Commercial Space Transportation

QUARTERLY LAUNCH REPORT

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

2nd 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

2ND 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**:* The Boeing Company (1999). Image is of the Sea Launch Zenit-3SL on its successful inaugural flight, March 27, 1999.

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This document was released on April 26, 1999.

SUMMARY

First Quarter 1999 Launch Events

- The United States conducted seven launches in the first quarter of 1999. Three were commercial (one Athena, one Atlas, and one Sea Launch) and four were non-commercial (three Delta and one Pegasus). All of these launches were successful.
- There were six Russian launches in this period. Proton and Soyuz each conducted two commercial launches and one non-commercial launch. All launches were successful.
- Europe conducted one successful commercial launch of the Ariane 4.

Second and Third Quarter 1999 Scheduled Launch Events

- U.S. launch providers intend to make 33 launches in the next two quarters. Sixteen of these launches will be commercial: one Athena 2, two Atlas 2, one Atlas 3, six Delta 2, two Delta 3, two Pegasus, and one each on Sea Launch and Taurus. Non-commercial launches will consist of four Atlas 2, three Delta 2, one Minotaur, one Pegasus, three Space Shuttle, two Titan 2, and three Titan 4.
- Russian launch vehicles are scheduled to make 16 launches, eleven of which are commercial. These commercial launches are on six Proton, three Soyuz, one Cosmos, and one Start. Non-commercial launches will include two Proton, one Soyuz, one Cyclone, and one Zenit.
- Europe plans six commercial Ariane 4 launches and one commercial launch of the Ariane 5 for a total of seven commercial launches.
- 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 M 5 launch scheduled.
- India plans one non-commercial launch of the PSLV.

SUMMARY

Commercial Products and Services

Second and Third Quarter 1999

New Commercial Vehicles and Markets to be Inaugurated

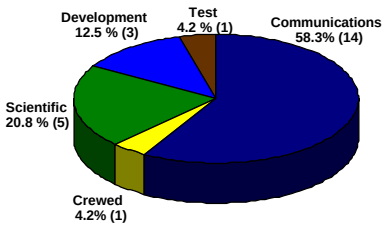
After a successful inaugural flight in March that deployed a dummy test payload to GTO, Sea Launch announced that it will begin commercial operations in August. The Sea Launch partnership, a multi-national consortium led by Boeing, will use its Ukrainian/Russian launch vehicle to carry an unspecified communications satellite into orbit. The flight will take place from the Sea Launch ocean platform.

A new sector of the commercial space market will open up with the scheduled launch of IKONOS 1. Operated by Space Imaging, Inc., IKONOS 1 is a remote sensing satellite capable of providing commercial imagery with up to one-meter resolution. Until this launch, high resolution imagery was available only from military or intelligence satellites. OrbView 3, a second commercial satellite that will produce one-meter imagery, is scheduled for launch in late 1999.

ICO plans to launch the first two satellites of its low-Earth orbit communications constellation onboard Proton vehicles during the summer of 1999. When complete, the 12 Hughes-built ICO satellites will provide mobile satellite communications. The remaining ten satellites are scheduled for launch on two Atlas, five Delta 3, two additional Proton, and one Sea Launch vehicle.

Payload Use Analysis

First Quarter 1999



In the first quarter of 1999, there were 24 payloads launched worldwide. These payloads were divided between communications (58.3 percent), crewed missions to *Mir* (4.2 percent), scientific (20.8 percent), development (12.5 percent), and test (4.2 percent).

Of the 15 internationally competed payloads on commercial launches, 13 were communications payloads. The remaining two were development and test payloads.

LAUNCH SCHEDULE

Scheduled Launch Events

Vehicle	Payload	Site
APRIL 1999		
Ariane 42P	Insat 2E	Kourou
Ariane 42P	Intelsat K-TV	Kourou
Athena 2	IKONOS	VAFB
Atlas 2AS	Eutelsat W3	CCAS
Cosmos	Abrixas	Kasputin Yar
	Megsat 0	
Delta 2 7920	Landsat 7	VAFB
Delta 2 7925	Navstar GPS 2R-3	CCAS
Delta 3	Orion F3	CCAS
Long March 3B	ChinaSat 8	Xichang
Soyuz	Globalstars 29-32	Baikonur
Soyuz	Progress M-41	Baikonur
Titan 4B	USA 1999-04	VAFB
Titan 4B/Centaur	Milstar II-F1	CCAS
Titan 4B/IUS	DSP 19	CCAS
MAY 1999		
Atlas 2A	GOES L	CCAS
Delta 2 7320	FUSE	CCAS
PSLV	IRS P4	Sriharikota
	Kitsat 3	
	Tubsat C-DLR	
Delta 2 7920	Iridiums 88-91, 94	VAFB
Proton	Nimiq 1	Baikonur
Shuttle Discovery	STS 96	KSC
Soyuz	Globalstars 33-36	Baikonur
Titan 2	QuickSCAT	VAFB
JUNE 1999		
Ariane 5	Eutelsat W4	Kourou
	Telkom 1	
Atlas 3A	Telstar 7	CCAS
Delta 2 7420	Globalstars 45-48	CCAS
Proton	ICO 2	Baikonur
VLS	SACI 2	Alcantara

