Commercial Space Transportation

QUARTERLY LAUNCH REPORT

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

3rd Quarter 1999

United States Department of Transportation • Federal Aviation Administration

Associate Administrator for Commercial Space Transportation

800 Independence Ave. SW Room 331

Washington, D.C. 20591

3RD QUARTER 1999 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 (1999). Image is of the Atlas 2AS which successfully launched the Eutelsat W3 satellite from Cape Canaveral Air Station on April 12, 1999.

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This document was released on July 28, 1999.

SUMMARY

Second Quarter 1999 Launch Events

- The United States conducted twelve successful launches in the second quarter of 1999. Five were commercial (one Athena, one Atlas, one each Delta 2 and 3, and one Pegasus). Seven were non-commercial (two Delta 2, one Shuttle, one Titan 2 and three Titan 4). The United States had four launch failures in this period: losing two Titan 4, a Delta 3, and an Athena 2 vehicle.
- There were six Russian launches in this period. Proton conducted two commercial launches. Soyuz, Cosmos, and Dnepr each had one commercial launch. One non-commercial Soyuz launch was also made. All launches were successful.
- Europe conducted one successful commercial launch of the Ariane 4.
- China made two successful Long March launches, one commercial.
- India successfully launched a PSLV on a non-commercial flight.

Third and Fourth Quarter 1999 Scheduled Launch Events

- U.S. launch providers intend to make 29 launches in the next two quarters. Fifteen of these launches will be commercial: one Athena 2, three Atlas 2, one Atlas 3, five Delta 2, two Delta 3, two Pegasus, and one Taurus. Non-commercial launches will consist of four Atlas 2, two Delta 2, one Minotaur, one Pegasus, four Space Shuttle, one Titan 2, and one Titan 4.
- Russian launch vehicles are scheduled to make 21 launches, 14 of which are commercial. These commercial launches are on two Cosmos, seven Proton, one Rockot, three Soyuz, and one Start. Non-commercial launches will include one Cyclone, one Molniya, two Proton, two Soyuz, and one Zenit.
- Europe plans nine flights. Five Ariane 4 launches (four commercial) and three Ariane 5 launches (two commercial). The remaining Ariane launch will be the commercial launch of either an Ariane 4 or 5 (the vehicle is undetermined at this time).
- China anticipates the launch of three Long March vehicles, one of which is commercial.
- Brazil will make a second attempt to launch its VLS launch vehicle.
- Japan has one non-commercial H2 launch scheduled.
- The Sea Launch international joint venture plans to launch a commercial GEO communications satellite.

SUMMARY

Commercial Products and Services

U.S. Launch Industry Grapples With Multiple Launch Failures

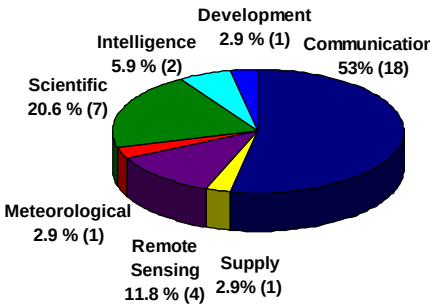
In the second quarter of 1999, the U.S. launch industry experienced four failures. Two of the failures involved the two newest commercial vehicles, Athena 2 and Delta 3. The other two failures involved the Air Force's Titan 4 launch vehicle, which carried payloads for the Department of Defense. Despite being government sponsored launches, the Titan failures have affected commercial launches because the Centaur upper stage used on one of these vehicles is closely related to the versions used to deploy commercial payloads on the Atlas 2 and the Delta 3.

The Athena 2 vehicle was to deploy the high-resolution earth imaging spacecraft IKONOS 1 on April 27. A malfunction prevented the payload fairing from separating, and the spacecraft never achieved orbit. Earth Imaging Inc. plans to launch a replacement satellite on another Athena 2 vehicle in August. On the Delta 3, the upper stage failed to fire properly a second time to insert the Orion F3 communications satellite into geosynchronous orbit. An upper stage malfunction also failed to place a Milstar communications satellite in the proper orbit following its launch on a Titan 4 on April 30. Another upper stage failure placed a DSP early warning satellite in an improper orbit on another Titan 4 launched April 9. The Titan 4 returned to flight on May 22 and deployed a classified satellite for the National Reconnaissance Office, but the vehicle used on this flight contained no upper stage.

These failures have prompted President Clinton to order a special investigation into these failures and have delayed the deployment of several upcoming launches while the failure investigations continue. Preliminary results from the special investigation are due at the end of August while a full report is expected at the end of November.

Payload Use Analysis

Second Quarter 1999



In the second quarter of 1999, there were 34 payloads launched worldwide. These payloads were divided between communications (53 percent), scientific (20.6 percent), remote sensing (11.8 percent), classified/intelligence (5.9 percent), development (2.9 percent), *Mir* supply (2.9), and meteorological (2.9 percent).

Of the 19 internationally competed payloads on commercial launches, 16 were communications payloads. The remaining three were scientific payloads.

LAUNCH SCHEDULE

Scheduled Launch Events

Vehicle	Payload	Site
JULY 1999		
Ariane 44P	Intelsat K-TV	Kourou
Delta 2 7420	Delta Globalstar #4	CCAS
Delta 2 7420	Delta Globalstar #5	CCAS
Molniya	Molniya 3-50	Plesetsk
Proton	Raduga 35	Baikonur
Proton	Sesat	Baikonur
Shuttle Columbia	Chandra STS 93	KSC
Soyuz	Progress M-42	Baikonur
START 1	Odin	Svobodny
Zenit 2	Okean O1	Baikonur
AUGUST 1999		
Ariane 5	AsiaStar 1 Telkom 1	Kourou
Athena 2	IKONOS 2	VAFB
Atlas 2AS	Terra	VAFB
Atlas 3A	Telstar 7	CCAS
Delta 2 7420	Delta Globalstar #6	CCAS
Delta 2 7920	Delta Iridium #12	VAFB
H 2	MTSat 1	Tanegashima
Sea Launch	DBS 1R	Sea Launch Platform
Titan 2	DMSP 5D-3-F15	VAFB
SEPTEMBER 1999		
Ariane 44LP	Orion F2	Kourou
Atlas 2AS	Echostar 5	CCAS
Atlas 2AS	TDRS F8	CCAS
Delta 2 7925	Navstar GPS 2R- 4	CCAS
Minotaur	Jawsat Artemis Picosat ASUSat 1 DARPA Picosat FalconSat MASAT OPAL STENSAT	California Spaceport
Proton	Garuda 1	Baikonur
Proton	LMI 1	Baikonur
Shuttle Endeavour	STS 99	KSC
Soyuz	Soyuz Globalstar #4	Baikonur

LAUNCH SCHEDULE

Scheduled Launch Events

(Continued)

Vehicle	Payload	Site
OCTOBER 1999		
Ariane 5	Insat 3B	Kourou
Cosmos	Champ	Plesetsk
	Mita	
Delta 3	ICO 3	CCAS
Long March 2F	Test Spacecraft	Jiuquan
Long March 4	CBERS/Ziyuan 1	Taiyuan
	SACI 1	
Shuttle Discovery	STS 103	KSC
Soyuz	Soyuz Globalstar #5	Baikonur
Titan 4B/IUS	DSP 20	CCAS
NOVEMBER 1999		
Ariane 4-TBA	Clementine (France)	Kourou
	Helios (European) 1B	
Atlas 2AS	USAF 1999-11	CCAS
Delta 3	ICO 4	CCAS
Proton	Zvezda	Baikonur
Soyuz	Soyuz Globalstar #6	Baikonur
DECEMBER 1999		
Ariane 4-TBA	Superbird 4	Kourou
Ariane 5	XMM	Kourou
Atlas 2AS	Hispasat 1C	CCAS
Cosmos	QuickBird 1	Plesetsk
Delta 2 7320	Earth Orbiter 1	VAFB
	Citizen Explorer	
	Munin	
	SAC C	
Delta 2 7420	Delta Globalstar #7	CCAS
Rockot	Rockot Iridium #1	Plesetsk
Shuttle Atlantis	STS 101	KSC
Soyuz	Progress M-ISS-01	Baikonur

LAUNCH SCHEDULE

Additional Launch Events to be Announced*

For the Third and Fourth Quarter 1999

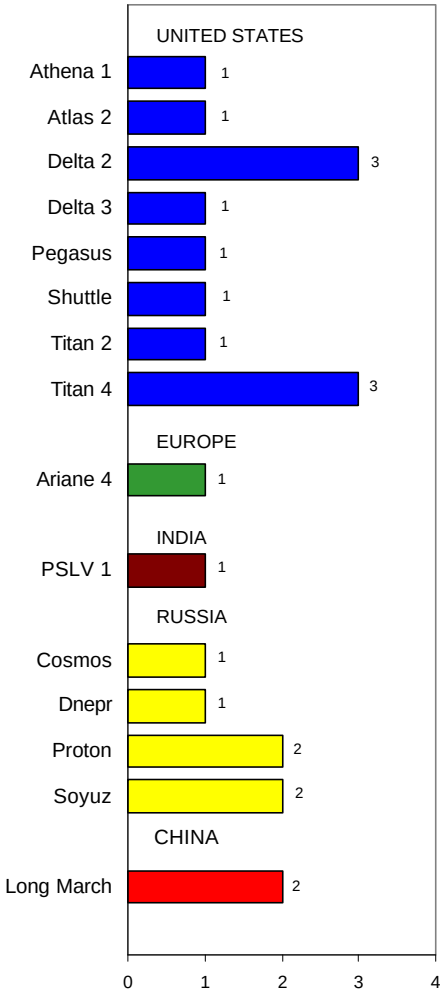
Vehicle	Payload	Site
THIRD QUARTER OF 1999		
Ariane 4-TBA	KoreaSat 3	Kourou
Atlas 2A	GOES L	CCAS
Pegasus XL/HAPS	Pegasus	Kwajalein
	Orbcomm #4	
Proton	ICO 1	Baikonur
FOURTH QUARTER OF 1999		
Ariane 4 or 5	Agila 2A	Kourou
Atlas 2AS	ICO 2	CCAS
Cyclone 3	Coronas F	Plesetsk
Long March TBA	Tsinghua 1	Taiyuan
Pegasus XL	OrbView 3	VAFB
Pegasus XL	TSX 5	VAFB
Proton	GE 1A	Baikonur
Proton	GE 4	Baikonur
Proton	ICO 5	Baikonur
Taurus 1	ACRIMSAT	VAFB
	Celestis 3	
	Kompsat	
VLS	SACI 2	Alcantara

* 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 1999



Number of Launches
April-June 1999

In the second quarter of 1999, United States launch vehicles conducted 12 of the 22 launches worldwide. Five of these launches were commercial: one Athena 2 with a remote sensing satellite; one Atlas 2 with a GEO communications satellite, a Delta 2 with four LEO communications satellites, a Delta 3 with a GEO communications satellite, and a Pegasus with a science and a communications satellite. Non-commercial launches of U.S. vehicles consisted of two Delta 2 vehicles with a NASA scientific payload on one and a remote sensing payload on the other. Other non-commercial launches were a Shuttle with a science payload, a Titan 2 with a science payload, and three Titan 4 with a communications payload and two classified/intelligence payloads.

