Commercial Space Transportation

QUARTERLY LAUNCH REPORT

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

3rd Quarter 1998

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

3RD QUARTER 1998 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: International Launch Services (1998). Image is of the Atlas IIAS launch on June 18, 1998 from Cape Canaveral Air Station. The commercial launch successfully deployed the Intelsat 805 satellite to geosynchronous orbit.

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This document was released on July 31, 1998.

SUMMARY

Second Quarter 1998 Launch Events

- In the second quarter of 1998, the United States conducted nine launches. Four of these launches were commercial (three Delta and one Atlas) and five were non-commercial (two Shuttle, a Titan 2, a Titan 4, and a Pegasus). All of these launches were conducted successfully.
- There were eight Russian launches in this period, two of them commercial launches on Proton vehicles. The remaining six non-commercial launches were on one Proton, one Molniya, and one Cyclone 3 launch vehicle, with three more launches on Soyuz launch vehicles. Seven of these launches were successful. The eighth, a Cyclone 3 launch, put six communications satellites in an incorrect (although apparently useable) orbit in an apparent upper-stage failure.
- Europe conducted one successful commercial launch of an Ariane vehicle with no Ariane failures.
- China launched two Long March vehicles, one commercial and one not, with both launches successful.

Third and Fourth Quarter 1998 Scheduled Launch Events

- The United States plans to make 27 launches in the next two quarters. Of these, 16 launches will be commercial: four Atlas, two Delta 2, two Delta 3, one Sea Launch, three Athena, and four Pegasus launches. Non-commercial launches will consist of three Delta 2, one Pegasus, two Shuttle launches, two Taurus, one Titan 2, and two Titan 4 launches.
- Russian launch vehicles are scheduled to make 14 launches, eight of which are commercial. These commercial launches are on one Shtil and seven Proton launch vehicles. Non-commercial launches will include three Soyuz, one Proton, one Zenit 2 launch vehicle, and one Molniya launch vehicle.
- Three Ukrainian Zenit launch vehicles are to be launched from Baikonur on commercial missions.
- Europe plans seven commercial Ariane 4 launches and the third and final developmental launch of the Ariane 5 launch vehicle.
- China intends to launch five Long March vehicles, one of which will be commercial.
- India will conduct a non-commercial launch of the PSLV.
- Japan is preparing to launch a non-commercial science payload on an M 5 launch vehicle.

SUMMARY

Commercial Products and Services

Third and Fourth Quarter 1998

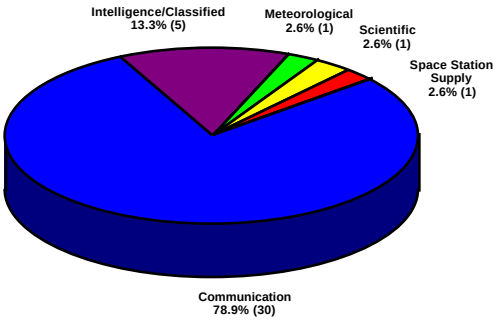
Several Launch Vehicles Make Their Commercial Debut in 1998

In the next two quarters, two launch vehicles will enter the commercial launch market and two more will move closer to commercial operations. The first pair, Delta 3 and Zenit, will both make their commercial debuts before the end of the year. The Delta 3 extends the Delta franchise into the lifting range of the Atlas and Ariane launch vehicles. In its first two launches, the Delta 3 will launch the Galaxy 10 communications satellite for PanAmSat and the Orion F3 communications satellite for Orion Network Systems. The Zenit launch vehicle will enter commercial service with two separate launch providers. Boeing Sea Launch will use one Zenit 3 vehicles to launch the Galaxy 11 Communications satellite for PanAmSat, and the Ukrainian Space Agency will launch three Ukrainian Zenit 2 vehicles with Globalstar LEO communications satellites from the Russian launch site at Baikonur.

Also moving towards commercialization are the European Ariane 5 and the Indian PSLV vehicles. The Ariane 5 was to make its first launch of a commercial satellite on its third (and if successful, final) developmental launch but the commercial payload, the Eutelsat W1 satellite, was damaged and possibly ruined in a testing accident earlier this year. The PSLV will carry the IRS P-4 as its primary payload as well as two small secondary satellites. These satellites, the remote sensing Kitsat 3 and the experimental Tubsat C-DLR will be launched as a commercial venture as part of India's attempt to commercialize the PSLV. Although India has not yet sold a commercial PSLV launch of a primary payload, this piggyback launch is a step on the road to greater commercialization of the PSLV.

Payload Use Analysis

Second Quarter 1998



In the second quarter of 1998, there were 38 payloads launched worldwide. These payloads were divided between communications (78.9 percent), intelligence/classified (13.3 percent), meteorological (2.6 percent), scientific (2.6 percent), and space station supply (2.6 percent).

Communications payloads constituted all of the 23 internationally competed payloads on commercial launches.

LAUNCH SCHEDULE

Scheduled Launch Events

Vehicle	Payload	Site
JULY 1998		
Atlas 2AS	JCSAT 6	CCAS
Long March 2C	Iridium R-1	Taiyuan
	Iridium R-2	
Long March 3B	Sinosat 1	Xichang
M 5	Planet B	Kagoshima
Molniya	Molniya 3	Plesetsk
Shtil	Tubsat N	Delfin sub
	Tubsat N1	
Titan 4/Centaur	USA 1998-06	CCAS
Zenit 2	Resurs-O1 N4	Baikonur
	IRIS R1	
	FASat-Bravo	
	SAFIR 2	
	Tech Sat 2	
	TMSAT 1	
AUGUST 1998		
Ariane 44P	ST 1A	Kourou
Athena 2	IKONOS 1	VAFB
Delta 2 7420	Iridiums R-3/R-5	VAFB
Delta 3	Galaxy 10	CCAS
Proton (SL-12)	Astra 2A	Baikonur
Soyuz	Soyuz TM-28	Baikonur
Zenit 2	Globalstars 5, 7, 9-13, and 16-20	Baikonur
SEPTEMBER 1998		
Ariane 44LP	PAS 7	Kourou
Atlas 2A	GBS 9	CCAS
Proton (SL-12)	Nimiq	Baikonur
TR 1A*	JEM Microgravity Test	Tanegashima
Zenit 2	Globalstars 21-32	Baikonur

* Denotes a suborbital launch

LAUNCH SCHEDULE

Scheduled Launch Events

(Continued)

Vehicle	Payload	Site
OCTOBER 1998		
Ariane 42L	Eutelsat W2	Kourou
Ariane 44L	AfriStar 1 Sirius 3	Kourou
Ariane 5	ARD Ariane 503 Dummy	Kourou
Athena 2	IKONOS 2	VAFB
Atlas 2AS	Hot Bird Plus 5	CCAS
Delta 2 7326	Deep Space 1 Sedsat-1	CCAS
Delta 3	Orion F3	CCAS
Long March 4	FY 1-C	Xichang
Proton (SL-12)	Telstar 6	Baikonur
Proton (SL-12)	PAS 8	Baikonur
Sea Launch	Galaxy 11	Pacific Sea Launch
Shuttle Discovery	STS 95 PANSAT 1 Spartan 201-04R	KSC
Titan 2	QuickSCAT	VAFB
NOVEMBER 1998		
Ariane 44L	GE 5 Insat 2E	Kourou
Delta 2 7925	Bonum 1	CCAS
Long March 3B	ChinaSat 8	Xichang
Proton (SL-13)	Zarya	Baikonur
DECEMBER 1998		
Ariane 42L	PAS 6B	Kourou
Ariane 42L	SatMex 5	Kourou
Athena 1	Rocsat 1	CCAS
Atlas 2AS	ICO 1	CCAS
Delta 2 7425	Mars Climate Orbiter	CCAS
Delta 2 7920	Argos Oersted Sunsat	VAFB
Proton (SL-12)	Tempo 1	Baikonur
Proton (SL-12)	LMI 1	TBA
Proton (SL-12)	Sesat	Baikonur
Shuttle Endeavour	STS 88 Unity Pressurized Mating A 1&2 SAC A	KSC
Titan 4B/IUS	USA 1998-12	CCAS
Zenit 2	Globalstars 33-44	Baikonur

LAUNCH SCHEDULE

Additional Launch Events to be Announced*

For the Third and Fourth Quarter 1998

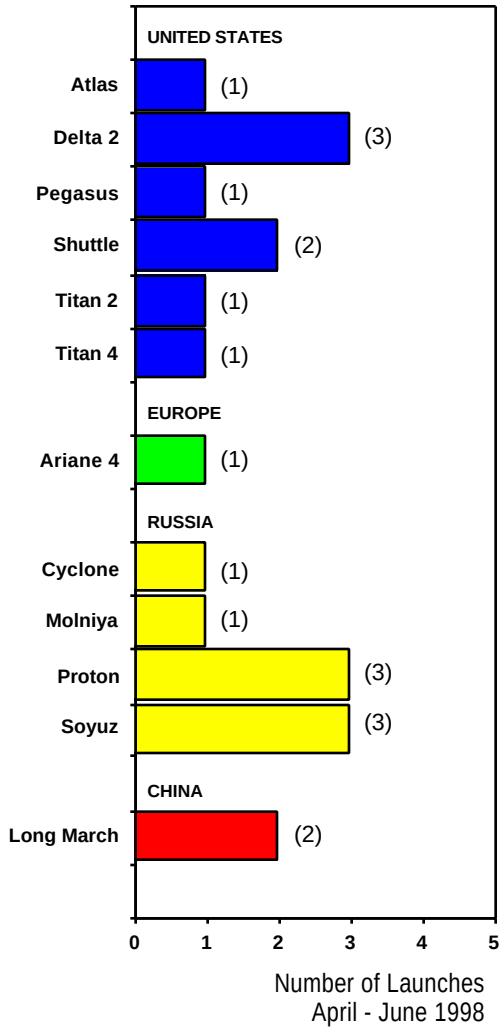
Vehicle	Payload	Site
THIRD QUARTER OF 1998		
Pegasus XL	SCD 2	CCAS
Pegasus XL	WIRE	VAFB
Pegasus XL/HAPS	Orbcomms 13-20	Wallops Flight Facility
Pegasus XL/HAPS	Orbcomms 21-28	Wallops Flight Facility
PSLV	IRS P4 Kitsat 3 Tubsat C-DLR	Sriharikota
Soyuz	Progress M-40	Baikonur
Taurus 1	STEX 1	VAFB
Long March 4	CBERS/Ziyuan 1 SACI 1	Taiyuan
FOURTH QUARTER OF 1998		
Pegasus XL	TERRIERS MUBLCOM	VAFB
Soyuz	Progress M-41	Baikonur
Taurus 1	TSX 5	CCAS

* 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 1998



In the second quarter, United States launch vehicles made nine of the 20 total launches worldwide. Of these nine launches, four were commercial. Delta vehicles made three commercial launches, orbiting one set of five Iridium satellites, a set of four Globalstar satellites, and a GEO communications payload. An Atlas launched a GEO communications satellite for the fourth commercial launch. United States non-commercial launches included two Shuttle flights, a Pegasus launch with a science payload, a Titan 2 with a meteorological satellite, and the launch of a classified payload on a Titan 4.

Europe made one successful commercial launch of the Ariane 4. Further launches were delayed when manifested satellites were not ready for launch on schedule and replacements could not be found.

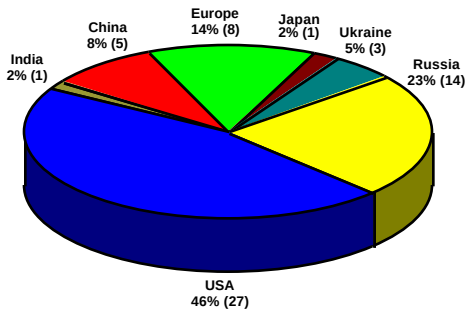
Russia launched eight vehicles with two of the launches being commercial. The commercial launches were a set of seven Iridium LEO communications satellites launched on one Proton and a GEO communications satellite launched on another Proton. A non-commercial Proton and a Molniya both carried classified defense payloads to orbit while a Cyclone 3 launch placed six military LEO communications satellites in a lower-than-intended orbit. Three Soyuz vehicles launched a Progress resupply mission to Mir along with two intelligence satellites.

