-11	DoD	DoD	No	Non-Commercial	CCAS
February 16, 1998	Titan 2	NOAA K	NOAA	Lockheed Martin Corp.	No	Non-Commercial	VAFB
March 1998	Titan 4B/Centaur	USA 1998-03	DoD	DoD	No	Non-Commercial	CCAS