Russia carried out six launches, five commercial. The commercial launches were a Cosmos launch of a science and a communications satellite, the introductory launch of a Dnepr vehicle with a science payload, two Proton vehicles with GEO communications satellites, and a Soyuz with four LEO communications satellites. A non-commercial Soyuz sent supplies to the *Mir* space station for Russia's sixth launch.

Europe launched one Ariane 4, which successfully took two commercial communications satellites to GTO.

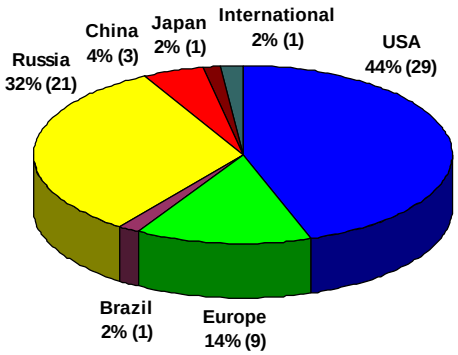
China successfully launched two Long March vehicles, one commercially with two LEO communications satellites and one with a meteorological and a science payload.

India made a successful launch of its PSLV orbiting two remote sensing satellites and a development payload.

LAUNCH REPORT

Scheduled Launch Events

Third and Fourth Quarter 1999



Scheduled Launch Events, by Region
July-December 1999

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

Sixty-five orbital launch events are scheduled in the third and fourth quarters of 1999. United States launch providers plan to conduct 29 of these launches. An Athena 2 launch is to carry a remote sensing satellite to LEO, seven Atlas 2 vehicles will loft payloads for communications, remote sensing, intelligence, and meteorology, and the sole Atlas 3 launch is scheduled to place a communications satellite into GEO. Seven Delta 2 vehicles will carry 5 sets of LEO communications satellites, as well as navigation, development, and scientific payloads. Two launches of the Delta 3 will carry GEO communications satellites. The first Minotaur (a converted Minuteman ICBM) will carry eight small scientific, communications, and development satellites. Three Pegasus launches will loft development and remote sensing payloads (one each) and a set of Orbcomm LEO communications satellites. The Shuttle will launch four times: an ISS assembly flight, the Shuttle Radar Topography Mission, the Chandra scientific mission, and the third Hubble servicing mission. One Taurus launch will orbit remote sensing, science and funerary payloads. A Titan 2 will loft a meteorological satellite and a Titan 4 will carry an intelligence payload.

Russia plans to launch 21 vehicles. Two will be Cosmos vehicles- one with a remote sensing payload and one with a science and a communications payload. One Cyclone 3 is launch scheduled with a scientific satellite. One Molniya vehicle is to launch a communications satellite. Nine Proton launches are planned: eight communications satellites and the ISS Service Module, Zvezda. Five Soyuz launches will loft three sets of Globalstar and two progress supply flights. A START vehicle is scheduled to launch once with a scientific payload. One Zenit 2 will carry a remote sensing payload.

Europe's Ariane is scheduled to orbit four GEO communications satellites on four Ariane 4 vehicles with a fifth vehicle lifting an intelligence and a development satellite. Two Ariane 5 vehicles are to carry three GEO communications satellites with a third vehicle lifting a science payload. One further Ariane launch is to carry a GEO communications satellite on an undetermined Ariane launch vehicle.

China intends to launch three Long March vehicles. One will carry two remote sensing satellites, another will carry another remote sensing satellite, and the third will launch an uninhabited prototype of China's crewed space vehicle.

Japan plans the launch of an H2 with a navigation satellite.

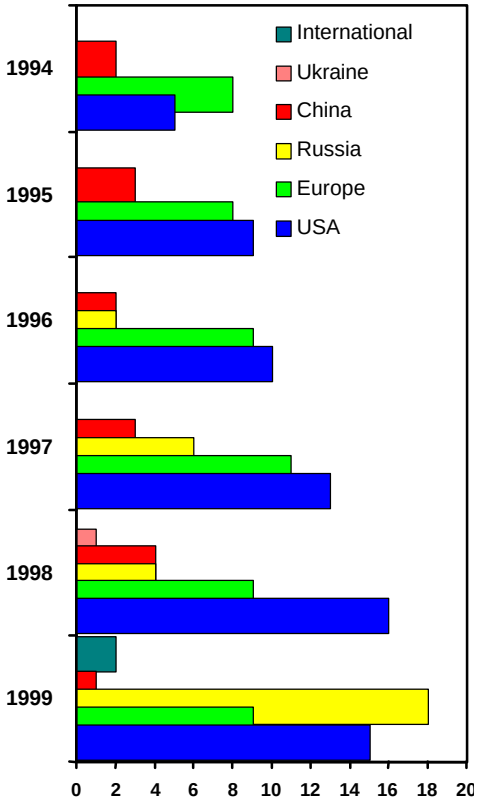
Brazil will make a second attempt to launch its VLS small launch vehicle caring a remote sensing satellite.

International launch providers (currently only the international Sea Launch venture is included in this category) involved a GEO communications satellite.

LAUNCH REPORT

Scheduled Commercial Launch Events

Third and Fourth Quarter 1999



Commercial Launch Events
January 1994 - December 1999
(small vehicles excluded)

Of the 65 planned launches for the second and third quarters of 1999, 38 are commercial. Excluding small launch vehicles, the total number of planned launches drops to 54, of which 29 are commercial. Of the 38 commercial launches, United States launch providers plan to conduct 15. Atlas 2 vehicles are scheduled to conduct three commercial launches while Atlas 3 is scheduled for only one launch. All of these Atlas commercial launches are of communications satellites. The Delta 2 is scheduled for five commercial launches, placing four sets of Globalstar satellites and one set of Iridium satellites into LEO. Delta 3 will make two flights, both of which will loft GEO communications satellites. Four of the 15 commercial U.S. launches are on small launch vehicles: the Athena 2 will place a remote sensing satellite in orbit, while the Pegasus will launch twice, once carrying eight ORBCOMM LEO communications satellites and once with a remote sensing payload. A Taurus will lift a remote sensing and a science satellite along with a funerary payload.

Europe plans a total of seven commercial launches, all on the intermediate Ariane 4 and large Ariane 5 vehicles. Four Ariane 4 launches will carry communications satellites to GEO, while two Ariane 5 flights will deploy GEO communications satellites. An undetermined Ariane is to launch a single GEO communications satellite.

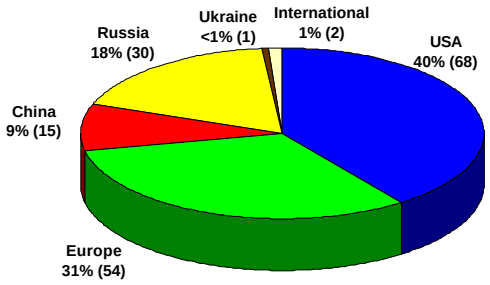
Russia plans a total of 14 commercial launches, four of them small. Seven of these are commercial flights of the Proton, which plans to loft two MEO and five GEO communications satellites. Soyuz will launch commercially three times, each time carrying a set of Globalstar satellites to LEO. In addition, the small Cosmos launch vehicle is scheduled to make a commercial flight to place a scientific and a communications payload in orbit as well as another commercial flight with a remote sensing satellite. The Rockot will place a pair of Iridium communications satellites into LEO and a START 1 vehicle will loft a scientific payload.

China plans one commercial launch. A Long March is scheduled to carry a remote sensing satellite to orbit.

International launch providers (Sea Launch) plan one commercial launch of a GEO communications satellite in this period.

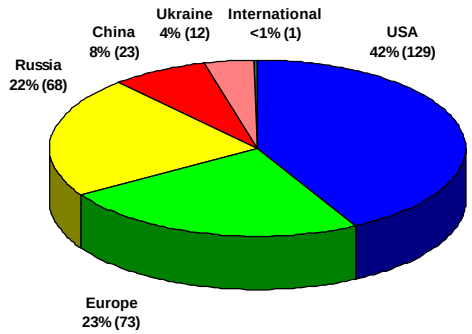
LAUNCH REPORT

Commercial Launch Trends



Commercial Launch Market Trend
January 1994 - December 1999

(small vehicles excluded)



Internationally Competed Payloads
Market Trend
January 1994 - December 1999

(small vehicles excluded)

Excluding small launch vehicles, commercial launch events are projected to total 170 for the period between January 1994 and December 1999. The United States has a 40-percent share or 68 launches. In terms of internationally competed payloads on commercial launches (excluding small launch vehicles), the United States will have launched 129 of 306 payloads, for a 42-percent share of payloads.

Europe's portion of the total is 54 launches, for a 31-percent share of launches, and 73 payloads, or 23 percent of total payloads.

China will have 15 launches for nine percent of launches, and 23 payloads for eight percent of the total.

Russia will have conducted 30 commercial launches for an 18-percent share and deployed 68 internationally competed payloads or 22 percent of the total.

Ukraine has made one commercial launch from Russia's launch site at Baikonur representing just under one percent of launches, to deploy 12 payloads or four percent of total payloads.

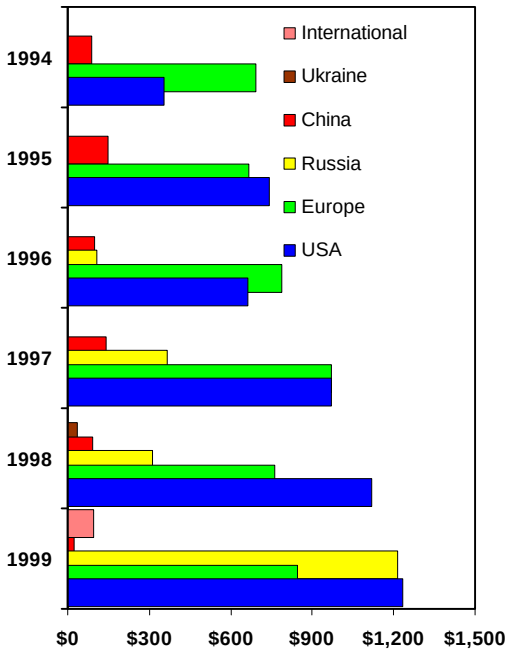
International launches (made by the Sea Launch joint venture) have comprised one percent of the total with two launches and less than one percent of payloads with one internationally competed payload.