China's Long March was used twice, once commercially and once not. The commercial launch placed a pair of Iridium satellites in LEO. The non-commercial launch was of a government-owned Lockheed Martin-built GEO communications satellite. The Chinese experienced no launch failures in this period.

LAUNCH REPORT

Scheduled Launch Events

Third and Fourth Quarter 1998



Scheduled Launch Events, by Region
July - December 1998

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

Fifty-nine orbital launch events are scheduled in the third and fourth quarters of 1998. The United States share of these is 27 launches. Four of these launches will be made on Atlas vehicles each carrying a communications satellite. Of these, three will go to GEO and one to MEO. Five Delta 2 vehicles will carry four science satellites, four communications satellites, one remote sensing satellite, and one development satellite. The first two flights of the Delta 3 will each launch a GEO communications satellite. Two Athena 2 vehicles will carry a single remote sensing satellite each, and an Athena 1 will carry a remote sensing satellite. Two Taurus flights will have a military and a developmental payload respectively. Pegasus vehicles will launch five times. Two launches will carry a set of eight Orbcomm LEO communications satellites while the other three will carry two communications and two scientific satellites between them. There will also be two Shuttle missions. One of these will carry International Space Station (ISS) components and a developmental satellite, the other a deployable science satellite and a small communications satellite. There will also be one Titan 2 launch with a science satellite and two Titan 4 launches carrying classified payloads.

Russia plans to launch 14 vehicles. Eight will be Proton rockets, seven with communications satellites and one with an ISS component. Three are Soyuz vehicles lofting one crewed and two supply flights to Mir. The remaining three launches will be of a Molniya carrying a communications satellite, a Shtil submarined-launched vehicle with two small communications satellites, and a Zenit with multiple small satellites and a Russian remote sensing payload.

Ukraine plans to launch three sets of LEO communications satellites on Zenit vehicles from Russia's Baikonur site.

Europe's Ariane 4 is scheduled to orbit nine GEO communications satellites and to make the final Ariane 5 developmental launch with a dummy satellite and a developmental payload.

China intends to launch five Long March vehicles, four with communications payloads and one with two remote sensing payloads.

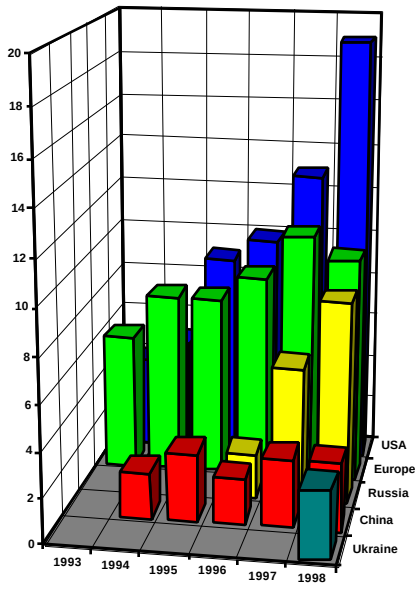
Japan will launch a scientific payload on an M 5 vehicle.

India is scheduled to launch an IRS remote sensing satellite and two small foreign satellites on a PSLV.

LAUNCH REPORT

Scheduled Commercial Launch Events

Third and Fourth Quarter 1998



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

Excluding small launch vehicles, 48 launches are planned for the next two quarters. Of these, 27 will be commercial launches. When small launch vehicles are included, this total increases to 59, of which 35 are expected to be commercial. The United States plans to conduct one third of these with nine commercial launches. These will consist of four Atlas vehicles launching GEO communications satellites and the first launch of the Sea Launch Zenit 3 from its ocean platform with a GEO communications satellite. The first two Delta 3 vehicles will each carry one GEO communications payload, and two Delta 2 vehicles are manifested to carry a GEO satellite and a set of LEO communications satellites. Commercial small vehicle launches will include two launches of Athena 2 vehicles, each of which is to loft a remote sensing satellite, and one Athena 1 which is to carry an experimental payload. Four Pegasus vehicles are to be launched carrying a total of 18 communications satellites and a science satellite into orbit.

All but one of Europe's eight scheduled launches are commercial. All seven commercial launches will be on Ariane 4 vehicles carrying a total of nine GEO communications satellites. Arianespace is planning an unusually crowded schedule for the remainder of 1998 to make up for scheduling problems earlier in the year.

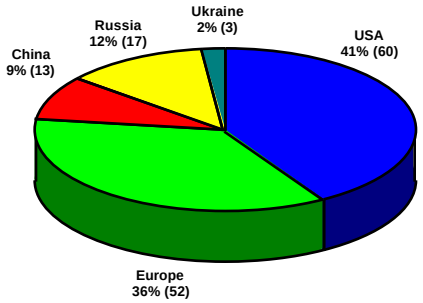
Russia intends to conduct seven commercial Proton launches of GEO communications satellites. In addition, an eighth small commercial launch will use a submarine-launched Shtil vehicle (a converted SSN-23 missile) to orbit a pair of small German communications satellites.

Ukraine will enter the commercial launch arena with the launch of 36 Globalstar LEO communications satellites on three Zenit launch vehicles.

China's one commercial launch will carry two Iridium communications satellites to LEO.

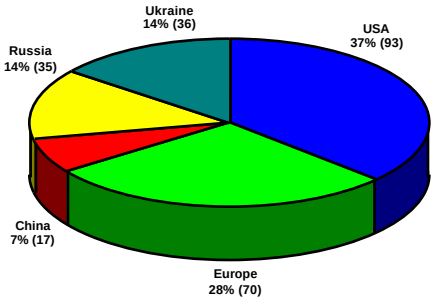
LAUNCH REPORT

Commercial Launch Trends



Commercial Launch Market Trend
January 1993 - December 1998

(Small Vehicles Excluded)



Internationally Competed Payloads
Market Trend
January 1993 - December 1998

(Small Vehicles Excluded)

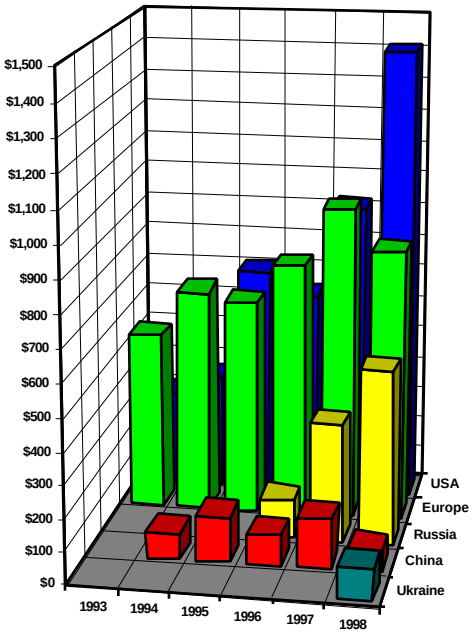
One hundred forty-five commercial launch events (excluding small launch vehicles) are projected for the period between January 1993 and December 1998. The United States has a 42-percent share, or 60, of these launches. In terms of internationally competed payloads on commercial launches (including small launches), the United States will have launched 93 of 251 payloads, for a 37-percent share.

Europe's portion of the total is 52 launches, for a 36-percent share of launches, and 70 payloads or 28 percent of total payloads. China had 13 launches for 9 percent of launches, and 17 payloads for 7 percent of the total. Russia will have conducted 17 commercial launches for a 12-percent share and deployed 35 internationally competed payloads or 14 percent of the total. Ukraine will make its first three commercial launches from Russia's launch site at Baikonur in the second half of 1998 with 36 internationally competed payloads representing 14 percent of payloads and two percent of launches in this period.

In the period covered by this report, April 1998 through December 1998, 35 commercial launches (excluding small launch vehicles) are planned worldwide. It is expected that there will be 85 internationally competed payloads (excluding small launch vehicles). The United States plans 13 launches for 37 percent of these launches and will loft 20 internationally competed payloads for 23 percent of such payloads. Europe plans eight launches (23 percent) and 10 payloads (12 percent). China's share is two launches (6 percent) and four payloads (five percent), while Russia's plans include 15 payloads on nine vehicles for 18 percent of payloads and 26 percent of launches. Ukraine's three launches will account for eight percent of commercial launches and their 36 payloads will constitute 42 percent of total internationally competed payloads in the last three quarters of 1998.

LAUNCH REPORT

Commercial Launch Revenues



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

January 1993 - December 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.

For the year 1998, revenues from commercial launch events are projected to be around $3.0 billion. Revenues for the five-year period between January 1993 and December 1998 are expected to be about $10.5 billion. The United States will have a 41-percent share of these revenues with about $4.3 billion, and Europe will have 43 percent with about $4.5 billion. Russia holds an estimated 10-percent share with about $1.0 billion, and China will have a five-percent share of about $540 million. Ukraine will gain a one-percent share, about $98 million, in commercial launch revenues in its first year of conducting commercial launches.

In 1998, the United States has almost half (48 percent) of total world launch revenues of $1.4 billion. This position reflects the strength of the United States' larger launch vehicles and the growing importance of its small launch vehicles. This year small commercial launch vehicles are projected to earn $167 million (or 12 percent) of the United States' commercial launch revenues, while larger vehicles are expected to garner $1.2 billion (or 88 percent) of the United States total.

Special Report

AN OVERVIEW OF THE U.S. COMMERCIAL SPACE LAUNCH INFRASTRUCTURE

Unprecedented Growth Seen for U.S. Commercial Space Launch Infrastructure

The commercial space transportation industry has witnessed unparalleled growth in the number of commercial launches over the past few years. Last year witnessed the largest number yet, 35 commercial launches worldwide, nearly twice the 21 commercial launches of the previous year. The United States, in particular, has experienced dramatic growth in commercial launch activity, with a record 17 commercial launches taking place in 1997 (up from 11 commercial launches in 1996). This growth trend is likely to continue, with a very ambitious 29 commercial launches planned for U.S. launch sites this year and at least another 25 such launches for 1999.

The United States government has, since the 1950s, built, operated, and maintained a space launch infrastructure for launching satellites into space. Most notably, Cape Canaveral Air Station and Vandenberg Air Force Base have been the backbone of the U.S. orbital launch infrastructure. Much of the demand for and use of these launch sites has traditionally come from U.S. military and civil government agencies. Beginning in the early 1980s, a number of the government-operated launch sites began providing support for commercial launch activities as well, with NASA acting as the primary intermediary for providing launch services to satellite operators. Following the Challenger accident, a White House decision in August 1986 ruled that launch customers could solicit bids directly from the launch vehicle builders who would, in turn, lease launch facilities

Figure 1. U.S. Commercial Space Launch Infrastructure

from NASA or the U.S. Air Force. This decision, coupled with the 1984 U.S. Commercial Space Launch Act and its 1988 amendments, did much to foster a true commercial launch business, which continues to grow to this day.

Today, even further commercialization of the U.S. launch infrastructure is evident, with two trends taking place in the launch industry. First, true commercially operated launch facilities have made significant progress toward realization. Earlier this year, the very first launch from a U.S. commercial launch site took place at Spaceport Florida. Second, the U.S. Air Force is taking steps to accommodate a much greater number of commercial launches from the federal ranges as well. A range modernization and upgrade program has been established to help reduce launch site costs and turn around times as well as to improve range flexibility and responsiveness. Some range organizations are also making business process improvements in a concerted effort to improve service quality for commercial and government users of the eastern and western ranges.