LAUNCH SCHEDULE

Scheduled Launch Events

(Continued)

Vehicle	Payload	Site
JULY 1999		
Ariane 4-TBA	Astra 2B	Kourou
Atlas 2A	DSCS III 3-11	CCAS
Atlas 2AS	Terra	VAFB
Delta 2 7420	Globalstars 49-52	CCAS
Delta 3	ICO 4	CCAS
Long March 4	CBERS/ Ziyuan 1 SACI 1	Taiyuan
Proton	Garuda 1	Baikonur
Shuttle Columbia	STS 93 Chandra	KSC
START 1	Odin	Svobodny
AUGUST 1999		
Ariane 4-TBA	KoreaSat 3	Kourou
Atlas 2AS	TDRS F8	CCAS
Delta 2 7420	Globalstars 53-56	CCAS
Delta 2 7420	Iridiums 95-99	VAFB
Sea Launch	TBA 1999-08	Sea Launch Platform
Titan 2	DMSP 5D-3-F15	VAFB
Zenit 2	Badr 2 Meteor 3M-1	Baikonur
SEPTEMBER 1999		
Delta 2 7920	Globalstars 57-60	VAFB
Minotaur	Jawsat	CSP
Proton	Service Module	Baikonur
Shuttle Endeavour	STS 99	KSC
Soyuz	Globalstars 37-40	Baikonur

LAUNCH SCHEDULE

Additional Launch Events to be Announced*

For the Second and Third Quarter 1999

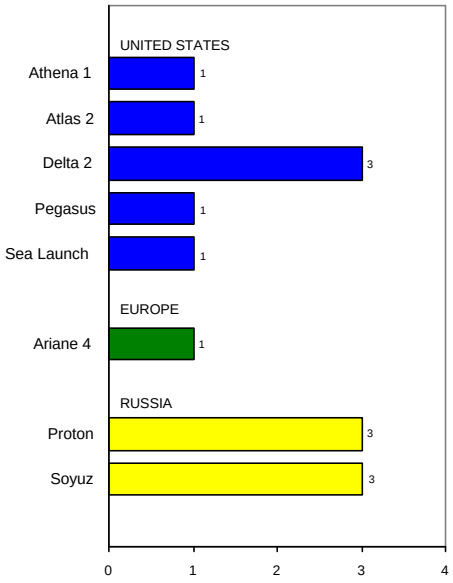
Vehicle	Payload	Site
SECOND QUARTER OF 1999		
Ariane 44L	PAS 1R	Kourou
Cyclone 3	Coronas F	Plesetsk
Long March 2C	Iridium 100	Taiyuan
	Iridium 101	
Pegasus XL	TERRIERS	VAFB
	MUBLCOM	
Pegasus XL	TSX 5	VAFB
Proton	Astra 1H	Baikonur
Proton	Glonass Replacem.	Baikonur
	01-03	
Proton	ICO 1	Baikonur
THIRD QUARTER OF 1999		
Ariane 44LP	Orion F2	Kourou
Atlas 2A	GBS 10	CCAS
M5	Lunar A	Kagoshima
Pegasus XL	Orbcomms 37-44	TBA
Proton	LMI 1	Baikonur
Taurus 1	Kompsat	VAFB

* 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

First Quarter 1999



Number of Launches
January-March 1999

In the first quarter of 1999, United States launch vehicles conducted seven of the 14 total worldwide launches. Three of these launches were commercial: one Athena 1 with a development satellite; one Atlas 2 with a GEO communications satellite, and the Sea Launch vehicle with a dummy GEO communications satellite. Non-commercial launches of U.S. vehicles consisted of two Delta 2 vehicles with scientific NASA payloads, a Delta 2 with scientific and development payloads, and a Pegasus with a scientific payload.