Thirty-nine commercial launches (excluding small launch vehicles) are planned worldwide for the period of this report; these launches are expected to carry 75 internationally competed payloads. The United States plans 14 of these launches (36 percent), which will carry 33 (44 percent) internationally competed payloads. Europe's share of this launch market is 20 percent (eight launches), carrying 12 percent of the internationally competed payloads (9 satellites). China's two commercial launches will capture five percent of the commercial launch market, and three percent of internationally competed payloads (two satellites). Russia's 14 planned commercial launches (39 percent) will place 30 internationally competed payloads (40 percent) into orbit.

International launch service providers (Sea Launch) will conduct one launch (three percent) and will deploy one payload (one percent).

LAUNCH REPORT

Commercial Launch Revenues



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

January 1994 - December 1999

* 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 current dollars. Includes small vehicles.

Revenues for the period between January 1994 and December 1999 are expected to be approximately $12.5 billion. United States launch providers will achieve a 40-percent share of these revenues (approximately $5.1 billion) and European launch providers will capture 38 percent (approximately $4.7 billion). Russian launch providers hold an estimated 16-percent share (approximately $2.0 billion) and launch service revenues from China will consist of about $587 million representing a five-percent share. Ukraine's single launch accounts for less than one percent of revenues at roughly $33 million. International launch providers (currently only the international Sea Launch venture is included in this category) hold one percent of total revenues with $95 million.

For 1999, revenues from commercial launch events are projected to approach $3.4 billion. In this period, United States launch service providers will have about $1.2 billion (36 percent) of the total. Europe plans to use both Ariane 4 and Ariane 5 vehicles for commercial launches in 1999 and European revenues are expected to reach $843 million (25 percent) in 1999. An increase in Russian launch service revenues is expected in 1999 with $1.2 billion expected compared to $313 million for 1998. This will constitute 35 percent of 1999 world launch revenues. This growth is due to the first Soyuz launches of Globalstar LEO satellites in addition to a large number of projected GEO Proton launches. China so far plans one commercial launch valued at about $23 million (one percent), and Ukraine has not announced plans for commercial launches in 1999. International launch providers (Sea Launch) hold three percent of total revenues for 1999 with $95 million.

Special Report

U.S. LAUNCH RANGE MODERNIZATION PROGRAMS

The United States' launch ranges are experiencing considerable growth in commercial and government launch activities. The years 1997 and 1998 witnessed the greatest number of launches from the federal launch ranges yet. In 1998, the total number of commercial and FAA-licensed launches from U.S. launch sites surpassed launches for government purposes for the first time in U.S. space history. Commercial satellite services are now driving demand for launch services worldwide. Such demands have resulted in the U.S. launch industry facing greater challenges from its foreign competitors.

As a result, the national security, civil, and commercial sectors have reached consensus that the United States launch infrastructure and technologies have not kept pace with the changing launch business. Much of the equipment and systems at the ranges (such as tracking radars, telemetry systems, and fixed optical systems) were installed in the 1950s and 1960s and are still used today. It is widely acknowledged that the rapid reconfiguration of the launch ranges from one launch to the next is a much needed capability. Realizing this capability is frustrated by out-of-date technologies and an architecture not equipped to handle the continuing changes in space transportation. This capability is an important element to accommodating future commercial launch demands.

The United States space launch ranges (see Figure 1) are undertaking a series of programs to upgrade and modernize. Before 1993 Improvement and

Figure 1: The U.S. Spacelift Range System

Modernization (I&M) of the ranges was handled by the individual ranges on an ad hoc basis without the requirement to maintain commonality between ranges. In 1993, the U.S. Air Force began a new program called Range Standardization & Automation (RSA). This $1.6 billion program is anticipated to fully modernize the U.S. space launch ranges by 2006. In addition to hardware and software upgrades, the RSA program is intended to standardize range operations, hardware, and software between the ranges for common operations. A follow-on contract called Spacelift Range Systems Contract (SLRSC) will complete U.S. range modernization by transferring all responsibilities for I&M, integration, systems engineering, sustainment, and configuration management under one contract. The SLRSC contract is currently in the request for proposal (RFP) phase and is expected to be awarded in March, 2000.

THE UNITED STATES LAUNCH RANGES

The United States Air Force Space Command (USAFSPACECOM) is responsible for operating and maintaining many portions of the United States' launch range infrastructure. Although this infrastructure was created to support mostly military space missions, the USAFSPACECOM today also supports civil and commercial launches.

The U.S. launch infrastructure is physically divided into two "ranges," an Eastern Range (ER) and a Western Range (WR). The primary mission of the ranges is to support the Department of Defense spacelift operations. Secondary missions include providing support to civilian and commercial spacelift operations, ballistic missile testing, aeronautical operations, and space surveillance.[1]

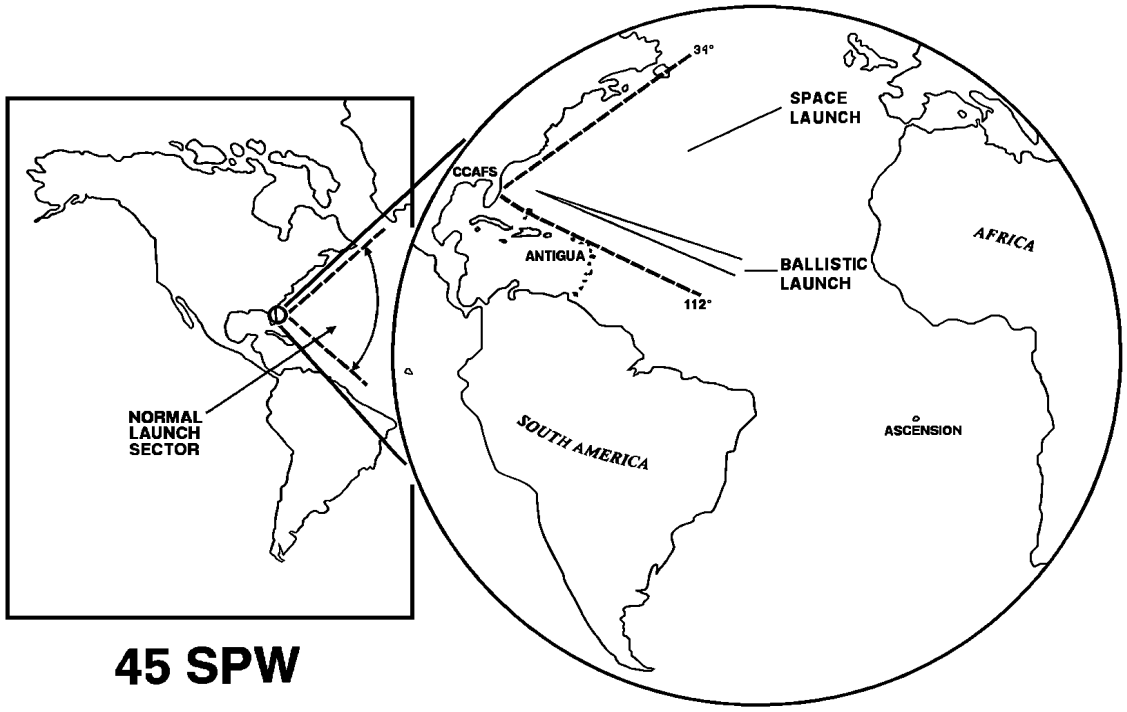


Figure 2: The U.S. Eastern Range and 45th Space Wing

[1] Source: Statement of Objectives for the Spacelift Range System Contract http://www.dwsc.stai.com/slcsacq/RFP/SOO_20_May99.htm

To accomplish these missions safely, the ranges have installed a complex system of radar and optical instrumentation, telemetry equipment, devices to monitor the weather and surrounding airspace and waterways, command and destruct capabilities, as well as facilities to process, integrate, and disseminate all the data generated by these systems.

The Eastern Range (managed by the 45th Space Wing at Patrick Air Force Base, see Figure 2) extends from Argentia in Newfoundland to Ascension Island in the South Atlantic Ocean. The Eastern Range consists of Cape Canaveral Air Station, Kennedy Space Center, and Spaceport Florida.

The Western Range (managed by the 30th Space Wing at Vandenberg Air Force Base, see Figure 3) provides uprange support by radar, telemetry, and optical sensors located at Vandenberg Air Force Base, Pillar Point Air Force Station, as well as Anderson Peak, and Santa Ynez Peak. The Western Range supports launch activities from Vandenberg Air Force Base and Edwards Air Force Base (both in California).

Both ranges also provide occasional support to launches from other U.S. launch sites such as NASA's Wallops Flight Facility and U.S. commercial launch facilities.

Collectively, the two launch ranges are referred to as the SpaceLift Range System (SLRS). The official functions of the SLRS include:[2]

- Protecting people, property and environment;
- Collecting, processing and distributing data for safety, test and evaluation, and command and control;

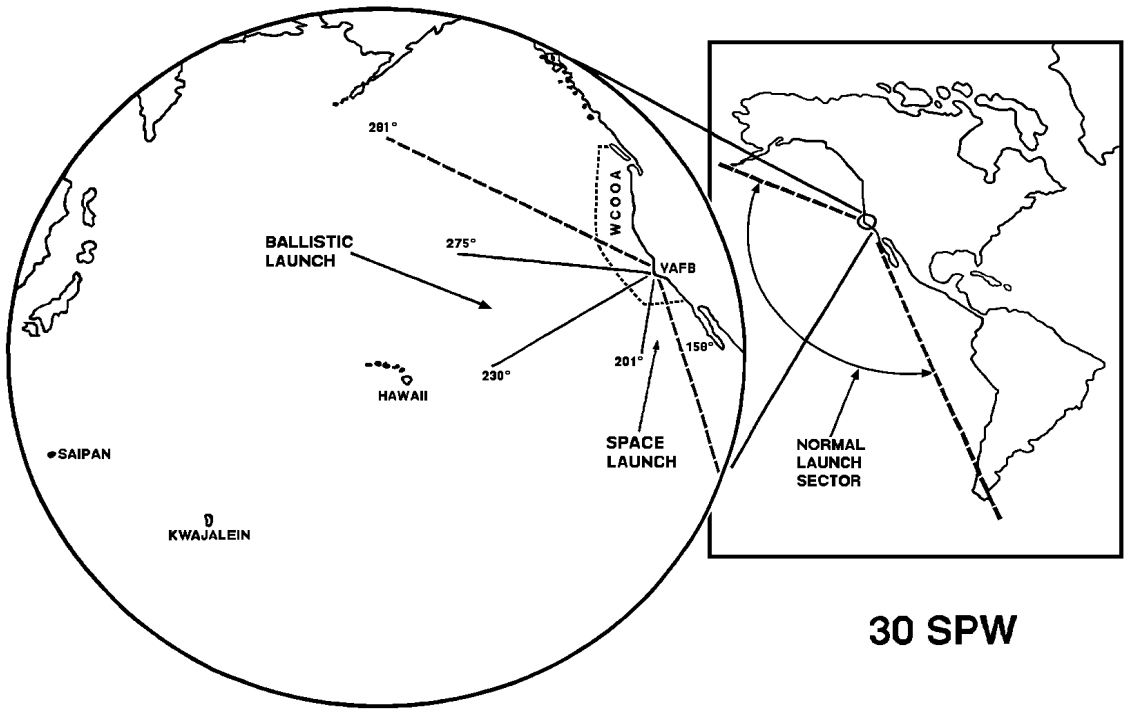


Figure 3: The U.S. Western Range and 30th Space Wing

[2] Satellite and Launch Control Systems Fact Sheet (U.S. Air Force); http://www.laafb.af.mil/SMC/PA/Fact_Sheets/cw_fs.htm