CURRENT COMMERCIAL LAUNCH SITES

Since September 1996, three organizations have been awarded a commercial Launch Site Operator License by the FAA Associate Administrator for Commercial Space Transportation. These licenses support three sites – Spaceport Florida, California Spaceport, and the Virginia Space Flight Center – which are co-located with federal launch facilities but are run by non-federal organizations at these sites.

Up until January 1998, the majority of U.S. commercial launch activity had taken place at the federal launch ranges. Spaceport Florida's launch of Lunar Prospector on an Athena 2 on January 6, 1998 marked the first ever launch from a commercial site. Sea Launch, a commercial partnership headed by Boeing Commercial Space Company, will begin operation of its own mobile launch facility off shore, in international waters, later this year. Sea Launch's mobility is similar to that of Orbital Sciences Corporation's Pegasus, an air-launched small launch vehicle deployed from an L-1011 aircraft. Other organizations examining the possibility of commercial launch sites include the Alaska Aerospace Development Corporation, the New Mexico Office of Space Commercialization, Beal Aerospace Technology, Inc., and the Texas Aerospace Commission. A discussion of each of the current and proposed commercial launch sites follows.

Spaceport Florida

The Spaceport Florida Authority (SFA) was established in 1989 by the state of Florida to facilitate the development of the state's space related industry. A commercial license from the FAA Associate Administrator for Commercial Space Transportation was awarded to the Spaceport Florida Authority on May 22, 1997. The SFA facility consists of about 70 acres of land owned by the U.S. Air Force and operated by the U.S. Navy's Strategic Systems Program Office. The Spaceport Florida Authority charges approximately $300,000 per use of the facility.

The cornerstone of SFA's efforts was refurbishing Launch Complex 46, an old Trident missile launch site at Cape Canaveral Air Station, to accommodate small commercial launch vehicles. The philosophy behind developing Launch Complex 46 was not to tailor a facility for a single launch system, but rather to build a public transportation infrastructure for several competing launch systems. SFA's Launch Complex 46 can accommodate a variety of launch vehicle configurations, and payload lift

capabilities up to 4,000 pounds to LEO are possible. In the future, the complex could even accommodate lift capabilities in excess of 4,900 pounds to LEO. From its position on Cape Canaveral, Launch Complex 46 can accommodate mission profiles with launch azimuths ranging from 47° NE to 110° SE (and any other azimuths that the Air Force would approve), and orbital inclinations from 28.5° to 58°. Launches to LEO, GEO, and interplanetary trajectories can be conducted from this site.

As Spaceport Florida is located on the Cape Canaveral Air Station, the commercial launch site can offer all necessary support services by relying on existing range infrastructure. Payload processing facilities, including cleanroom environments are available from off-site commercial providers, in addition to range tracking and telemetry equipment required to conduct launch operations.

Currently, the launch complex is configured to launch vehicles that use the Castor 120 or similar solid motor as a first stage. Examples include Lockheed Martin's Athena launch vehicle and Orbital Sciences Corporation's Taurus vehicle. Infrastructure can support launch vehicles with a maximum height of 120 feet and diameters ranging from 50 to 120 inches. The first launch from Launch Complex 46 was of the Lockheed Martin Athena 2 launch vehicle, which deployed the Lunar Prospector mission for NASA in January, 1998. The next launch planned from Spaceport Florida will be of the Athena 1 vehicle this December, when it will deploy the Rocsat satellite for Taiwan.

The next major effort by the SFA is to convert former Titan 1, Titan 2, and suborbital pads to service a variety of small launch vehicles for both orbital and suborbital launches. In September 1997, the SFA announced plans to develop Launch Complex 20, which includes three launch pads, a launch control blockhouse, and an on-site facility for small payload preparation and storage. The SFA hopes to take advantage of these facilities to provide a rapid response capability for the LEO communications satellite replacement market or for scientific payloads. By refurbishing the blockhouse, the SFA hopes to offer a multi-user launch control and data monitoring system that will serve several types of vehicle and payload systems. Development of Launch Complex 20 is expected to cost about $3 million. The Air Force will provide about $2.5 million in funding, and the State of Florida has appropriated $125,000 for the project, according to the Spaceport Florida Authority.

Other current SFA activities include the development of a new $16 million Space Operations Support Complex to provide a single operations facility for visiting launch and payload teams.

The Spaceport Florida Authority has also attracted several launch industry support providers to the state, including a $27 million liquid hydrogen rocket fuel production facility, a $27 million rocket motor storage facility, and a $5 million university-based satellite technology development center.

SPACEPORT FLORIDA
Cape Canaveral Air Station, Florida

Location.....28.5° N, 81° W
Launch Azimuths.....47° NE to 110° SE
Operator.....Florida Spaceport Authority
First Launch.....1998
Orbital Launches to Date.....1
First Commercial Launch.....1998
Orbits Addressed.....All Orbits
Most Launches in One Year.....1 (1998)
Most Commercial Launches.....1 (1998)
Vehicles Currently Serviced.....Athena
Vehicles Proposed for Site.....Taurus, various RLVs

California Spaceport

While the Spaceport Florida is operated by a public transportation authority, the California Spaceport is a commercially operated launch services company, utilizing leased property on Vandenberg Air Force Base. The California Spaceport is operated and managed by Spaceport Systems International, L.P. (SSI), a limited partnership between ITT Federal Services Corporation and California Commercial Spaceport, Inc.

The California Spaceport was the first commercial launch site to be licensed by the Associate Administrator for Commercial Space Transportation (September 19, 1996). From its position on Vandenberg, the launch site is situated to support a variety of mission profiles to low polar orbit inclinations, with possible launch azimuths ranging from 220° to 150°.

The focus of the California Spaceport's payload processing services was originally on the refurbishment of the Payload Preparation Room, which was a cleanroom facility designed to process three Space Shuttle payloads simultaneously. The Payload Preparation Room, located near Space Launch Complex 6 (SLC-6), is now leased by SSI as their Integrated Processing Facility (IPF). SSI will be a provider of payload processing services and orbital launch support services for both commercial and government users. California Spaceport provided payload processing services for the NASA Lewis satellite and has contracts to provide payload processing for two Earth Observation System (EOS) satellites.

California Spaceport's new launch complex, when complete, will be equipped to accommodate several configurations of small launch vehicles, based on either Castor 120 or Minuteman solid motor first stages. SSI also has plans to provide facilities to service launch vehicles using a variety of liquid and cryogenic fuels. Additionally, the completed launch complex will provide two Stack & Checkout Facilities for preparing launch vehicles. Rail-mounted Mobile Launch Platforms (MLP's) will transport the stacked vehicle and payload to the launch site.

Phase I construction at California Spaceport's launch complex began in 1995. Currently in place are the concrete flame ducts, communication, electrical, and water infrastructure. Phase II construction in preparation for the Minotaur launch will commence in the fall of 1998, to be completed by May 1999. Further construction will depend on requirements provided by the California Spaceport's next orbital launch customer.

In September 1999, California Spaceport will support the launch of an orbital payload under the Air Force's Orbital/Sub-orbital Program (OSP) intended to use surplus ballistic missile assets to deploy government payloads. The launch will be carried out by the new Minotaur launch vehicle, which consists of a modified Minuteman II first stage and second stage, with an Orbital Sciences Corporation Pegasus upper stage. The Minotaur will deploy JAWSAT, a

CALIFORNIA SPACEPORT
Vandenberg Air Force Base, Lompoc, California

Location	34.4° N, 120.35° W
Launch Azimuths	150° SE to 220° SW
Operator	Spaceport Systems International
First Launch	1999 (projected)
Orbital Launches to Date	None
First Commercial Launch	1999 (projected)
Orbits Addressed	LEO
Most Launches in One Year	N/A
Most Commercial Launches	N/A
Vehicles Currently Serviced	N/A
Vehicles Proposed for Site	Athena, Taurus, Minotaur, Various RLVs

joint project by the Air Force Academy and Weber State University.

Virginia Space Flight Center

The Virginia Space Flight Center (VSFC) is operated by the Virginia Commercial Space Flight Authority in cooperation with NASA at the Wallops Flight Facility on Wallops Island, Virginia.

The origins of this commercial launch site began at Virginia's Old Dominion University in 1992. That year, the Center for Commercial Space Infrastructure was created to establish commercial space research and operations facilities in the state of Virginia. The Center worked in cooperation with Wallops Flight Facility to develop a commercial launch infrastructure there. Three years later, Virginia Governor George Allen signed a bill into law creating the Virginia Commercial Space Flight Authority (VCSFA) as a public organization specifically to develop a Virginia commercial launch capability. The Center for Commercial Space Infrastructure is currently the Executive Directorate for the VCSFA.

From its position on Virginia's southeastern Atlantic coast, Wallops Island can accommodate orbital inclinations between 38° and 60°. Launch azimuths available from VSFC range between 90° east and 160° southeast (or any other azimuth approved by NASA Goddard Space Flight Center, Wallops Flight Facility, and the FAA). Facilities exist to service a variety of solid-fueled vehicles. The Virginia Commercial Space Flight Authority was awarded a commercial launch site operator license by the FAA on December 19, 1997.

In 1997, the VCSFA signed an agreement with NASA to use NASA facilities at Wallops in support of commercial launches under what is known as the NASA/Virginia Commercial Space Flight Authority Reimbursement Space Act Agreement. The 30-year agreement allows the Authority access to the NASA facilities on a cost reimbursement basis.

VIRGINIA SPACE FLIGHT CENTER
Wallops Flight Facility, Virginia

Location	37.8° N, 75.5° W
Launch Azimuths	90° E to 160° SE
Operator	Virginia Commercial Space Flight Authority
First Launch	1999 (projected)
Orbital Launches to Date	None
First Commercial Launch	1999 (projected)
Orbits Addressed	LEO
Most Launches in One Year	N/A
Most Commercial Launches	N/A
Vehicles Currently Serviced	N/A
Vehicles Proposed for Site	Athena, Taurus, various RLVs

The Virginia Space Flight Center is not the first commercial venture at Wallops Flight Facility. In 1994, EER Systems of Seabrook, Maryland, built and operated pad LP 0-A, to be used by EER's Conestoga launch vehicle. The Conestoga's first and only attempted launch from this location took place in fall 1995. The launch pad is still commercially owned by EER Systems.

Development of the commercial facilities include completion of launch pad LP 0-B, which will consist of a 19,000-square foot pad and a 182-foot service tower, equipped with a 75-ton crane for vehicle and payload handing. Phase I construction of the pad began in early 1998 and is planned to be completed by the end of the year. Phase I includes the pad, launch mount, and some additional supporting infrastructure. The service tower will be included in subsequent phases. The new pad is designed as a "Universal Launch Pad," capable of supporting a variety of small and medium launch vehicles. The most likely vehicles

for the facility are the Lockheed Martin Athena or the Orbital Sciences Corporation Taurus.

A new payload processing and integration facility with a class-100,000 cleanroom[1] is also planned. Other available facilities include downrange tracking equipment, including a ground station on Antigua and the mobile ground equipment based out of Wallops.

Sea Launch

In April 1995 it was announced that a new venture called Sea Launch planned to loft Ukrainian-built Zenit rockets from a mobile, floating launch platform in international waters in the east-central equatorial Pacific Ocean. The Sea Launch partnership is led by Boeing Commercial Space Company and includes Norwegian ship building company Kvaerner Maritime a.s., the Ukrainian rocket builder KB Yuzhnoye, and the Russian space company RKK Energia, which produces the vehicle's upper stage.

The Sea Launch system consists of three main parts: the Assembly & Command Ship (ACS), the launch platform, and the Zenit 3SL vehicle. The ACS houses the vehicle integration facilities and is where the vehicle stages are assembled while docked at the Sea Launch home port in Long Beach, CA. Ground breaking began at the home port in August 1996 and was completed in March 1998. Construction of the ACS began in December 1995. The ship was later outfitted with launch systems hardware at St. Petersburg, Russia. The command ship departed Russia in June 1998 and arrived in Long Beach in mid-July.