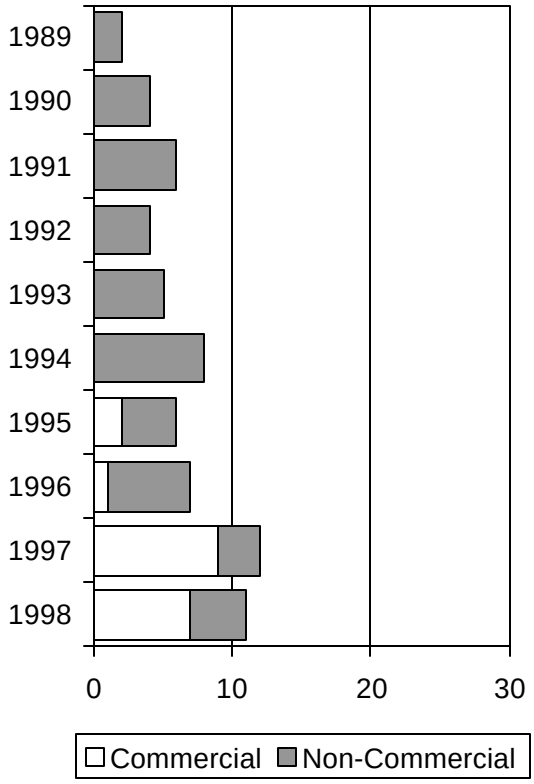


Figure 4. Launches by the Western Range sites, 1989 through 1998 (includes Vandenberg Air Force Base and Pegasus launches staged from Edwards Air Force Base); note: "Commercial" launches includes all launches licensed by FAA

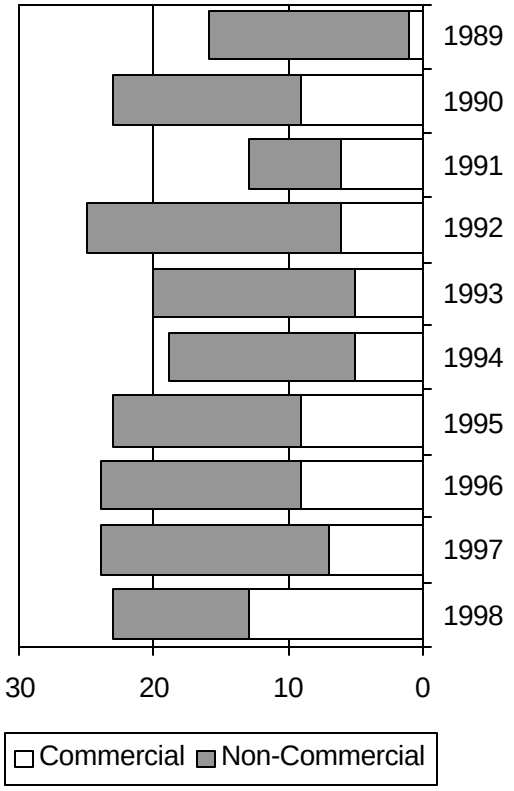


Figure 5. Launches by the Eastern Range sites, 1989 through 1998 (includes Cape Canaveral Air Station, Spaceport Florida, and Kennedy Space Center); note: "Commercial" launches includes all launches licensed by FAA

- Providing communications between instrumentation sites, control centers, and outside ranges, facilities and organizations;
- Supporting military, civilian and commercial sub-orbital, orbital and interplanetary launches;
- Testing and evaluating ballistic missiles, guided weapons and aeronautical programs; and
- Providing excess radar capacity to the space surveillance network.

CHANGING LAUNCH RANGE REQUIREMENTS

The Cape Canaveral and Vandenberg launch sites conduct the majority of United States launch activities today and support both commercial and U.S. Government launches. The Western Range and Vandenberg Air Force Base conduct polar LEO launches for the U.S. government, as well as commercial launches of LEO satellites such as the Iridium system. The Eastern Range conducts all launches to GEO, typically from Cape Canaveral, in addition to a variety of LEO missions for remote sensing and commercial LEO satellites.

The increase in commercial launch rates has placed greater demands on range facilities (see Figures 4 and 5). Last year, commercial and FAA-licensed launches from the Eastern and Western ranges exceeded those of U.S. government payloads for the first time in U.S. space launch history.

The recent deployment of commercial LEO communications satellite systems is the primary driver of the relatively higher commercial launch rates. Of the 17 commercial launches conducted in 1998, for example, ten placed spacecraft in low Earth orbit and seven were to geosynchronous transfer orbit (GTO). Additionally, in the last five years, fourteen new vehicle derivatives were introduced at the launch ranges including a new vehicle family from Lockheed Martin in August 1995 (Athena).

The Eastern and Western ranges were originally built in the 1950s and early 1960s as research and development facilities for early missile programs. The architecture of the ranges and much of the equipment remain basically unchanged to this day. The majority of today's tracking radars, telemetry systems, fixed optical systems, and flight termination command sites were built or acquired in the late 1950s and early 1960s. Nearly 25 percent of the components required for the major range systems are deemed obsolete and have no source of spares.

A survey conducted in 1992 by the Air Force Space Command revealed a lack of responsiveness to changing range demands due to out-of-date technologies, an inefficient infrastructure, as well as an inability to support simultaneous operations.[3]

To accommodate increased launch activities at the U.S. launch sites, the ranges have identified a need for more efficient architectures, greater responsiveness to programmatic and weather changes, and shorter equipment reconfiguration times.

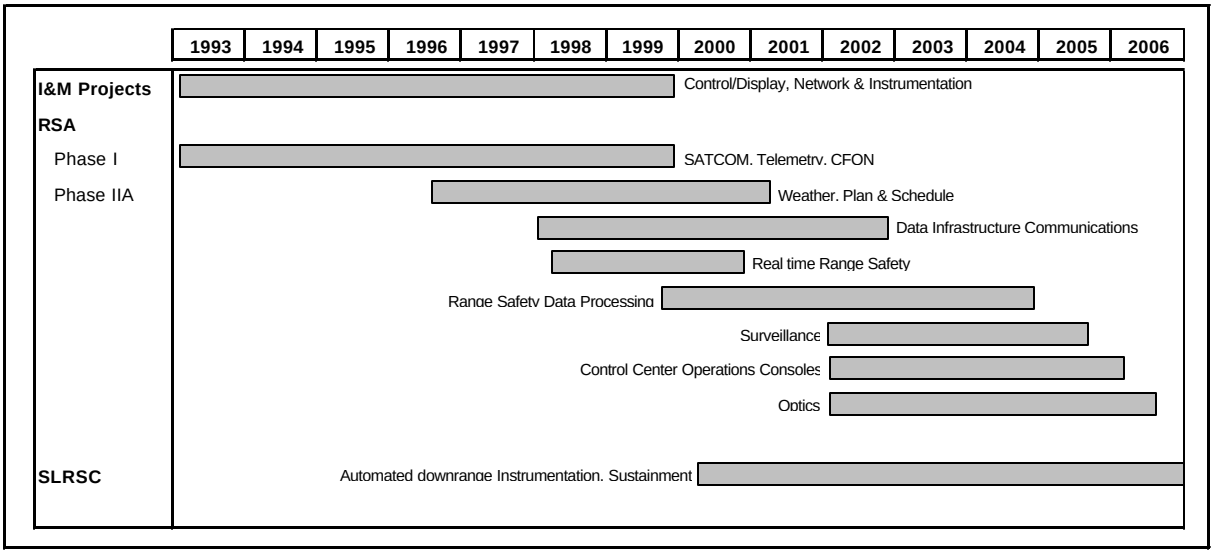


Figure 6. Integrated SpaceLift Range System Modernization Schedule

[3] Moorman, Thomas S., Air Force Space Command, *Operational Requirements Document, Range Standardization and Automation (RSA) ACAT Level II*, July 18, 1994

To bring about these improvements, the Air Force has implemented several range modernization initiatives, largely under the Range Standardization and Automation (RSA) program. The Spacelift Range System Contract (SLRSC) will continue the modernization, consolidating engineering integration and sustainment into one contract, with contract award in early to mid 2000. This contract will finish the process begun with the RSA program by both maintaining and update range assets and organizing operations for more efficient function.

THE RANGE STANDARDIZATION AND MODERNIZATION PROGRAM

The aim of the Range Standardization and Automation (RSA) program, which began in 1993, is to fully modernize the U.S. Spacelift Range System (SLRS) by 2006 (see figure 6). The program is intended to help reduce range costs and turnaround times and to improve range flexibility and responsiveness. It is also intended to replace obsolete 1960s and 1970s vintage telemetry, tracking, command and control, weather, area surveillance, and communications systems with modern and more cost effective systems.

Overall, the RSA program is designed to standardize operations so that the Eastern and Western ranges will operate with common equipment and procedures. It will centralize and consolidate many existing facilities, effectively integrating the capabilities and facilities of the Eastern Range and Western Range into a single launch system with common systems and operations.

By the end of fiscal year 1999, the USAF expects to have spent over $500 million to bring much of the range equipment up to modern standards and will spend over $1.0 billion between fiscal years 2000 and 2006 to complete the program.[4]

The Range Standardization and Automation program is essentially divided into three phases:

- Phase I – automate the communication network at Cape Canaveral and telemetry processing for both ranges
- Phase IIA – focuses on the architecture and integration of the spacelift range system as well as standardizing and automating hardware and software
- Phase IIB - focuses on replacement and automation of the ranges' fixed instruments, i.e., instrumentation and modernization (I&M). This phase will now be completed under the SLRS contract.