The launch platform is a self-propelled semi-submersible ocean vessel converted from an oil-drilling platform. Installation of the launch support hardware began in Russia in April 1997 before the platform departed for Long Beach in June 1998. The launch hardware included the transporter erector system, fueling systems, and control systems for the highly automated Zenit vehicle.

The Zenit, on which the Sea Launch vehicle is based, is built by Yuzhnoye of Dnepropetrovsk, Ukraine. Unlike other Soviet heritage launch vehicles, Zenit was not derived from a ballistic missile. Rather, it was built as a next generation space launch vehicle in the early 1980's and has been primarily used to loft heavy LEO satellites for the Soviet and Russian military.

Payload processing for Sea Launch is conducted at Astrotech's new Payload Processing Facility located at the Long Beach home port. The integrated vehicle is rolled off onto the launch platform, where an environmentally controlled hanger stores the vehicle until launch. The command ship and the launch platform then depart for the launch site, located along the equator about 1,400 miles from Hawaii. The vehicle is rolled out of the hanger and erected on the launch platform, while launch operations are conducted from the control ship.

SEA LAUNCH
Pacific Ocean

Location .....Mobile (first launch from 0° N, 154° W)
Launch Azimuths .....N/A
Operator.....Sea Launch
First Launch.....Projected 1998
Orbital Launches to Date.....None
First Commercial Launch.....None
Orbits Addressed.....GEO, MEO
Most Launches in One Year.....N/A
Most Commercial Launches.....N/A
Vehicles Currently Serviced.....None
Vehicles Proposed for Site.....Zenit Sea Launch

[1] A class-100,000 cleanroom is a facility inside which each cubic foot of air contains no more than 100,000 particles greater than or equal to 0.5 microns in size.

Sea Launch has firm commitments for 18 launches: thirteen for Hughes and five for Loral. The first launch of the Zenit Sea Launch is planned for early 1999 and will loft the Galaxy 11 satellite for PanAmSat.

Pegasus

A report on the U.S. commercial launch infrastructure would not be complete without some mention of the Pegasus launch vehicle manufactured by Orbital Sciences Corporation. Because this vehicle is air-launched from underneath an aircraft, the Pegasus launch system is considered unique from "fixed' launch systems in that its launch site is mobile (not unlike the Sea Launch platform, which can change its ocean-based location to accommodate a variety of launch requirements).

The Pegasus is primarily used to launch small payloads to LEO for U.S. government and commercial customers. A B-52 aircraft and, now, an L-1011 aircraft have departed from numerous locations carrying the Pegasus launch vehicle, demonstrating the mobility offered by its air-launched configuration. Pegasus launch sites, from which the aircraft have flown, have included Vandenberg Air Force Base, Edwards Air Force Base, Kennedy Space Center, Wallops Flight Facility, Cape Canaveral Air Station, as well as one launch from the Spanish Canary Islands (the only Pegasus launch from a location outside of the United States).

PEGASUS
Various Launch Locations

Location ..... Mobile
Launch Azimuths ..... N/A
Operator ..... Orbital Sciences Corporation
First Launch 1990
Orbital Launches to Date 22
First Commercial Launch 1993
Orbits Addressed ..... LEO, ELI
Most Launches in One Year 5 (1996, 1997)
Most Commercial Launches 3 (1997)
Vehicles Currently Serviced ..... Pegasus
Vehicles Proposed for Site ..... N/A

The launch from Spain successfully deployed the Minisat 01 satellite for the Spanish National Institute of Aerospace Technology (INTA) on April 21, 1997. Officials at Orbital Sciences Corporation have indicated that they would like to conduct additional launches from satellite owners' home countries in the future.

PROPOSED COMMERCIAL LAUNCH SITES

Southwest Regional Spaceport

The Southwest Regional Spaceport (SRS) is a proposed commercial launch site that would be located adjacent to the White Sands Missile Range in New Mexico.

The Southwest Regional Spaceport has been promoted by the New Mexico Office of Space Commercialization (NMOSC), a division of the Economic Development Department of the State of New Mexico. Support for developing a spaceport comes from the U.S. Air Force and the New Mexico State government. The Environmental Impact Study for this site was funded with $1.3 million in state funds.

Unlike the other commercial launch sites, the Southwest Regional Spaceport would be able to service the next generation of reusable launch vehicles (RLVs) due to its inland location. Previously McDonnell Douglas had used White Sands for testing and development of the Clipper Graham (or DC-XA), a precursor to a vertical take-off and landing reusable launch vehicle. The New Mexico site was a strong contender as a site for continued DC-XA development under the NASA X-33 program, as well as the further development of an operational RLV based on that

SOUTHWEST REGIONAL SPACEPORT
White Sands, New Mexico

Location .....33° N, 106.5° W
Launch Azimuths .....N/A
Operator.....New Mexico Office of Space Commercialization
First Launch.....N/A
Orbital Launches to Date.....None
First Commercial Launch .....N/A
Orbits Addressed .....Planned suborbital, LEO
Most Launches in One Year .....N/A
Most Commercial Launches.....N/A
Vehicles Currently Serviced.....None
Vehicles Proposed for Site .....Various RLVs

design. Lockheed Martin's lifting body configuration was chosen for the X-33 program over the McDonnell Douglas proposal. Nevertheless, attracting an RLV launch provider remains a priority for the New Mexico site.

Several studies related to building a commercial launch site in New Mexico have been conducted. In April 1995, an 18-month study was completed by New Mexico State University's Physical Sciences Lab and McDonnell Douglas outlining requirements for a site to conduct commercial and government launches. Environmental impact studies are also progressing. A commercial launch facility at the New Mexico site would initially use tracking facilities from neighboring White Sands. Plans also call for construction of launch pads, an aircraft runway, and payload processing facilities. The cost of establishing a commercial launch site at the New Mexico site has been estimated to be between $80 and $120 million.

Kodiak Launch Complex

Narrow Cape, on Kodiak Island off the southern coast of Alaska, is the Alaska Aerospace Development Corporation's site for the state's first commercial launch site. From this location, the launch site can accommodate a variety of orbital and sub-orbital mission profiles. The location's wide launch-azimuth range allows for launches between 64° posigrade and 64° retrograde. This feature would allow a variety of remote sensing, communication, and scientific payloads to be launched into LEO and highly elliptical orbits.

The Alaska Aerospace Development Corporation (AADC) is a public corporation founded by the Alaskan state government in 1991 to support the development of the aerospace industry in Alaska. In 1993, the agency was awarded $1.1 million from the U.S. Air Force to develop plans for a launch complex in Alaska that would be capable of launching payloads of about 3,500 pounds to a high inclination orbit. In 1994, the AADC rejected a proposal to build a launch site at the Poker Flat Research Range, a university-owned facility for launching sounding rockets near the city of Fairbanks, in favor of the Kodiak facility. In 1996, the Air Force awarded the AADC $6 million to support launches of Minuteman II derivative vehicles, with launches commencing in 1998 under the Orbital/Sub-orbital Program (OSP).

A commercial launch site license application was filed by AADC with the FAA on January 22, 1997 for the Kodiak Launch Complex.

Construction of the new launch site began in

KODIAK LAUNCH COMPLEX
Narrow Cape, Kodiak Island, Alaska

Location .....57.5° N, 153° W
Launch Azimuths .....116° SE to 244° SW
Operator.....Alaska Aerospace Development Corp.
First Launch.....Projected 1998
Orbital Launches to Date.....None
First Commercial Launch .....None
Orbits Addressed .....Planned suborbital, LEO, highly elliptical
Most Launches in One Year .....N/A
Most Commercial Launches.....N/A
Vehicles Currently Serviced.....None
Vehicles Proposed for Site .....Athena, Taurus, various RLVs

January 1998, and AADC plans to conduct its first launch from Kodiak Launch Complex in September 1998. The first launch will be a suborbital launch for the U.S. Air Force Space and Missile Systems Center, Launch Test Programs Division (SMC/TEB) at Kirtland AFB, NM. The primary goal of the flight will be to simulate a ballistic missile attack profile and evaluate the performance of early warning radar systems. The ait-1 (atmospheric interceptor technology) mission will use a vehicle supplied by Orbital Sciences Corporation.

The vehicle's first and second stages will be a modified second and third stage Minuteman II, without the Minuteman II first stage.

The fully operational commercial launch site would include facilities for payload processing, including a class-100,000 cleanroom. The payload processing facility will include a 40-foot by 60-foot airlock and a 40-foot by 60-foot processing bay, each with 2,400 sq. ft. of floor space. Detailed designs have also been completed for the pad service structure and a facility for transporting the completed vehicle to the pad. No firm orbital launch customers have yet been found for the Kodiak site.

The AADC is also supporting the development of ground station facilities near Fairbanks, Alaska in cooperation with several commercial remote sensing companies. The high latitude location makes the Fairbanks site favorable for polar orbiting satellites, which typically pass above Fairbanks several times daily. Also under consideration is the use of Wallops Flight Facility's mobile tracking stations.

Other Proposed Commercial Launch Sites

Beal Aerospace Technology, Inc. has selected Sombrero Island in the Caribbean to be the launch site for its BA-2 launch vehicle. From this location, the BA-2 will be able to address a variety of orbital destinations, and the low latitude of the site will allow the BA-2 to deliver more than 11,000 pounds to geosynchronous transfer orbit. The Caribbean nation of Anguilla has leased Sombrero Island to Beal Aerospace under a 98-year exclusive use agreement. The island is a dependent territory of the United Kingdom and is located about 35 miles northwest of Anguilla. Sombrero Island is approximately one mile long and three-eighths of a mile across, comprising 100 acres. Sombrero Island is uninhabited, except for a lighthouse located at one end of the island. Beal Aerospace plans to construct a launch pad for its BA-2 vehicle at one end of the island and a horizontal vehicle integration building at the other. Additional planned infrastructure includes an aircraft runway, a heavy-load roadway between the vehicle integration building and the launch pad, and a port area near the vehicle integration building to allow barge access for vehicle stages and other equipment. Beal Aerospace Technology, Inc. is unique in that it is developing a new vehicle and launch site as a wholly commercial venture.

The Texas Aerospace Commission, an agency established by the Texas state government to promote development of aerospace industries in Texas, has been investigating the possibility of establishing a commercial launch site in that state. Currently up to seven sites including five along the Texas gulf coast and two in west Texas are being evaluated as potential locations for the commercial launch site. Texas Aerospace Commission officials are continuing discussions with various government and launch industry representatives concerning Texas as a host for a new launch site.

COMMERCIAL DEVELOPMENTS AT THE FEDERAL RANGES

The U.S. federal ranges have supported commercial launch activity since the mid 1980s. The Eastern range at Cape Canaveral and the Western range at Vandenberg Air Force Base are where the bulk of the nation's government and commercial launches are conducted today. Additional orbital launch activities are conducted at the Kennedy Space Center, Wallops Flight Facility, and Edwards Air Force Base. Wallops has also supported commercial launches of Pegasus from other locations, such as Spain. A number of government-operated missile and scientific research sites (e.g., White Sands, the Pacific Missile Range Facility) have also been home to FAA-licensed suborbital launch activity. Other suborbital facilities, such as Kwajalein and Poker Flat, have considered expanding their launch sites to full-fledged orbital launch facilities as well.

The U.S. government, primarily the Air Force, is preparing to accommodate the continuing increase in the number of commercial launches from the federal launch sites. This will be accomplished through range modernization programs that will upgrade much of the range's support and communications systems. The U.S. Air Force began a complete range modernization program in 1987 and in July 1993. The Range Standardization and Automation (RSA) program is a key effort to modernize and upgrade the Eastern range at Cape Canaveral and portions of the Western range at Vandenberg.

The RSA program will replace obsolete 1960s and 1970s vintage telemetry, tracking, command and control, weather, area surveillance, and communications systems with modern and efficient systems. The program is intended to help reduce range costs and turn around times, and improve range flexibility and responsiveness.

One of the key RSA proposals is the change from ground-based radar tracking to GPS-based tracking. This will provide highly accurate launch vehicle time, space, and position information. However, it will also require upgrades to both U.S. range systems and launch vehicles. Once these conversions are complete, the U.S. Air Force projects that it will be able to close 12 range radars, saving over $300M in operations and sustainment costs.[2]

Launch pad modifications are also underway to accommodate the next generation of the Delta and Atlas launch systems, the Delta 3 and the Atlas 3. Work is also progressing to support the new EELV family of launch vehicles, each being separately developed by Boeing and Lockheed Martin. A more complete discussion on each of the federal launch sites and their individual efforts at modernization and upgrades is provided below.

Cape Canaveral Air Station

The two launch complexes at Cape Canaveral Air Station (CCAS) most frequently used for commercial launch activity are launch complexes 17 and 36, used for Delta and Atlas vehicles respectively. CCAS also currently supports launches of Athena, Titan, and Pegasus vehicles.

The Boeing Delta 2 launch vehicle family has deployed a wide variety of commercial and government payloads from CCAS. The Globalstar system of LEO communication satellites have been launched on Delta 2 vehicles.

[2] Speech by Lt Gen Lord at the Federal Aviation Administration's conference on *Commercial Space Transportation in the 21st Century: Technology and Environment, 2001-2025*, 10 February 1998, at the Key Bridge Marriott Hotel, Arlington, VA

The Delta 2 is also used to launch medium-weight class satellites to GEO from Launch Complex 17 pads A and B. Pad B has been modified to accommodate the larger Delta 3, which will be used to launch intermediate-weight class GEO communications satellites. Improvements include new flame ducts and additional umbilical connectors. The first Delta 3 launch will deploy the Galaxy 10 satellite for PanAmSat in August of this year.

The Lockheed Martin Atlas 2 launch vehicle family primarily uses CCAS to launch intermediate-weight class communications satellites to GEO from Launch Complex 36 pads A and B. Pad B is undergoing modifications for the Atlas 3, which is expected to launch its first payload in early 1999. Modifications include improvements to the Mobile Service Tower, Umbilical Tower, and Launch Support Building. New flame ducts are also being installed, along with a variety of equipment related to fueling vehicles with liquid propellants. Work on both the Atlas and Delta pads is being conducted concurrently on a non-interference basis with existing Atlas 2 and Delta 2 operations from these pads.

CAPE CANAVERAL AIR STATION
Merritt Island, Florida

Location	28.5° N 81° W
Launch Azimuths	93° SE to 105° SE
Operator	U.S. Air Force / 45th Space Wing
First Launch	1950
Orbital Launches to Date	508
First Commercial Launch	1982
Orbits Addressed	All orbits
Most Launches in One Year	30 (1966)
Most Commercial Launches	9 (1990, 1995, 1996)
Vehicles Currently Serviced	Atlas 2, Athena 1 & 2, Delta 2, Titan 4, Pegasus
Vehicles Proposed for Site	Atlas 3, Delta 3, Delta 4, Lockheed Martin EELV, various RLVs

Modernization of range support equipment, including radar and telemetry facilities, play a vital part in the commercial launch providers' ability to conduct launch operations efficiently and cost effectively. The Range Operations Control Center (ROCC) began initial services in 1995, after an eight-year effort to modernize and consolidate range safety assets at Cape Canaveral Air Station. Improvements at CCAS allowed for better handling of information related to range communications, range safety control systems, scheduling, weather forecasting at the range, and other data processing functions.

Vandenberg Air Force Base

Almost all launch activity to date from Vandenberg Air Force Base (VAFB) has been for missions to low Earth orbit, the majority for government customers. Vandenberg Air Force Base has supported commercial activity since 1989. To date, all 18 commercial launches from VAFB have been LEO launches.

The Boeing Delta 2 launch vehicle has carried out commercial missions from Vandenberg as well as from Cape Canaveral. The Vandenberg launch site is situated to accommodate mission profiles to polar LEO orbits and has been used to deploy the Iridium constellation of communication satellites. Work was completed on the pad at Space Launch Complex 2 West (SLC 2W) in 1995 to accommodate Delta 2 launches, and can handle up to six launches annually.

The Lockheed Martin Atlas 2 has not flown commercial missions from Vandenberg, but Space Launch Complex 3 East (SLC 3E) has been modified to handle future launches of the Atlas 2. The first mission for the Atlas 2 at Vandenberg will be to deploy the Earth Observation System (EOS) AM-1 mission for NASA on an Atlas 2AS, now set for early 1999. Extensive work at

VANDENBERG AIR FORCE BASE
Lompoc, California

Location ..... 34.4° N 120.35° W
Launch Azimuths ..... 147° SE to 286° NW
Operator ..... U.S. Air Force / 33rd Space Wing
First Launch 1958
Orbital Launches to Date 591
First Commercial Launch 1989
Orbits Addressed ..... LEO
Most Launches in One Year 46 (1966)
Most Commercial Launches 9 (1997)
Vehicles Currently Serviced ..... Atlas 2, Athena 1 & 2, Delta 2, Titan 2, Titan 4, Pegasus
Vehicles Proposed for Site ..... Athena, Taurus, various RLVs

this facility included a new mobile service tower and umbilical tower, for a total project cost of about $300 million. At least three additional classified launches for the Department of Defense have been identified for polar Atlas 2 launches through 2002. The Atlas 2 can be used to launch to a variety of polar LEO orbits from this location, but no commercial customers are known to have purchased a polar Atlas 2 launch at this time.

Kennedy Space Center

The Kennedy Space Center (KSC) is located on Merritt Island adjacent to the U.S. Air Force launch facilities at the Cape Canaveral Air Station. It was originally created to support the Apollo lunar landing program, and all of the crewed Apollo flights took place from KSC. Following the last Saturn launches from this site it was modified to support the Space Shuttle program. In addition to ongoing non-commercial Shuttle flights, between 1982 and 1986, 11 Shuttles were launched from the KSC with commercial payloads. Since that time there have been no commercial shuttle flights, although United Space Alliance has proposed a return to commercial shuttle operations.

KENNEDY SPACE CENTER
Merritt Island, Florida

Location ..... 28.5° N, 81° W
Launch Azimuths ..... 39° NE to 120° SE
Operator ..... NASA
First Launch 1964
Orbital Launches to Date 119
First Commercial Launch 1982
Orbits Addressed ..... All Orbits
Most Launches in One Year 9 (1985)
Most Commercial Launches 4 (1985)
Vehicles Currently Serviced ..... Space Shuttle
Vehicles Proposed for Site ..... N/A

In 1985, a commercial Pegasus launch was made from the KSC. There have been no Pegasus launches from this site since.

Wallops Flight Facility

Wallops Island has operated as a sounding rocket range since 1945 and conducted its first orbital launch in 1961, when a Scout launch vehicle deployed the Explorer 9 balloon that was used to study atmospheric density. Since that time, several orbital and suborbital missions have been conducted at Wallops for NASA. In 1994, EER Systems completed launch pad LP 0-A, which was built to support its Conestoga launch vehicle. The first and only flight of Conestoga failed to deploy the METEOR recoverable satellite, designed for microgravity experiments, in 1995.

Other orbital launches from Wallops have included flights of Orbital Sciences Corporation's Pegasus air-launched vehicle, the first of which deployed the MSTI 3 satellite in 1996 on a commercially licensed launch. The next two Pegasus flights will deploy 16 Orbcomm LEO communication satellites this year. In April 1996, the Air Force designated Wallops Flight Facility as one of the sites to conduct launches of converted Minuteman II missiles under the Orbital/Sub-orbital Program (OSP), along with Kodiak Launch Complex and the California Spaceport.

WALLOPS FLIGHT FACILITY
Wallops Island, Virginia

Location .....37.8° N 75.5° W
Launch Azimuths .....90° E to 109° SE and 126° SE to 129° SE
Operator.....NASA
First Launch.....1945
Orbital Launches to Date.....26*
First Commercial Launch 1995
Orbits Addressed .....LEO
Most Launches in One Year.....3 (1961, 1964, 1965)
Most Commercial Launches.....3 (1961, 1964, 1965)
Vehicles Currently Serviced.....Pegasus
Vehicles Proposed for Site .....N/A
* Includes Pegasus launches.

At present, a Wallops tracking station located on the island of Bermuda has not been appropriated funds for continued operation. Plans call for using the TDRS satellites for tracking purposes.

Other Federal Launch Facilities

Several military ranges have also entered the commercial space market, either launching commercial missions or using commercially-available launch vehicles. In one example, two licensed commercial suborbital flights of a Talos Castor were launched from Barking Sands, Hawaii, in September 1994. These launches carried the Zest 1 and Zest 2 experiments for the Ballistic Missile Defense Organization (BMDO). Between 1989 and 1996, eight commercial suborbital missions launched from New Mexico's White Sands Missile Range. One of these launches lofted a Black Brant 9 for EER Systems while the remaining seven launches were of Starfire vehicles. Edwards Air Force Base was the site of six non-commercial flights of the commercially-available Pegasus rocket between 1990 and 1994.

In 1997, the Department of Energy granted the Nevada Test Site (NTS) Development Corporation access to the Nevada Test Site for commercial development. Original plans called in part for Kistler Aerospace to use the test site as the development and launch site for its K-1 reusable two-stage launch vehicle. Kistler must first obtain approval from the Federal Aviation Administration before beginning operations in Nevada. Kistler has also invested $32 million in the development of a launch site in Woomera, Australia. Construction in Woomera began in May 1998 and the first test launch is scheduled to take place in the second half of 1998.

The Army first considered offering the Kwajalein Missile Range, located about 2500 miles southwest of Honolulu, as a commercial space launch site in 1997. According to the U.S. Army Space and Missile Defense Command, Kwajalein's near-equatorial position makes it an ideal site for launching larger payloads into a geostationary orbit. As of early July 1998, it is unknown whether plans to develop Kwajalein as a commercial launch site will proceed.

OTHER FEDERAL LAUNCH SITES:

EDWARDS AIR FORCE BASE
California

Location .....35° N 117° W
Launch Azimuths .....N/A
Operator.....U.S. Air Force
First Launch.....1990
Orbital Launches to Date.....6
First Commercial Launch .....None
Orbits Addressed .....LEO
Most Launches in One Year 3 (1994)
Most Commercial Launches.....N/A
Vehicles Currently Serviced.....Pegasus
Vehicles Proposed for Site .....Various RLVs

PACIFIC MISSLE RANGE FACILITY
Barking Sands, Kauai, Hawaii

Location .....22.7° N 157.40° W
Launch Azimuths .....N/A
Operator.....U.S. Navy
First Launch.....1962
Orbital Launches to Date.....None
First Commercial Launch 1991
Orbits Addressed .....Suborbital only
Most Launches in One Year .....N/A
Most Commercial Launches.....2 (1991)
Vehicles Currently Serviced.....None
Vehicles Proposed for Site .....None

KWAJALEIN MISSILE RANGE
Kwajalein Atoll, Marshall Islands

Location .....9.15° N 166.12° W
Launch Azimuths .....N/A
Operator.....U.S. Army
First Launch.....N/A
Orbital Launches to Date.....None
First Commercial Launch .....None
Orbits Addressed .....Suborbital only, proposed all orbits
Most Launches in One Year .....N/A
Most Commercial Launches.....N/A
Vehicles Currently Serviced.....None
Vehicles Proposed for Site .....Various ELVs & RLVs

OTHER FEDERAL LAUNCH SITES (CONTINUED)...