One of the key RSA proposals is the change from ground-based radar 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.[5]

Phase I Program

In 1987, the Air Force funded the first studies for range modernization and, in July 1993, awarded the RSA Phase I contract to Harris Corporation.

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[4] Lt. Gen. Roger Dekok, "Spacelift in and Beyond the Millennium," Launchspace Magazine, May/June 1999, p. 6.

[5] Speech by Lt. Gen. Lord at the Federal Aviation Administration's conference on *Commercial Space Transportation in the 21st Century: Technology and Environment, 2001-2005,* 10 February 1998, at the Key Bridge Marriott Hotel, Arlington, VA

Phase I of the RSA was designed to modernize and automate the communications network at Cape Canaveral, including satellite links for major stations at the Cape. Phase I also provides standardization and centralization of telemetry processing for both Cape Canaveral and Vandenberg Air Force Base.

The communications network segment at Cape Canaveral consists of the Eastern Range Satellite Communications Network, which includes communications hardware, processors and software, and leased capacity on Intelsat Atlantic region satellites to provide high-speed data and voice connection throughout the range. Also part of the network segment is the Cape Area Fiber Optics Network, which provides communication backbone architecture for data, voice and video services. The Network Control Subsystem monitors and displays the status of the range communication assets.

Phase IIA Program

RSA Phase IIA, initiated in 1996, is envisioned to modernize the architecture of the spacelift range system as well as integrate, standardize, and automate range hardware and software. Phase IIA is expected to be completed by 2006 (see Figure 6). It consists of seven separate efforts:

1. Weather, Plan & Schedule - involves weather instrumentation improvements and automated planning and scheduling.
2. Data Infrastructure and Communications - includes fiber optic and LAN communications, a voice and analog video communications net as well as timing services and stable reference frequencies along with a communications interface for remote sites.
3. Real Time Range Safety – involves safety and data processing improvements for standard flight operations and analysis. Network upgrades will include data format updates while the planning and scheduling systems will receive automation enhancements. These improvements will allow for real-time, near real-time and post-mission data products and will also involve an initial simulation capability for testing and training.
4. Range Safety Data Processing: new flight operations software improves range safety.
5. Surveillance - involves improved air, sea, and rail surveillance and radio frequency monitoring.
6. Control Center Operations – benefits from new control center operations consoles.
7. Optics - involving improved optics for fixed and mobile observation systems.

Phase IIB Program

A third phase, Phase IIB, of the RSA program involved complete replacement and automation of the ranges' fixed instruments such as command systems, telemetry systems, and radars. This phase will now be completed under the SLRS contract which seeks to sustain and improve the spacecraft range system.

OTHER RANGE MODERNIZATION PROGRAMS

Prior to 1993, the U.S. launch ranges conducted numerous but functionally independent life extension and technology upgrades to sustain their respective range systems. These projects were conducted under I&M contracts. Other efforts such as the replacement of the range control center at CCAS under the Range Operations Control Center (ROCC) program and the creation of a new consolidated operations center, for the Western Range (the Western Range Operations Control Center or WROCC) have also taken place. In addition to current and future programs and contracts, there are also on-going studies such

as the Air Force Space Command sponsored range integrated product team and OSD-led National Launch Capability Study Team which are examining how the U.S. launch infrastructure can better handle increased launch activities.

I&M contracts have allowed the ranges to focus on those systems with the highest need of upgrade or improvement at each range. Since 1993, the Spacelift Range Systems Contract, I&M efforts have been gradually moving towards a more coordinated system of managed modernization. The Spacelift Range Systems Contract assumes I&M responsibilities at the ranges after the 2000 contract award.

The Range Operations Control Center (ROCC) program was designed to consolidate and upgrade many of the systems at Cape Canaveral involved with range safety and range control, range scheduling, weather, electronic security, and data processing systems associated with pre-test and post-test flight analysis. The ROCC had to be developed and installed without disrupting on-going launch activity at the range. The first study contract was awarded in 1987 concluding in the operational ROCC in March 1995.

At the Western Range a new consolidated operations center, the Western Range Operations Control Center (WROCC) has been under construction since May 1998 with completion planned in February 2000. Similar to the ROCC, the WROCC will involve increased automation and centralized command as well as contributing to range standardization under the RSA.

The Air Force Space Command (AFSPC) sponsored range integrated product team (IPT) was formed to address issues raised at the AFSPC December 1997 Commercial Space Industry Leaders' Conference. The range IPT was chaired by retired Lt. General Dick Henry. Issues included range capacity and equipment reconfiguration time, modernization programs, government/commercial interfaces and the long-range plans for the ranges.

The congressionally directed National Launch Capability Study (NLCS) is an interagency working group led by the OASD (OSD C^3I). The working group is comprised of members from the Air Force Headquarters, Air Force Space Command, NASA, FAA's Associate Administrator for Commercial Space Transportation, the Department of Commerce, and the Joint Staff. The working group is examining domestic launch needs and the domestic launch capacity to meet those needs.

A major effort to rationalize United States range operations falls within the Spacelift Range System Contract (SLRSC) which will finish the process started under the RSA program by centralizing both maintenance and ongoing range improvements into a single contract for more efficient future operations.

SpaceLift Range System Contract (SLRSC)

The Spacelift Range System (SLRS) contract is the continuation of the RSA program implementation. Its program objective is to modernize instrumentation, sustain and improve the Spacelift Range System while reducing its total cost of ownership through a single systems contract for sustainment, integration, and development.

The specific SLRSC objectives are to:

1. Complete transition of depot maintenance responsibilities to the SLRSC within phase-in period without impacting operational readiness.
2. Use disciplined systems engineering approaches to sustain and improve the existing range system and integrate new SLRS components. Achieve seamless interface and activation of products delivered by this contract and any other contracts with the existing range. Improve range reliability, maintainability, and availability while reducing life cycle costs.
3. Improve range reliability, maintainability, and availability while reducing life cycle costs.
4. Establish an integrated configuration baseline system and process. Establish a single entity for SLRS integration and architecture services.
5. Modernize and integrate the Instrumentation Segment assets to include fixed and mobile optics, telemetry, command, radar, surveillance, and remaining weather systems.

The SLRSC is the vehicle by which the United States will achieve an up-to-date launch infrastructure for the next century. It is intended to improve upon the advantages initiated by the RSA program. The RFP for the SLRSC contract was issued in May 1999 with proposals due by the end of October 1999 and the contract award scheduled for March 2000. Details of the transition between RSA and SLRSC are still to be decided.

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

ABRIXAS - A Broadband Imaging X-Ray All-Sky Survey
CBERS China-Brazil Earth Remote Sensing
CCAS Cape Canaveral Air Station
DARPA Defense Advanced Research Projects Agency
DASA Deutsche Aerospace
DLR German National Space Agency
DMSP Defense Meteorological Satellite Program
DoD Department of Defense
DoT Department of Transportation
DSCS Defense Satellite Communication System
DSP Defense Support Program
ELI Elliptical
ESA European Space Agency
FAA Federal Aviation Administration
FUSE Far Ultraviolet Spectrometer Explorer
GBS Global Broadcast System
GEO Geosynchronous Orbit
GOES Geostationary Operational Environmental Satellite
GTO Geosynchronous Transfer Orbit
ICO Intermediate Circular Orbit
INPE National Institute for Space Research
IRS Indian Resource Satellite
ISAS Institute of Space and Astronautical Science
ISRO Indian Space Research Organization
JSAT Japan Communications Satellite Co. Satellite
JPL Jet Propulsion Laboratory
KARI Korea Aerospace Research Institute
KSC Kennedy Space Center
LEO Low Earth Orbit
LMI Lockheed Martin Intersputnik
MEO Medium Earth Orbit
MoD Ministry of Defense
MUBLCOM - Multiple Beam Beyond Line-of-Sight Communications
NASA National Aeronautics and Space Administration
nMI Nautical Mile
NOAA National Oceanic and Atmospheric Administration
NPO Scientific Production Organization
NSPO National Space Program Office
OPAL Orbiting Picosat Automatic Launcher
OSC Orbital Sciences Corporation
PAS Pan American Satellite
PM Prikladnoi Mekhaniki
PSLV Polar Satellite Launch Vehicle
PTT Post Telegraph and Telecommunications
QuickSCAT – Quick Scatterometer
RKA Russian Space Agency
RKK Energia - Rocket and Space Company Energia
ROCSAT – Republic of China Satellite
SACI Satellite Cientifico
STS Space Transportation System
SUPARCO - Space and Upper Atmosphere Research Commission
TDRS Tracking and Data Relay Satellite
TERRIERS - Tomographic Experiment using Radiative Recombinative Ionospheric EUV and Radio Sources
TSX Tri-Service Experiment
VAFB Vandenberg Air Force Base
VLS Veiculo Lancador de Satelites
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	2/3|66.7%	39600 lb 18000 kg	15000 lb 6800 kg	N/A	N/A	$150-180 M	Kourou
Long March 2F	N/A	N/A	N/A	N/A	N/A	N/A	Jiuquan
Proton (SL-12)	207/230|90%	46297 lb 21000 kg	10851 lb 4910 kg	4155 lb 1880 kg	N/A	$75-95 M	Baikonur
Proton (SL-13)	25/28|89.3%	46000 lb 20900 kg	N/A	N/A	N/A	$75-95 M	Baikonur
Sea Launch	1/1|100%	35000 lb 15876 kg	11050 lb 5000 kg	N/A	N/A	$75-95 M	Sea Launch Platform
Shuttle Atlantis	19/19|100%	47300 lb 21455 kg	13007 lb 5900 kg	5203 lb 2360 kg	N/A	$300 M	KSC
Shuttle Columbia	25/25|100%	47300 lb 21455 kg	13007 lb 5900 kg	5203 lb 2360 kg	N/A	$300 M	KSC
Shuttle Discovery	28/28|100%	47300 lb 21455 kg	13007 lb 5900 kg	5203 lb 2360 kg	N/A	$300 M	KSC
Shuttle Endeavour	13/13|100%	47300 lb 21455 kg	13007 lb 5900 kg	5203 lb 2360 kg	N/A	$300 M	KSC
Titan 4B	1/1|100%	47800 lb 21629 kg	N/A	N/A	N/A	$350-450 M	CCAS, VAFB
Titan 4B/Centaur	2/3|66.7%	47800 lb 21629 kg	N/A	12700 lb 5747 kg	N/A	$350-450 M	CCAS
Titan 4B/IUS	1/2|50%	47800 lb 21629 kg	N/A	6321 lb 2860 kg	N/A	$350-450 M	CCAS
Zenit 2	25/31|80.6%	30300 lb 13740 kg	N/A	N/A	N/A	$35-50 M	Baikonur
Intermediate							
Ariane 42P	11/12|91.7%	13400 lb 6100 kg	6260 lb 2840 kg	N/A	N/A	$65-85 M	Kourou
Ariane 44LP	18/19|94.7%	18300 lb 8300 kg	8950 lb 4060 kg	N/A	N/A	$90-110 M	Kourou
Ariane 44P	14/14|100%	15200 lb 6900 kg	7320 lb 3320 kg	N/A	N/A	$80-100 M	Kourou
Atlas 2A	14/14|100%	16050 lb 7280 kg	6700 lb 3039 kg	3307 lb 1500 kg	N/A	$75-85 M	CCAS, VAFB
Atlas 2AS	17/17|100%	19050 lb 8640 kg	8150 lb 3688 kg	4604 lb 2090 kg	N/A	$90-105 M	CCAS, VAFB
Atlas 3A	N/A	19097 lb 8641 kg	8940 lb 4055 kg	N/A	N/A	$90-105 M	CCAS
Delta 3	0/2|0%	18408 lb 8350 kg	8360 lb 3800 kg	N/A	N/A	$75-90 M	CCAS
H 2	5/6|83.3%	23000 lb 10500 kg	8800 lb 4000 kg	4800 lb 2200 kg	N/A	$170-190 M	Tanegashima
Soyuz	957/964|99.3%	15400 lb 7000 kg	N/A	N/A	N/A	$35-40 M	Baikonur, Plesetsk