POKER FLAT RESEARCH RANGE
University of Alaska Fairbanks, Alaska

Location .....65.07° N 147.29° W
Launch Azimuths .....N/A
Operator.....Geophysical Institute, NASA
First Launch.....1968
Orbital Launches to Date.....None
First Commercial Launch .....None
Orbits Addressed .....Suborbital only
Most Launches in One Year .....N/A
Most Commercial Launches.....N/A
Vehicles Currently Serviced.....None
Vehicles Proposed for Site .....Various RLVs

WHITE SANDS MISSILE RANGE
Tularosa Basin, New Mexico

Location .....33° N 106.5° W
Launch Azimuths .....N/A
Operator.....Department of Defense
First Launch.....1945
Orbital Launches to Date.....None
First Commercial Launch 1989
Orbits Addressed .....Suborbital only
Most Launches in One Year .....N/A
Most Commercial Launches.....2 (1989)
Vehicles Currently Serviced.....None
Vehicles Proposed for Site .....Various RLVs

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

BSAT Broadcast Satellite System Corp. Satellite
CBERS China/Brazil Earth Resources Satellite
CCAS Cape Canaveral Air Station
DARA German Space Agency
DASA Deutsche Aerospace
DoD Department of Defense
DoT Department of Transportation
ELI Elliptical
ELINTS Electronic intelligence satellites
ELV Expendable Launch Vehicle
ESA European Space Agency
ETS Engineering Test Satellite
EXT Extra-Orbital
FAA Federal Aviation Administration
FY Fen Yung
GBS Global Broadcast System
GEO Geosynchronous Orbit
GTO Geosynchronous Transfer Orbit
INMARSAT - International Maritime Satellite Organization
INPE National Institute for Space Research
INTA Instituto Nacional de Tecnica Aeroespacial
INTELSAT - International Telecommunications Satellite Organization
IRS Indian Resource Satellite
ISAS Institute of Space and Astronautical Science
ISRO Indian Space Research Organization
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
MEO Middle Earth Orbit
MoD Ministry of Defense
MUBLCOM - Multiple Beam Beyond Line-of-Sight Communications
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
NSAB Nordiska Satellit AB
OSC Orbital Sciences Corporation
PAS Pan American Satellite
PSLV Polar Satellite Launch Vehicle
PTT Post Telegraph and Telecommunications
QuickSCAT - Quick Scatterometer
RKK Energia - Rocket and Space Company Energia
SACI Satellite Cientifico
SCD Satellite de Coleta de Dados
SES Societe Europeene des Satellites
SLV Satellite Launch vehicle
STEX Sensor Test Experiement
STS Space Transportation System
TERRIERS - Tomographic Experiment using Radiative Recombinative Ionospheric EUV and Radio Sources
TRACE Transition Region and Coronal Explorer
USMP United States Microgravity Payload
VAFB Vandenberg Air Force Base
WIRE Wide-Field Infrared Explorer
XL Extra Long

Characteristics of Cited Vehicles

Vehicle	(Success + Partials) / Attempts	LEO 28 Degrees	GTO	GEO	SUB	Price per Launch (Approx.)	Launch Sites
Heavy							
Ariane 5	1/2|50%	39600 lb. 18000 kg	15000 lb. 6800 kg	N/A*	N/A	$115-143 M	Kourou
Long March 3B	3/4|75%	29900 lb. 13600 kg	9900 lb. 4500 kg	4950 lb. 2250 kg	N/A	$60-70 M	Xichang
Proton (SL-12)	196/219|89.5%	46297 lb. 21000 kg	12100 lb. 5500 kg	4850 lb. 2200 kg	N/A	$50-70 M	Baikonur
Proton (SL-13)	27/30|90%	46000 lb. 20900 kg	16535 lb. 7500 kg	N/A	N/A	$50-70 M	Baikonur
Sea Launch	N/A	35000 lb. 15876 kg	11050 lb. 5000 kg	N/A	N/A	$90-100 M	Pacific Ocean (Pacific Sea Launch)
Shuttle Columbia	25/25|100%	47300 lb. 21455 kg	13007 lb. 5900 kg	5203 lb. 2360 kg	N/A	N/A	KSC
Shuttle Discovery	26/26|100%	47300 lb. 21455 kg	13007 lb. 5900 kg	5203 lb. 2360 kg	N/A	N/A	KSC
Shuttle Endeavour	12/12|100%	47300 lb. 21455 kg	13007 lb. 5900 kg	5203 lb. 2360 kg	N/A	N/A	KSC
Titan 4/Centaur	8/8|100%	39100 lb. 17736 kg	14000 lb. 6350 kg	10200 lb. 4627 kg	N/A	$240-270 M	CCAS
Titan 4B/Centaur	2/2|100%	N/A	N/A	N/A	N/A	N/A	CCAS, VAFB
Titan 4B/IUS	1/1|100%	47800 lb. 21727 kg	N/A	12700 lb. 5773 kg	N/A	N/A	CCAS, VAFB
Zenit 2	23/28|82.1%	30300 lb. 13740 kg	N/A	N/A	N/A	$25-40 M	Baikonur
Intermediate							
Ariane 42L	5/5|100%	16300 lb. 7400 kg	7450 lb. 3380 kg	N/A	N/A	$75-85 M	Kourou
Ariane 44L	24/25|96%	21100 lb. 9600 kg	9965 lb. 4520 kg	N/A	N/A	$90-110 M	Kourou
Ariane 44LP	17/18|94.4%	18300 lb. 8300 kg	8950 lb. 4060 kg	N/A	N/A	$80-95 M	Kourou
Ariane 44P	13/13|100%	15200 lb. 6900 kg	7320 lb. 3320 kg	N/A	N/A	$75-90 M	Kourou
Atlas 2A	13/13|100%	16050 lb. 7280 kg	6700 lb. 3039 kg	3307 lb. 1500 kg	N/A	$65-80 M	CCAS
Atlas 2AS	14/14|100%	19050 lb. 8640 kg	8150 lb. 3688 kg	4604 lb. 2090 kg	N/A	$90-100 M	CCAS, VAFB
Delta 3	N/A	18408 lb. 8350 kg	8360 lb. 3800 kg	N/A	N/A	$55-60 M	CCAS
Soyuz	950/957|99.3%	15400 lb. 7000 kg	N/A	N/A	N/A	$12-25 M	Baikonur, Plesetsk
Medium							
Cyclone 3	112/114|98.2%	8818 lb. 4000 kg	N/A	N/A	N/A	$10-15 M	Baikonur, Plesetsk
Delta 2 7326	N/A	N/A	N/A	N/A	N/A	$45-50 M	CCAS
Delta 2 7420	2/2|100%	N/A	N/A	N/A	N/A	$45-50 M	CCAS
Delta 2 7425	N/A	N/A	N/A	N/A	N/A	N/A	CCAS, VAFB
Delta 2 7920	13/13|100%	11109 lb. 5039 kg	2800 lb. 1270 kg	N/A	N/A	$45-50 M	CCAS, VAFB
Delta 2 7925	39/40|97.5%	11220 lb. 5089 kg	4060 lb. 1840 kg	2000 lb. 907 kg	N/A	$45-50 M	CCAS, VAFB

*GEO capable with kick motor

Characteristics of Cited Vehicles

Vehicle	(Success + Partials) / Attempts	LEO 28 Degrees	GTO	GEO	SUB	Price per Launch (Approx.)	Launch Sites
Medium (cont.)							
Long March 2C	18/18|100%	7040 lb. 3200 kg	2200 lb. 1000 kg	860 lb. 390 kg	N/A	$20-25 M	Jiuquan
Long March 4	2/2|100%	8818 lb. 4000 kg	2430 lb. 1100 kg	1220 lb. 550 kg	N/A	$20-30 M	Taiyuan
M 5	1/1|100%	5500 lb. 2500 kg	2680 lb. 1215 kg	1080 lb. 490 kg	N/A	$41-47 M	Kagoshima
Molniya	293/308|95.1%	3970 lb. 1805 kg	N/A	N/A	N/A	$19 M	Baikonur, Plesetsk
PSLV	3/4|75%	6400 lb. 2900 kg	990 lb. 450 kg	N/A	N/A	$15 M	Sriharikota
Titan 2	7/7|100%	7900 lb. 3583 kg	N/A	N/A	N/A	$41-47 M	VAFB
Small							
Athena 1	1/2|50%	1755 lb. 800 kg	N/A	N/A	N/A	$14-16 M	CCAS, VAFB, Wallops Island (proposed)
Athena 2	1/1|100%	4390 lb. 1990 kg	N/A	N/A	N/A	$19-21 M	CCAS, VAFB, Wallops Island (proposed)
Pegasus XL	9/12|75%	1015 lb. 460 kg	322 lb. 146 kg	181 lb. 82 kg	N/A	$12-14 M	VAFB, Wallops Island
Pegasus XL/HAPS	1/1|100%	1015 lb. 460 kg	N/A	N/A	N/A	$12-14 M	VAFB, Wallops Island
Shtil	N/A	N/A	N/A	N/A	N/A	N/A	Submarine Launch
Taurus 1	2/2|100%	3100 lb. 1400 kg	990 lb. 450 kg	N/A	N/A	$18-20 M	VAFB
Suborbital							
Black Brant 9	N/A	N/A	N/A	N/A	331 lb. 150 kg	N/A	Andoya, Poker Flat, Wallops Island, White Sands, Woomera, Spaceport Canada
TR 1A	N/A	N/A	N/A	N/A	1653 lb. 750 kg	N/A	Tanegashima