Characteristics of Cited Vehicles

Vehicle	(Success + Partials) / Attempts	LEO 28 Degrees	GTO	GEO	SUB	Price per Launch (Approx.)	Launch Sites
Medium							
Cyclone 3	112/114|98.2%	8818 lb 4000 kg	N/A	N/A	N/A	$20-25 M	Baikonur, Plesetsk
Delta 2 7320	1/1|100%	4370 lb 1982 kg	2100 lb 952 kg	N/A	N/A	$45-55 M	CCAS, VAFB
Delta 2 7420	3/3|100%	N/A	N/A	N/A	N/A	$45-55 M	CCAS, VAFB
Delta 2 7920	17/17|100%	11330 lb 5139 kg	2800 lb 1270 kg	N/A	N/A	$50-60 M	CCAS, VAFB
Delta 2 7925	40/41|97.6%	11330 lb 5139 kg	3965 lb 1799 kg	2000 lb 907 kg	N/A	$50-60 M	CCAS, VAFB
Dnepr	1/1|100%	9700 lb 4400 kg	N/A	N/A	N/A	$10-20 M	Baikonur
Long March 2C	21/21|100%	7040 lb 3200 kg	2200 lb 1000 kg	860 lb 390 kg	N/A	$20-25 M	Jiuquan
Long March 4	3/3|100%	8818 lb 4000 kg	2430 lb 1100 kg	1220 lb 550 kg	N/A	$20-30 M	Taiyuan
Molniya	297/312|95.2%	3970 lb 1805 kg	N/A	N/A	N/A	$30-40 M	Baikonur, Plesetsk
PSLV	4/5|80%	6400 lb 2900 kg	990 lb 450 kg	N/A	N/A	$15-25 M	Sriharikota Range
Titan 2	20/20|100%	7900 lb 3583 kg	N/A	N/A	N/A	$30-40 M	CCAS, VAFB
Small							
Athena 2	1/2|50%	4390 lb 1990 kg	N/A	N/A	N/A	$22-26 M	Spaceport Florida, VAFB, Wallops (proposed)
Cosmos	411/415|99%	3100 lb 1400 kg	N/A	N/A	N/A	$12-14 M	Baikonur, Plesetsk, Kapustin Yar
Minotaur	N/A	1472 lb 666 kg	N/A	N/A	N/A	$10-15 M	VAFB
Pegasus XL	12/15|80%	1015 lb 460 kg	322 lb 146 kg	181 lb 82 kg	N/A	$12-15 M	VAFB, Wallops, Kwajalein
Pegasus XL/HAPS	3/3|100%	1015 lb 460 kg	N/A	N/A	N/A	$12-15 M	Wallops Flight Facility
Rockot	1/1|100%	4100 lb 1850 kg	N/A	N/A	N/A	$12-15 M	Baikonur
START 1	3/3|100%	790 lb 359 kg	N/A	N/A	N/A	$5-10 M	Plesetsk, Svobodny
Taurus 1	3/3|100%	3100 lb 1400 kg	990 lb 450 kg	N/A	N/A	$18-20 M	VAFB
VLS	0/1|0%	440 lb 200 kg	N/A	N/A	N/A	$6-7 M	Alcantara

Characterisitcs of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in Orbit	Freq. Bands & Trans.	Stab.	Power
Classified										
USA 144	Classified	Unknown	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Communications										
MASAT	Communications	Unknown	LEO	N/A	N/A	N/A	N/A	Unknown	N/A	N/A
Agila 2A	Communications	Unknown	GEO	N/A	N/A	5658 lb 2560 kg	N/A	12 Ku, 26C	N/A	N/A
AsiaStar 1	Communications	Unknown	GEO 105 E	19305 nMi	19305 nMi	6155 lb 2785 kg	2093 lb 947 kg	3L, 3X, S	N/A	N/A
Astra 1H	Communications	Unknown	GEO 19.2 E	N/A	N/A	7260 lb 3300 kg	N/A	28 Ku, 2 Ka	3-axis	N/A
DBS 1R	Communications	Unknown	GEO 259 E	N/A	N/A	N/A	N/A	Unknown	N/A	N/A
Echostar 5	Communications	Unknown	GEO 250 E	N/A	N/A	N/A	N/A	Unknown	N/A	N/A
Eutelsat W3	Communications	Unknown	GEO 7 E	19332 nMi	19305 nMi	6599 lb 3000 kg	N/A	24 Ku	N/A	N/A
Garuda 1	Communications	$377.5 M	GEO 123 E	N/A	N/A	5986 lb 2721 kg	N/A	6 C, 88 L	N/A	N/A
GE 1A	Communications	Unknown	GEO 97 E	N/A	N/A	N/A	N/A	24 C, 24 Ku	N/A	N/A
GE 4	Communications	Unknown	GEO 259 E	N/A	N/A	N/A	N/A	24 C, 24 Ku	N/A	N/A
Globalstar	Communications	$15.5 M	LEO	764 nMi	764 nMi	988 lb 449 kg	N/A	L, C, S	N/A	875 W
Hispasat 1C	Communications	Unknown	GEO 330 E	N/A	N/A	6144 lb 2780 kg	N/A	Unknown	N/A	N/A
ICO	Communications	Unknown	MEO	5592 nMi	5592 nMi	6050 lb 2750 kg	N/A	1 C, 1 S	N/A	N/A
Insat 2E	Communications	Unknown	GEO 83 E	N/A	N/A	5500 lb 2500 kg	N/A	17 C	N/A	N/A
Insat 3B	Communications	Unknown	GEO	N/A	N/A	5525 lb 2500 kg	N/A	18 C, 6 Ku	N/A	N/A
Intelsat K-TV	Communications	Unknown	GEO 95 E	N/A	N/A	7150 lb 3250 kg	N/A	30 Ku	N/A	N/A
Iridium	Communications	Unknown	LEO	419 nMi	419 nMi	1496 lb 680 kg	N/A	Unknown	N/A	N/A
KoreaSat 3	Communications	Unknown	GEO 116 E	N/A	N/A	2895 lb 1316 kg	N/A	30 Ku, 3 Ka	N/A	N/A
LMI 1	Communications	Unknown	GEO 75 E	N/A	N/A	N/A	N/A	46 C, 38 Ku	N/A	N/A
MegSat 0	Communications	Unknown	LEO	N/A	N/A	111 lb 50 kg	N/A	Unknown	N/A	N/A
Milstar II-F1	Communications	$800 M	GEO	N/A	N/A	10000 lb 4525 kg	N/A	Unknown	N/A	N/A
Mita	Communications	Unknown	LEO	540 nMi	540 nMi	111 lb 50 kg	N/A	Unknown	N/A	N/A
Molniya 3-50	Communications	Unknown	ELI	22039 nMi	255 nMi	3868 lb 1750 kg	N/A	Unknown	N/A	1000 W
MUBLCOM	Communications	Unknown	LEO	N/A	N/A	106 lb 48 kg	N/A	Unknown	N/A	N/A
Nimiq 1	Communications	$210 M	GEO 269 E	N/A	N/A	7956 lb 3600 kg	N/A	32 Ku	N/A	N/A
Orbcomm	Communications	Unknown	LEO	446 nMi	446 nMi	87 lb 40 kg	N/A	Unknown	N/A	N/A
Orion F2	Communications	Unknown	GEO 348 E	N/A	N/A	8398 lb 3800 kg	N/A	34 Ku	3-axis	N/A
Orion F3	Communications	Unknown	GEO 139 E	N/A	N/A	7072 lb 3200 kg	N/A	25 Ku, 10 C	N/A	N/A
Raduga 35	Communications	Unknown	GEO	N/A	N/A	4332 lb 1965 kg	N/A	Unknown	3-axis	N/A
Sesat	Communications	Unknown	GEO 36 E	N/A	N/A	5720 lb 2600 kg	N/A	18 Ku	N/A	N/A
Superbird 4	Communications	Unknown	GEO 162 E	N/A	N/A	N/A	N/A	23 Ku, 6 Ka	N/A	N/A

Characterisitcs of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in Orbit	Freq. Bands & Trans.	Stab.	Power
Communications (cont.)										
TDRS F8	Communications	Unknown	GEO 319 E	N/A	N/A	6485 lb 2948 kg	3675 lb 1670 kg	1 Ku, 1 S, 1 Ka	N/A	N/A
Telkom 1	Communications	$84.6 M	GEO 108 E	N/A	N/A	5525 lb 2500 kg	N/A	36 C	N/A	N/A
Telstar 7	Communications	Unknown	GEO 231 E	N/A	N/A	7683 lb 3492 kg	N/A	24 C, 28 Ku	N/A	N/A
Development										
Clementine (France)	Development	Unknown	LEO	N/A	N/A	111 lb 50 kg	N/A	N/A	N/A	N/A
Earth Orbiter 1	Development	Unknown	LEO	N/A	N/A	939 lb 425 kg	N/A	N/A	N/A	N/A
FalconSat	Development	Unknown	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OPAL	Development	$0.1 M	LEO	N/A	N/A	30 lb 14 kg	0 lb 14 kg	N/A	N/A	N/A
TSX 5	Development	$85 M	LEO	N/A	N/A	286 lb 130 kg	N/A	N/A	N/A	N/A
Tubsat C-DLR	Development	Unknown	LEO	540 nMi	540 nMi	99 lb 45 kg	N/A	N/A	N/A	N/A
Intelligence										
DSP 19	Intelligence	Unknown	GEO	N/A	N/A	5171 lb 2340 kg	N/A	N/A	N/A	N/A
DSP 20	Intelligence	Unknown	GEO	N/A	N/A	5200 lb 2353 kg	N/A	N/A	N/A	N/A
Helios (European) 1B	Intelligence	Unknown	LEO	459 nMi	N/A	6050 lb 2750 kg	N/A	N/A	3-axis	N/A
USAF 1999-11	Intelligence	Unknown	TBA	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Meteorological										
DMSP 5D-3-F15	Meteorological	$60 M	LEO	462 nMi	438 nMi	2539 lb 1154 kg	N/A	N/A	3-axis	N/A
FY-1C	Meteorological	Unknown	LEO	470 nMi	470 nMi	1938 lb 881 kg	N/A	N/A	N/A	N/A
GOES L	Meteorological	Unknown	GEO 285 E	19330 nMi	19323 nMi	3991 lb 1814 kg	N/A	N/A	N/A	N/A
Navigation										
MTSat 1	Navigation	$109 M	GEO 140 E	N/A	N/A	6380 lb 2900 kg	N/A	N/A	3-axis	N/A
Navstar GPS 2R- 4	Navigation	Unknown	MEO	10899 nMi	10899 nMi	4470 lb 2032 kg	N/A	1 L	N/A	N/A
Other										
Celestis 3	Other	Unknown	LEO	N/A	N/A	2 lb 1 kg	N/A	N/A	N/A	N/A
Remote Sensing										
CBERS/Ziyuan 1	Remote Sensing	$75 M	LEO	420 nMi	420 nMi	3190 lb 1450 kg	N/A	N/A	3-axis	985 W
IKONOS 1	Remote Sensing	Unknown	LEO	367 nMi	367 nMi	1797 lb 817 kg	1216 lb 550 kg	N/A	3-axis	N/A
IKONOS 2	Remote Sensing	Unknown	LEO	367 nMi	367 nMi	1797 lb 817 kg	N/A	N/A	N/A	N/A
IRS P4	Remote Sensing	Unknown	LEO	497 nMi	481 nMi	2970 lb 1350 kg	N/A	N/A	N/A	N/A
Kitsat 3	Remote Sensing	Unknown	LEO	470 nMi	470 nMi	220 lb 100 kg	N/A	N/A	N/A	N/A
Kompsat	Remote Sensing	$92 M	LEO	N/A	N/A	1122 lb 510 kg	N/A	S, X	N/A	N/A
Landsat 7	Remote Sensing	$413 M	LEO	381 nMi	381 nMi	4862 lb 2200 kg	N/A	1 X	N/A	N/A
Okean O1	Remote Sensing	Unknown	LEO	N/A	N/A	4310 lb 1950 kg	N/A	N/A	N/A	N/A
OrbView 3	Remote Sensing	Unknown	LEO	248 nMi	248 nMi	407 lb 185 kg	N/A	N/A	N/A	N/A

Characterisitcs of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in Orbit	Freq. Bands & Trans.	Stab.	Power
Remote Sensing (cont.)										
QuickBird 1	Remote Sensing	$45 M	LEO	254 nMi	254 nMi	1803 lb 816 kg	N/A	N/A	N/A	N/A
SACI 1	Remote Sensing	Unknown	LEO	420 nMi	420 nMi	132 lb 60 kg	N/A	N/A	N/A	N/A
SACI 2	Remote Sensing	Unknown	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Terra	Remote Sensing	$1200 M	LEO	381 nMi	381 nMi	11470 lb 5190 kg	N/A	N/A	N/A	N/A
Tsinghua 1	Remote Sensing	Unknown	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scientific										
Abrixas	Scientific	$35 M	LEO	324 nMi	324 nMi	990 lb 450 kg	N/A	N/A	N/A	N/A
ACRIMSAT	Scientific	$8.3 M	LEO	N/A	N/A	221 lb 100 kg	N/A	N/A	N/A	N/A
Artemis Picosat	Scientific	Unknown	LEO	N/A	N/A	1 lb 0 kg	N/A	N/A	N/A	N/A
ASUSat 1	Scientific	Unknown	LEO	N/A	N/A	10 lb 5 kg	N/A	N/A	N/A	N/A
Champ	Scientific	$18 M	LEO	N/A	N/A	660 lb 300 kg	N/A	N/A	N/A	N/A
Chandra	Scientific	$1400 M	ELI	75600 nMi	5400 nMi	62166 lb 28200 kg	N/A	N/A	N/A	N/A
Citizen Explorer	Scientific	Unknown	LEO	N/A	N/A	81 lb 37 kg	N/A	N/A	N/A	N/A
Coronas F	Scientific	Unknown	LEO	270 nMi	270 nMi	4752 lb 2160 kg	N/A	N/A	N/A	N/A
DARPA Picosat	Scientific	Unknown	LEO	N/A	N/A	2 lb 1 kg	N/A	N/A	N/A	N/A
FUSE	Scientific	$100 M	LEO	432 nMi	432 nMi	2992 lb 1360 kg	N/A	N/A	N/A	N/A
Jawsat	Scientific	Unknown	LEO	N/A	N/A	150 lb 68 kg	N/A	N/A	N/A	N/A
Munin	Scientific	Unknown	LEO	N/A	N/A	12 lb 6 kg	N/A	N/A	N/A	N/A
Odin	Scientific	$4.3 M	LEO	324 nMi	324 nMi	550 lb 250 kg	N/A	N/A	N/A	N/A
QuickSCAT	Scientific	$39 M	LEO	N/A	N/A	2144 lb 970 kg	N/A	N/A	N/A	N/A
SAC C	Scientific	Unknown	LEO	N/A	N/A	935 lb 425 kg	N/A	N/A	N/A	N/A
SJ 5	Scientific	Unknown	LEO	N/A	N/A	751 lb 340 kg	N/A	N/A	N/A	N/A
Starshine	Scientific	Unknown	LEO	N/A	N/A	86 lb 39 kg	N/A	N/A	N/A	N/A
STENSAT	Scientific	Unknown	LEO	N/A	N/A	1 lb 0 kg	N/A	N/A	N/A	N/A
TERRIERS	Scientific	Unknown	LEO	297 nMi	297 nMi	268 lb 122 kg	N/A	N/A	N/A	N/A
UoSat 12	Scientific	Unknown	LEO	N/A	N/A	330 lb 150 kg	N/A	N/A	N/A	N/A
XMM	Scientific	Unknown	ELI	61560 nMi	3780 nMi	8800 lb 4000 kg	N/A	N/A	N/A	N/A
Space Station										
Zvezda	Space Station	Unknown	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Supply										
Progress M-41	Supply	Unknown	LEO	N/A	N/A	15983 lb 7250 kg	N/A	N/A	N/A	N/A
Progress M-42	Supply	Unknown	LEO	N/A	N/A	15983 lb 7250 kg	N/A	N/A	N/A	N/A
Progress M-ISS-01	Supply	Unknown	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Test										
Unmanned Test	Test	Unknown	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Launch Events
April - June 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
China								
			Long March					
May 10, 1999	Long March 4	FY-1C SJ 5	China Meteo. Admin. Chinese Acad. of Space Tech.	Shanghai Inst. of Sat. Eng. Chinese Acad. of Space Tech.	No	Non-Commercial	Success	Success
June 11, 1999	Long March 2C	Iridium 14A Iridium 21A	Iridium, Inc. Iridium, Inc.	Lockheed Martin Lockheed Martin	Yes	Commercial	Success	Success
Europe (ESA)								
			Ariane 4					
April 2, 1999	Ariane 42P	Insat 2E	ISRO	ISRO	Yes	Commercial	Success	Success
India								
			PSLV					
May 26, 1999	PSLV	IRS P4 Kitsat 3 Tubsat C-DLR	ISRO Korean Advncd. Inst. of Science Technical University of Berlin	ISRO Surrey Satellite Technology Technical University of Berlin	No	Non-Commercial	Success	Success
Russia								
			Cosmos					
April 29, 1999	Cosmos	Abrixas MegSat 0	DLR Meggiorin	OHB System Unknown	Yes	Commercial	Success	Success
			Dnepr					
April 21, 1999	Dnepr	UoSat 12	Surrey Satellite Technology	Surrey Satellite Technology	Yes	Commercial	Success	Success

Launch Events
April - June 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
Russia (cont.)								
				Proton				
May 21, 1999	Proton (SL-12)	Nimiq 1	Telesat Canada	Lockheed Martin	Yes	Commercial	Success	Success
June 18, 1999	Proton (SL-12)	Astra 1H	SES	Hughes	Yes	Commercial	Success	Success
				Soyuz				
April 2, 1999	Soyuz	Progress M-41	RKK Energia	RKK Energia	No	Non-Commercial	Success	Success
April 15, 1999	Soyuz	Globalstars 19,24,42,45	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Success	Success
USA								
				Athena				
April 27, 1999	Athena 2	IKONOS 1	Space Imaging Inc.	Lockheed Martin	No	Commercial	Failure	Failure
				Atlas				
April 12, 1999	Atlas 2AS	Eutelsat W3	Eutelsat	Aerospatiale	Yes	Commercial	Success	Success
				Delta 2				
April 15, 1999	Delta 2 7920	Landsat 7	NASA	Lockheed Martin Corp.	No	Non-Commercial	Success	Success
June 10, 1999	Delta 2 7420	Globalstars 25,47,49,52	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Success	Success
June 24, 1999	Delta 2 7320	FUSE	NASA	Orbital Sciences Corp.	No	Non-Commercial	Success	Success
				Delta 3				
May 4, 1999	Delta 3	Orion F3	Orion Network Systems	Hughes	Yes	Commercial	Failure	Failure
				Pegasus				
May 17, 1999	Pegasus XL	MUBLCOM TERRIERS	ARPA Boston University/NASA	Orbital Sciences AeroAstro	Yes	Commercial	Success	Failure

Launch Events
April - June 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
USA (cont.)								
				Shuttle				
May 27, 1999	Shuttle Discovery	STS 96 Starshine	NASA NASA	Rockwell International Utah State University	No	Non-Commercial	Success	Success
				Titan 2				
June 19, 1999	Titan 2	QuickSCAT	NASA	Ball Aerospace	No	Non-Commercial	Success	Success
				Titan 4				
April 9, 1999	Titan 4B/IUS	DSP 19	DoD	TRW	No	Non-Commercial	Failure	Failure
April 30, 1999	Titan 4B/Centaur	Milstar II-F1	DoD/USAF	Lockheed Martin	No	Non-Commercial	Failure	Failure
May 22, 1999	Titan 4B	USA 144	NRO	Unknown	No	Non-Commercial	Success	Success