Characteristics of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in Orbit	Freq. Bands & Trans.	Stab.	Power
Classified										
Kosmos 2351	Classified	N/A	ELI	N/A	N/A	N/A	N/A	N/A	N/A	N/A
USA 139	Classified	N/A	GEO	19400 nMi	19400 nMi	N/A	N/A	N/A	N/A	N/A
USA 1998-06	Classified	N/A	Unknown	N/A	N/A	N/A	N/A	N/A	N/A	N/A
USA 1998-12	Classified	N/A	Unknown	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Communication										
AfriStar 1	Communication	N/A	GEO 21E	19305 nMi	19305 nMi	6155 lb. / 2785 kg	2093 lb. / 947 kg	L, S, X	N/A	N/A
Astra 2A	Communication	N/A	GEO 28.2E	19400 nMi	19400 nMi	7260 lb. / 3300 kg	N/A	32 Ku	N/A	N/A
Bonum 1	Communication	N/A	GEO 36E	19400 nMi	19400 nMi	N/A	N/A	8 Ku	Spin	N/A
BSAT 1 B	Communication	N/A	GEO 110E	19330 nMi	19305 nMi	2750 lb. / 1250 kg	1593 lb. / 723 kg	4 Ku	Spin	N/A
ChinaSat 8	Communication	N/A	GEO	19400 nMi	19400 nMi	N/A	N/A	N/A	N/A	N/A
ChinaStar 1A	Communication	$ 86.8 M	GEO 87.5E	19400 nMi	19400 nMi	6595 lb. / 2984 kg	N/A	24C, 24Ku	N/A	N/A
EchoStar 4	Communication	N/A	GEO 241E	19400 nMi	19400 nMi	3000 lb. / 3000 kg	N/A	16 Ku	3-axis	N/A
Eutelsat W2	Communication	N/A	GEO 16E	19332 nMi	19305 nMi	6599 lb. / 3000 kg	N/A	24 Ku	N/A	N/A
Galaxy 10	Communication	N/A	GEO 237E	19330 nMi	19322 nMi	7683 lb. / 3492 kg	3730 lb. / 1692 kg	24 Ku, C	N/A	4700 W
Galaxy 11	Communication	N/A	GEO 286E	19400 nMi	19400 nMi	7683 lb. / 3492 kg	N/A	16 Ku, 8 Ku	N/A	N/A
GBS 9	Communication	N/A	GEO	19400 nMi	19400 nMi	6305 lb. / 2866 kg	N/A	EHF, UHF	N/A	2500 W
GE 5	Communication	N/A	GEO 281E	19400 nMi	19400 nMi	N/A	N/A	16 Ku	N/A	N/A
Globalstars 5-44	Communication	N/A	LEO	764 nMi	764 nMi	988 lb. / 449 kg	N/A	L, C, S	N/A	875 W
Hot Bird Plus 5	Communication	N/A	GEO 13E	19400 nMi	19400 nMi	6380 lb. / 2900 kg	N/A	19 Ku, 2 Ku	N/A	N/A
ICO 1	Communication	N/A	MEO	N/A	N/A	6050 lb. / 2750 kg	N/A	1 C, 1 S	N/A	N/A
Insat 2E	Communication	N/A	GEO 83E	19400 nMi	19400 nMi	5500 lb. / 2500 kg	N/A	16 C, 1 C	N/A	N/A
Intelsat 8A F5	Communication	N/A	GEO 305E	19400 nMi	19400 nMi	8122 lb. / 3692 kg	N/A	28 C, 3 Ku	N/A	N/A
Iridiums 62-75, R-1 to R-5	Communication	N/A	LEO	419 nMi	419 nMi	1496 lb. / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
IRIS R1	Communication	N/A	LEO	540 nMi	540 nMi	144 lb. / 65 kg	N/A	UHF	N/A	N/A
JCSAT 6	Communication	N/A	GEO 124E	19400 nMi	19400 nMi	N/A	N/A	32 Ku	3-axis	N/A
Kosmos 2352	Communication	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kosmos 2353	Communication	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kosmos 2354	Communication	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kosmos 2355	Communication	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kosmos 2356	Communication	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kosmos 2357	Communication	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LMI 1	Communication	N/A	GEO 75E	19400 nMi	19400 nMi	N/A	N/A	N/A	N/A	N/A
Molniya 3	Communication	N/A	ELI	N/A	N/A	N/A	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
Communication (cont.)										
MUBLCOM	Communication	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nilesat 101	Communication	N/A	GEO 353E	19400 nMi	19400 nMi	4066 lb. / 1840 kg	N/A	12 Ku	Spin	N/A
Nimiq	Communication	N/A	GEO 269E	19400 nMi	19400 nMi	N/A	N/A	32 Ku	N/A	N/A
Orbcomms 13-28	Communication	N/A	LEO	N/A	N/A	87 lb. / 40 kg	N/A	N/A	N/A	N/A
Orion F3	Communication	N/A	GEO 139E	19400 nMi	19400 nMi	N/A	N/A	Ku	N/A	N/A
PANSAT 1	Communication	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PAS 7	Communication	N/A	GEO 68.5E	19400 nMi	19400 nMi	7735 lb. / 3500 kg	N/A	30 Ku, 14 C	N/A	N/A
PAS 8	Communication	N/A	GEO 194E	19400 nMi	19400 nMi	7920 lb. / 3600 kg	N/A	24 Ku, 24 C	N/A	N/A
PAS 6B	Communication	N/A	GEO 217E	19400 nMi	19400 nMi	N/A	N/A	32 Ku	N/A	N/A
SAFIR 2	Communication	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SatMex 5	Communication	N/A	GEO 215E	19400 nMi	19400 nMi	N/A	N/A	N/A	N/A	N/A
SCD 2	Communication	N/A	LEO	427 nMi	392 nMi	253 lb. / 115 kg	N/A	N/A	N/A	N/A
Sesat	Communication	N/A	GEO 36E	19400 nMi	19400 nMi	5720 lb. / 2600 kg	N/A	18 Ku	N/A	N/A
Sinosat 1	Communication	N/A	GEO 110E	19400 nMi	19400 nMi	6232 lb. / 2820 kg	3536 lb. / 1600 kg	14 Ku, 24 C	3-axis	N/A
Sirius 3	Communication	N/A	GEO 5E	19400 nMi	19400 nMi	3190 lb. / 1450 kg	N/A	N/A	N/A	N/A
ST 1A	Communication	N/A	GEO 88E	19400 nMi	19400 nMi	6600 lb. / 3080 kg	N/A	12 Ku, 12 C	N/A	N/A
Telstar 6	Communication	N/A	GEO 267E	19400 nMi	19400 nMi	7683 lb. / 3492 kg	N/A	4 Ku, 24 Ku	N/A	N/A
Tempo 1	Communication	N/A	GEO 241E	19400 nMi	19400 nMi	7683 lb. / 3492 kg	N/A	32 Ku	N/A	N/A
Thor 3	Communication	N/A	GEO 359E	19400 nMi	19400 nMi	N/A	1422 lb. / 647 kg	14 Ku	Spin	N/A
Tubsat N	Communication	N/A	LEO	N/A	N/A	19 lb. / 9 kg	N/A	N/A	N/A	N/A
Tubsat N1	Communication	N/A	LEO	N/A	N/A	7 lb. / 3 kg	N/A	N/A	N/A	N/A
Crewed										
Soyuz TM-28	Crewed	N/A	LEO	221 nMi	213 nMi	15587 lb. / 7070 kg	14969 lb. / 6790 kg	N/A	N/A	N/A
Development										
ARD	Development	N/A	LEO	N/A	N/A	6002 lb. / 2716 kg	N/A	N/A	N/A	N/A
Argos	Development	N/A	LEO	450 nMi	450 nMi	N/A	N/A	N/A	N/A	N/A
MightySat 1	Development	N/A	LEO	N/A	N/A	150 lb. / 68 kg	N/A	N/A	N/A	N/A
SAC A	Development	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
STEX 1	Development	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TSX 5	Development	N/A	LEO	N/A	N/A	297 lb. / 135 kg	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
Experimental										
Rocsat 1	Experimental	N/A	LEO	N/A	N/A	878 lb. / 399 kg	N/A	N/A	N/A	N/A
Tech Sat 2	Experimental	N/A	LEO	N/A	N/A	106 lb. / 48 kg	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										
Kosmos 2350	Intelligence	N/A	GEO	19400 nMi	19400 nMi	N/A	N/A	N/A	N/A	N/A
Kosmos 2358	Intelligence	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kosmos 2359	Intelligence	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Meteorolgical										
FY 1-C	Meteorological	N/A	LEO	470 nMi	470 nMi	1938 lb. / 881 kg	N/A	N/A	N/A	N/A
NOAA 15	Meteorological	N/A	LEO	449 nMi	449 nMi	4920 lb. / 2226 kg	3205 lb. / 1454 kg	N/A	N/A	1400 W
Microgravity										
JEM Micrograv Test	Microgravity	N/A	SUB	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Remote Sensing										
CBERS/Ziyuan 1	Remote Sensing	$ 68.6 M	LEO	420 nMi	420 nMi	3190 lb. / 1450 kg	N/A	N/A	3-axis	985 W
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 lb. / 817 kg	1216 lb. / 550 kg	N/A	3-axis	N/A
IKONOS 2	Remote Sensing	N/A	LEO	367 nMi	367 nMi	1797 lb. / 817 kg	N/A	N/A	N/A	N/A
IRS P4	Remote Sensing	N/A	LEO	497 nMi	481 nMi	2970 lb. / 1350 kg	N/A	N/A	N/A	N/A
Kitsat 3	Remote Sensing	N/A	LEO	470 nMi	470 nMi	220 lb. / 100 kg	N/A	N/A	N/A	N/A
Resurs-O1 N4	Remote Sensing	N/A	LEO	451 nMi	451 nMi	6160 lb. / 2800 kg	N/A	N/A	N/A	N/A
SACI 1	Remote Sensing	N/A	LEO	420 nMi	420 nMi	132 lb. / 60 kg	N/A	N/A	N/A	N/A
Sedsat-1	Remote Sensing	N/A	LEO	432 nMi	432 nMi	80 lb. / 36 kg	N/A	N/A	N/A	N/A
TMSAT 1	Remote Sensing	N/A	LEO	N/A	N/A	110 lb. / 50 kg	N/A	N/A	N/A	N/A
Science										
Deep Space 1	Science	N/A	EXT	N/A	N/A	946 lb. / 430 kg	N/A	N/A	N/A	N/A
Mars Climate Orbiter	Science	N/A	EXT	N/A	N/A	990 lb. / 450 kg	N/A	N/A	N/A	N/A
Mars Probe Test	Science	N/A	SUB	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oersted	Science	N/A	LEO	N/A	N/A	136 lb. / 62 kg	N/A	N/A	N/A	44 W
OSIRIS Test	Science	N/A	SUB	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Planet B	Science	N/A	EXT	N/A	N/A	658 lb. / 299 kg	N/A	N/A	N/A	N/A
QuickSCAT	Science	$ 39 M	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spartan 201-04R	Science	N/A	LEO	168 nMi	159 nMi	2800 lb. / 1270 kg	N/A	N/A	N/A	N/A
Sunsat	Science	N/A	LEO	464 nMi	243 nMi	132 lb. / 60 kg	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
Science (cont.)										
TERRIERS	Science	N/A	LEO	297 nMi	297 nMi	268 lb. / 122 kg	N/A	N/A	N/A	N/A
TRACE	Science	N/A	LEO	N/A	N/A	491 lb. / 223 kg	N/A	N/A	N/A	N/A
WIRE	Science	N/A	LEO	270 nMi	270 nMi	649 lb. / 295 kg	N/A	N/A	N/A	N/A
Space Station										
Pressurized Mating A 1&2	Space Station	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Service Module 1	Space Station	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Unity	Space Station	N/A	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Zarya	Space Station	$ 164.9 M	LEO	N/A	N/A	42500 lb. / 19278 kg	N/A	N/A	3-axis	N/A
Supply										
Progress M-39	Supply	N/A	LEO	N/A	N/A	15983 lb. / 7250 kg	N/A	N/A	N/A	N/A
Progress M-40	Supply	N/A	LEO	N/A	N/A	15983 lb. / 7250 kg	N/A	N/A	N/A	N/A
Progress M-41	Supply	N/A	LEO	N/A	N/A	15983 lb. / 7250 kg	N/A	N/A	N/A	N/A
Test										
Ariane 503 Dummy	Test	N/A	ELI	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Launch Events
April - June 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
Canada								
			Black Brant					
April 28, 1998	Black Brant 9*	Mars Probe Test OSIRIS Test	CSA CSA	Unknown Unknown	No	Non-Commercial	Success	Success
China								
			Long March					
May 2, 1998	Long March 2C	Iridium 69 Iridium 71	Iridium, Inc. Iridium, Inc.	Lockheed Martin Lockheed Martin	Yes	Commercial	Success	Success
May 30, 1998	Long March 3B	ChinaStar 1A	Chin. Min. of Posts & Com.	Lockheed Martin	No	Non-Commercial	Success	Success
Europe (ESA)								
			Ariane					
April 28, 1998	Ariane 44P	BSAT 1 B Nilesat 101	Broadcst. Sat. System Corp. Egypt. Radio & TV Union	Hughes Matra Marconi	Yes	Commercial	Success	Success
Russia								
			Cyclone					
June 16, 1998	Cyclone 3	Kosmos 2352-2357	Russian MoD	Prikladnoi Mekhaniki	No	Non-Commercial	Partial	Success
			Molniya					
May 7, 1998	Molniya	Kosmos 2351	Russia	NPO Lavochkin	No	Non-Commercial	Success	Success
			Proton					
April 7, 1998	Proton (SL-13)	Iridiums 62-68	Iridium, Inc.	Lockheed Martin	Yes	Commercial	Success	Success
April 29, 1998	Proton (SL-12)	Kosmos 2350	Russian MoD	Unknown	No	Non-Commercial	Success	Success
May 8, 1998	Proton (SL-12)	EchoStar 4	EchoStar Satellite Corp.	Lockheed Martin	Yes	Commercial	Success	Success

*High-profile suborbital launch events included.