Launch Events
July 1999 - December 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
Brazil							
			VLS				
4th Qtr 1999	VLS	SACI 2	INPE	INPE	No	Non-Commercial	Alcantara
China							
			Long March				
October 1999	Long March 4	CBERS/Ziyuan 1 SACI 1	China/Brazil INPE	China Acad. of Space Technology INPE	No	Non-Commercial	Taiyuan
October 1999	Long March 2F	Unmanned Test	Unknown	Unknown	No	Non-Commercial	Jiuquan
4th Qtr 1999	Long March TBA	Tsinghua 1	Tsinghua University	Surrey Satellite Technology Ltd.	No	Commercial	Taiyuan
Europe (ESA)							
			Ariane 4				
July 1999	Ariane 44P	Intelsat K-TV	New Skies Satellites, N.V.	Matra Marconi	Yes	Commercial	Kourou
September 1999	Ariane 44LP	Orion F2	Orion Network Services	Space Systems/Loral	Yes	Commercial	Kourou
3rd Qtr 1999	Ariane 4-TBA	KoreaSat 3	Korea Telecom	Lockheed Martin Corp.	Yes	Commercial	Kourou
November 1999	Ariane 4-TBA	Clementine (France) Helios (European) 1B	DGA CNES/DGA	Surrey Satellite Technology Limited Matra Marconi	No	Non-Commercial	Kourou
December 1999	Ariane 4-TBA	Superbird 4	Space Communications Corp. (SCC)	Hughes	Yes	Commercial	Kourou
4th Qtr 1999	Ariane 4 or 5	Agila 2A	Philippine Agila Satellite Inc. (PASI)	Aerospatiale	Yes	Commercial	Kourou
			Ariane 5				
August 1999	Ariane 5	AsiaStar 1 Telkom 1	WorldSpace, Inc. PT Telekom	Alcatel Lockheed Martin	Yes	Commercial	Kourou
October 1999	Ariane 5	Insat 3B	ISRO	ISRO	Yes	Commercial	Kourou
December 1999	Ariane 5	XMM	European Space Agency (ESA)	Deutsche Aerospace (DASA)	No	Non-Commercial	Kourou

Launch Events
July 1999 - December 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
International							
			Sea Launch				
August 15, 1999	Sea Launch	DBS 1R	Hughes Communications Inc.	Hughes	Yes	Commercial	Sea Launch Platform
Japan							
			H 2				
August 1999	H 2	MTSat 1	Ministry of Transport	Space Systems/Loral	No	Non-Commercial	Tanegashima
Russia							
			Cosmos				
October 1999	Cosmos	Champ Mita	DARA Italian Space Agency (ASI)	Jena-Optronik GmbH Carlo Gavazzi Space	Yes	Commercial	Plesetsk
December 1999	Cosmos	QuickBird 1	EarthWatch, Inc.	Ball Aerospace	Yes	Commercial	Plesetsk
			Cyclone				
4th Qtr 1999	Cyclone 3	Coronas F	Izmiran & Lebedev Physical Institute	NPO Yuzhnoye	No	Non-Commercial	Plesetsk
			Molniya				
July 8, 1999	Molniya	Molniya 3-50	Russia/CIS PTT	NPO Prikladnoi Mekhaniki	No	Non-Commercial	Plesetsk
			Proton				
July 5, 1999	Proton (SL-12)	Raduga 35	Russia/CIS PTT	NPO Prikladnoi Mekhaniki	No	Non-Commercial	Baikonur
July 1999	Proton (SL-12)	Sesat	Eutelsat	NPO Prikladnoi Mekhaniki	Yes	Commercial	Baikonur
September 6, 1999	Proton (SL-12)	LMI 1	Lockheed Martin Intersputnik (LMI)	Lockheed Martin	Yes	Commercial	Baikonur
September 1999	Proton (SL-12)	Garuda 1	ACeS Consortium	Lockheed Martin Corp.	Yes	Commercial	Baikonur
3rd Qtr 1999	Proton (SL-12)	ICO 1	ICO Global Communications	Hughes	Yes	Commercial	Baikonur
November 20, 1999	Proton (SL-13)	Zvezda	Russian Space Agency (RKA)	RKK Energia	No	Non-Commercial	Baikonur

Launch Events
July 1999 - December 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
Russia (cont.)							
			Proton				
4th Qtr 1999	Proton (SL-12)	ICO 5	ICO Global Communications	Hughes	Yes	Commercial	Baikonur
4th Qtr 1999	Proton (SL-12)	GE 1A	GE Americom/LM Global Telecom	Lockheed Martin	Yes	Commercial	Baikonur
4th Qtr 1999	Proton (SL-12)	GE 4	GE Americom	Lockheed Martin	Yes	Commercial	Baikonur
			Rockot				
December 1999	Rockot	Rockot Iridium #1	Iridium, Inc.	Lockheed Martin	Yes	Commercial	Plesetsk
			Soyuz				
July 1999	Soyuz	Progress M-42	RKK Energia	RKK Energia	No	Non-Commercial	Baikonur
September 1999	Soyuz	Soyuz Globalstar #4	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur
October 1999	Soyuz	Soyuz Globalstar #5	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur
November 1999	Soyuz	Soyuz Globalstar #6	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur
December 3, 1999	Soyuz	Progress M-ISS-01	RKK Energia	RKK Energia	No	Non-Commercial	Baikonur
			START				
July 1999	START 1	Odin	Swedish National Space Board	Swedish Space Corp.	Yes	Commercial	Svobodny
			Zenit				
July 8, 1999	Zenit 2	Okean O1	NSAU	NPO Yuzhnoe	No	Non-Commercial	Baikonur

Launch Events
July 1999 - December 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
USA							
			Athena 2				
August 21, 1999	Athena 2	IKONOS 2	Space Imaging Inc.	Lockheed Martin	No	Commercial	VAFB
			Atlas 2				
August 27, 1999	Atlas 2AS	Terra	NASA	Lockheed Martin	No	Non-Commercial	VAFB
September 8, 1999	Atlas 2AS	Echostar 5	Echostar	Space Systems/Loral	Yes	Commercial	CCAS
September 30, 1999	Atlas 2AS	TDRS F8	NASA	Hughes	No	Non-Commercial	CCAS
3rd Qtr 1999	Atlas 2A	GOES L	NOAA	Space Systems/Loral	No	Non-Commercial	CCAS
November 22, 1999	Atlas 2AS	USAF 1999-11	DoD	TBA	No	Non-Commercial	CCAS
December 15, 1999	Atlas 2AS	Hispasat 1C	Hispasat	Aerospatiale	Yes	Commercial	CCAS
4th Qtr 1999	Atlas 2AS	ICO 2	ICO Global Communications	Hughes	Yes	Commercial	CCAS
			Atlas 3				
August 17, 1999	Atlas 3A	Telstar 7	Skynet	Space Systems/Loral	Yes	Commercial	CCAS
			Delta 2				
July 8, 1999	Delta 2 7420	Delta Globalstar #4	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	CCAS
July 24, 1999	Delta 2 7420	Delta Globalstar #5	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	CCAS
August 14, 1999	Delta 2 7420	Delta Globalstar #6	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	CCAS
August 21, 1999	Delta 2 7920	Delta Iridium #12	Iridium, Inc.	Lockheed Martin	Yes	Commercial	VAFB
September 23, 1999	Delta 2 7925	Navstar GPS 2R- 4	DoD	Lockheed Martin Corp.	No	Non-Commercial	CCAS
December 7, 1999	Delta 2 7420	Delta Globalstar #7	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	CCAS

Launch Events
July 1999 - December 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
USA (cont.)							
			Delta 2				
December 15, 1999	Delta 2 7320	Earth Orbiter 1 Citizen Explorer Munin SAC C	NASA Colorado Space Grant Consortium Swedish Inst. of Space Physics Argentina	Swales & Assoc. Inc., MIT/Lincoln Labs Colorado Space Grant Consortium Swedish Institute of Space Physics Bariloche Company Invap.	No	Non-Commercial	VAFB
			Delta 3				
October 23, 1999	Delta 3	ICO 3	ICO Global Communications	Hughes	Yes	Commercial	CCAS
November 29, 1999	Delta 3	ICO 4	ICO Global Communications	Hughes	Yes	Commercial	CCAS
			Minotaur				
September 15, 1999	Minotaur	Jawsat OPAL STENSAT MASAT DARPA Picosat Artemis Picosat FalconSat ASUSat 1	Air Force Acad. & Weber State Univ Space Systems Development Lab Radio Amateurs Unknown DARPA Santa Clara University USAF Arizona State University	Air Force Academy Space Systems Devlp. Lab. (SSDL) Radio Amateurs Unknown DARPA Santa Clara University USAF Arizona State University	No	Non-Commercial	California Spaceport
			Pegasus				
3rd Qtr 1999	Pegasus XL/HAPS	Pegasus Orbcomm #4	Orbcomm	Orbital Sciences Corp.	No	Commercial	Kwajalein
4th Qtr 1999	Pegasus XL	TSX 5	DoD	Orbital Sciences Corp.	No	Non-Commercial	VAFB
4th Qtr 1999	Pegasus XL	OrbView 3	Orbimage	Orbital Sciences Corp.	No	Commercial	VAFB
			Shuttle				
July 20, 1999	Shuttle Columbia	STS 93 Chandra	NASA NASA	Rockwell International TRW	No	Non-Commercial	KSC
September 16, 1999	Shuttle Endeavour	STS 99	NASA	Rockwell International	No	Non-Commercial	KSC
October 14, 1999	Shuttle Discovery	STS 103	NASA	Rockwell International	No	Non-Commercial	KSC

Launch Events
July 1999 - December 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
USA (cont.)							
			Shuttle				
December 2, 1999	Shuttle Atlantis	STS 101	NASA	Rockwell International	No	Non-Commercial	KSC
			Taurus				
4th Qtr 1999	Taurus 1	ACRIMSAT Celestis 3 Kompsat	NASA Celestis Korea Aerospace Research Institute	Orbital Sciences Corporation (OSC) Celestis TRW/KARI	Yes	Commercial	VAFB
			Titan 2				
August 18, 1999	Titan 2	DMSP 5D-3-F15	DoD	Locheed Martin	No	Non-Commercial	VAFB
			Titan 4				
October 16, 1999	Titan 4B/IUS	DSP 20	DoD	TRW	No	Non-Commercial	CCAS