Launch Events
April - June 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
Russia (cont.)								
				Soyuz				
May 15, 1998	Soyuz	Progress M-39	RKK Energia	RKK Energia	No	Non-Commercial	Success	Success
June 24, 1998	Soyuz	Kosmos 2358	Russian MoD	Unknown	No	Non-Commercial	Success	Success
June 25, 1998	Soyuz	Kosmos 2359	Russian MoD	Unknown	No	Non-Commercial	Success	Success
USA								
				Atlas				
June 18, 1998	Atlas 2AS	Intelsat 8A F5	Intelsat	Lockheed Martin	Yes	Commercial	Success	Success
				Delta				
April 24, 1998	Delta 2 7420	Globalstars 6, 8, 14, 15	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Success	Success
May 17, 1998	Delta 2 7920	Iridium 70, 72-75	Iridium, Inc.	Lockheed Martin	Yes	Commercial	Success	Success
June 9, 1998	Delta 2 7925	Thor 3	Telenor A.S.	Hughes	Yes	Commercial	Success	Success
				Pegasus				
April 1, 1998	Pegasus XL	TRACE	NASA	NASA Goddard	No	Non-Commercial	Success	Success
				Shuttle				
April 17, 1998	Shuttle Columbia	STS 90	NASA	Rockwell International	No	Non-Commercial	Success	Success
June 2, 1998	Shuttle Discovery	STS 91	NASA	Rockwell International	No	Non-Commercial	Success	Success

*High-profile suborbital launch events included.

Launch Events
April - June 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
USA (cont.)								
				Titan 2				
May 13, 1998	Titan 2	NOAA 15	NOAA	Lockheed Martin	No	Non-Commercial	Success	Success
				Titan 4				
May 8, 1998	Titan 4B/Centaur	USA 139	DoD	Unknown	No	Non-Commercial	Success	Success

*High-profile suborbital launch events included.

Launch Events
June - December 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
China							
			Long March				
July 14, 1998	Long March 3B	Sinosat 1	EurasSpace/Sinosatcom	Aerospatiale	No	Non-Commercial	Xichang
July 20, 1998	Long March 2C	Iridium R- 1 Iridium R- 2	Iridium, Inc. Iridium, Inc.	Lockheed Martin Lockheed Martin	Yes	Commercial	Taiyuan
3rd Qtr 1998	Long March 4	CBERS/Ziyuan 1 SACI 1	China/Brazil INPE	China Acad. of Space Tech. INPE	No	Non-Commercial	Taiyuan
October 1998	Long March 4	FY 1-C	Chinese Acad. of Space Tech.	Shanghai Inst. of Sat. Engineering	No	Non-Commercial	Xichang
November 1998	Long March 3B	ChinaSat 8	Chinese Broadcst. Sat. Sys. Corp.	Space Systems/Loral	No	Non-Commercial	Xichang
Europe (ESA)							
			Ariane 4				
August 25, 1998	Ariane 44P	ST 1A	Singapore Telecom	Matra Marconi	Yes	Commercial	Kourou
September 15, 1998	Ariane 44LP	PAS 7	Pan American Satellite Corp.	Space Systems/Loral	Yes	Commercial	Kourou
October 3, 1998	Ariane 44L	AfriStar 1 Sirius 3	WorldSpace, Inc. NSAB	Alcatel Espace Hughes	Yes	Commercial	Kourou
October 23, 1998	Ariane 42L	Eutelsat W2	Eutelsat	Aerospatiale	Yes	Commercial	Kourou
November 13, 1998	Ariane 44L	Insat 2E GE 5	ISRO GE Americom	ISRO Aerospatiale Espace & Defense	Yes	Commercial	Kourou
December 2, 1998	Ariane 42L	SatMex 5	Telecomm Mexico	Hughes	Yes	Commercial	Kourou
December 22, 1998	Ariane 42L	PAS 6B	PanAmSat	Hughes	Yes	Commercial	Kourou
			Ariane 5				
October 13, 1998	Ariane 5	Ariane 503 Dummy ARD	Arianespace ESA	Arianespace Aerospatiale	Yes	Non-Commercial	Kourou

*High-profile suborbital launch events included.

Launch Events
June - December 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
India							
			PSLV				
3rd Qtr 1998	PSLV	IRS P4 Kitsat 3 Tubsat C-DLR	ISRO Korean Advncd. Instit. of Science Technical University of Berlin	ISRO Surrey Satellite Technology Technical University of Berlin	No	Non-Commercial	Sriharikota
Japan							
			M 5				
July 4, 1998	M 5	Planet B	ISAS	NEC	No	Non-Commercial	Kagoshima
			TR 1A				
September 11, 1998	TR 1A*	JEM Micrograv Test	NASDA	Unknown	No	Non-Commercial	Tanegashima
Russia							
			Molniya				
July 1, 1998	Molniya	Molniya 3	Russia/CIS PTT	NPO Prikladnoi Mekhaniki	No	Non-Commercial	Plesetsk
			Proton				
August 25, 1998	Proton (SL-12)	Astra 2A	SES	Hughes	Yes	Commercial	Baikonur
September 16, 1998	Proton (SL-12)	Nimiq	Telesat Canada	Lockheed Martin Overseas Corp.	Yes	Commercial	Baikonur
October 8, 1998	Proton (SL-12)	Telstar 6	Skynet	Space Systems/Loral	Yes	Commercial	Baikonur
October 29, 1998	Proton (SL-12)	PAS 8	PanAmSat	Space Systems/Loral	Yes	Commercial	Baikonur
November 20, 1998	Proton (SL-13)	Zarya	International	Krunichev/Salyut	No	Non-Commercial	Baikonur
December 12, 1998	Proton (SL-12)	Tempo 1	Tempo Satellite, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur
December 25, 1998	Proton (SL-12)	Sesat	Eutelsat	NPO PM	Yes	Commercial	Baikonur
December 1998	Proton (SL-12)	LMI 1	LMI	Lockheed Martin	Yes	Commercial	Baikonur

*High-profile suborbital launch events included.

Launch Events
June - December 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
Russia (cont.)							
			Shtil				
July 1998	Shtil	Tubsat N Tubsat N1	Technical University of Berlin Technical University of Berlin	Technical University of Berlin Technical University of Berlin	Yes	Commercial	Delfin-class sub
			Soyuz				
August 2, 1998	Soyuz	Soyuz TM-28	RKK Energia	RKK Energia	No	Non-Commercial	Baikonur
3rd Qtr 1998	Soyuz	Progress M-40	RKK Energia	RKK Energia	No	Non-Commercial	Baikonur
4th Qtr 1998	Soyuz	Progress M-41	RKK Energia	RKK Energia	No	Non-Commercial	Baikonur
			Zenit				
July 8, 1998	Zenit 2	Resurs-O1 N4 FASat-Bravo IRIS R1 SAFIR 2 Tech Sat 2 TMSAT 1	Russia Chilean Air Force European Space Agency (ESA) OHB System Asher Space Research Institute Thai MicroSatellite Co.	VNII Elektromekhaniki Surrey Satellite Technology Limited SAIT Systems SA OHB System Technion Institute of Technology Surrey Satellite Technology	No	Non-Commercial	Baikonur
Ukraine							
			Zenit				
August 1998	Zenit 2	Globalstars 5, 7, 9-13, 16-20	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur
September 15, 1998	Zenit 2	Globalstars 21-32	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur
December 1998	Zenit 2	Globalstars 33-44	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur

*High-profile suborbital launch events included.

Launch Events
June - December 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
USA							
			Athena				
August 12, 1998	Athena 2	IKONOS 1	Space Imaging Inc.	Lockheed Martin	No	Commercial	VAFB
October 1998	Athena 2	IKONOS 2	Space Imaging Inc.	Lockheed Martin	No	Commercial	VAFB
December 1998	Athena 1	Rocsat 1	NSPO	TRW	Yes	Commercial	CCAS
			Atlas				
July 29, 1998	Atlas 2AS	JCSAT 6	JSAT	Hughes	Yes	Commercial	CCAS
September 15, 1998	Atlas 2A	GBS 9	DoD	Hughes	No	Commercial	CCAS
October 5, 1998	Atlas 2AS	Hot Bird Plus 5	Eutelsat	Matra Marconi	Yes	Commercial	CCAS
December 13, 1998	Atlas 2AS	ICO 1	ICO Global Com.	Hughes	Yes	Commercial	CCAS
			Delta 2				
August 1998	Delta 2 7420	Iridium R-3, R-4, R-5	Iridium, Inc.	Lockheed Martin	Yes	Commercial	VAFB
October 1998	Delta 2 7326	Deep Space 1 Sedsat-1	NASA Univ. of Alabama	Spectrum Astro, Inc. University of Alabama	No	Non-Commercial	CCAS
November 1998	Delta 2 7925	Bonum 1	Bonum 1	Hughes	Yes	Commercial	CCAS
December 10, 1998	Delta 2 7425	Mars Climate Orbiter	NASA	Lockheed Martin Corp.	No	Non-Commercial	CCAS
December 17, 1998	Delta 2 7920	Argos Oersted Sunsat	STPO (USAF) Danish Space Research Inst. Univ. of Stellenbosch	TRW Computer Resources Intl. Stellenbosch University	No	Non-Commercial	VAFB
			Delta 3				
August 3, 1998	Delta 3	Galaxy 10	PanAmSat	Hughes	Yes	Commercial	CCAS
October 1998	Delta 3	Orion F3	Orion Network Sys.	Hughes	Yes	Commercial	CCAS

*High-profile suborbital launch events included.

Launch Events
June - December 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
USA (cont.)							
			Pegasus				
3rd Qtr 1998	Pegasus XL/HAPS	Orbcomms 13-20	Orbcomm	Orbital Sciences Corp. (OSC)	No	Commercial	Wallops
3rd Qtr 1998	Pegasus XL	SCD 2	INPE	INPE	Yes	Commercial	CCAS
3rd Qtr 1998	Pegasus XL/HAPS	Orbcomms 21-28	Orbcomm	Orbital Sciences Corp. (OSC)	No	Commercial	Wallops
3rd Qtr 1998	Pegasus XL	WIRE	NASA	NASA Goddard	No	Non-Commercial	VAFB
4th Qtr 1998	Pegasus XL	TERRIERS MUBLCOM	Boston Univ./NASA TBA	AeroAstro TBA	Yes	Commercial	VAFB
			Sea Launch				
October 1998	Sea Launch	Galaxy 11	PanAmSat	Hughes	Yes	Commercial	Pacific Sea Launch
			Shuttle				
October 29, 1998	Shuttle Discovery	STS 95 PANSAT 1 Spartan 201-04R	NASA Naval Postgraduate School NASA	Rockwell International Naval Postgrad. School, Monterey NASA	No	Non-Commercial	KSC
December 3, 1998	Shuttle Endeavour	STS 88 MightySat 1 Press. Mating A 1&2 SAC A Unity	NASA DoD NASA NASA NASA	Rockwell International CTA Space Systems NASA Bariloche Company Invap. NASA	No	Non-Commercial	KSC
			Taurus				
3rd Qtr 1998	Taurus 1	STEX 1	DoD	DoD	No	Non-Commercial	VAFB
4th Qtr 1998	Taurus 1	TSX 5	DoD	Orbital Sciences Corp.	No	Non-Commercial	CCAS

*High-profile suborbital launch events included.

Launch Events
June - December 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
USA (cont.)							
			Titan 2				
October 31, 1998	Titan 2	QuickSCAT	NASA	Ball Aerospace	No	Non-Commercial	VAFB
			Titan 4				
July 25, 1998	Titan 4/Centaur	USA 1998-07	DoD	DoD	No	Non-Commercial	CCAS
December 20, 1998	Titan 4B/IUS	USA 1998-12	DoD	Unknown	No	Non-Commercial	CCAS

*High-profile suborbital launch events included.