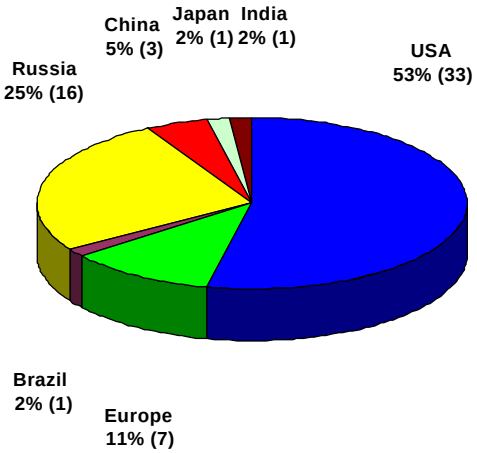
Russia carried out six launches. Two of the three Proton launches carried commercial GEO communications satellites; the third Proton launch carried a civil GEO communications satellite. Two of the three Soyuz launches carried LEO communications satellites. The third Soyuz launch brought a new crew to the *Mir* space station.

Europe successfully launched one Ariane 4 with two commercial communications satellites to GEO.

LAUNCH REPORT

Scheduled Launch Events

Second and Third Quarter 1999



Scheduled Launch Events, by Region
April-September 1999

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

Sixty-two orbital launch events are scheduled in the second and third quarters of 1999. United States launch providers plan to conduct 33 of these launches. Nine Delta 2 will carry 6 sets of LEO communications satellites, as well as navigation, communications, and scientific payloads. Six Atlas 2 vehicles will loft payloads for communications, remote sensing, and meteorology. Three Pegasus launches will carry military communications and scientific payloads, a development payload, and a set of Orbcomm satellites. Three Titan 4 launches will carry military communications, intelligence, and classified payloads. The Shuttle will also launch three times: an ISS assembly flight, the Shuttle Radar Topography Mission, and the Chandra scientific mission. Two launches of the Delta 3 will carry navigation and GEO communications satellites. The Titan 2 will loft a scientific and a military communications payload on separate launches. The sole Atlas 3 launch is scheduled to place a communications satellite into GEO, while the single planned Athena 2 launch will carry a remote sensing satellite to LEO and the only Taurus will carry a remote sensing payload. Sea Launch plans the launch of one communications satellite and the first Minotaur converted Minuteman ICBM will carry a scientific satellite.

Russia plans to launch 16 vehicles. Eight will be Proton launches: six communications satellites, one set of navigation satellites, and the Service Module for the International Space Station. Four Soyuz launches will loft three sets of Globalstar and a crew to *Mir*. The Cosmos, Cyclone 3, and START vehicles are all scheduled to launch once with scientific payloads. One Zenit 2 will carry a meteorological and development payload to LEO.

Europe is scheduled to orbit six GEO communications satellites on six Ariane 4 vehicles. One Ariane 5 vehicle will carry two more GEO communications satellites.

China intends to launch three Long March vehicles. One will carry two LEO communications satellites, another will carry a GEO communications satellite, and the third will place two remote sensing satellites into LEO.

Japan plans one launch of the M5 to send a scientific probe to the lunar surface.

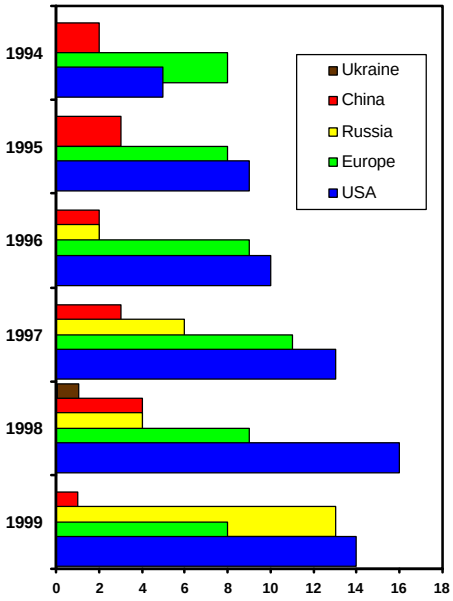
India is scheduled to launch an IRS remote sensing satellite and two small foreign satellites on a PSLV.

Brazil will make a second attempt to launch its VLS small launch vehicle.

LAUNCH REPORT

Scheduled Commercial Launch Events

Second and Third Quarter 1999



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

Of the 62 planned launches for the second and third quarters of 1999, 35 are commercial launches. Excluding small launch vehicles, the total number of planned launches drops to 53, of which 29 are commercial. Of the 35 commercial launches, United States launch providers plan to conduct 16. The Delta 2 is scheduled for six commercial launches, placing four sets of Globalstar and two sets of Iridium into LEO. Both the Atlas 2 and Delta 3 will make two commercial flights, placing four GEO communications satellites into orbit. The Atlas 3 and Sea Launch each have one commercial launch planned, both of which will loft GEO communications satellites. Only four of the 16 commercial U.S. launches are on small launch vehicles: the Athena 2 will place a remote sensing satellite in orbit, and the Pegasus will launch commercially three times, carrying two communications payloads, a scientific payload, and a remote sensing payload.

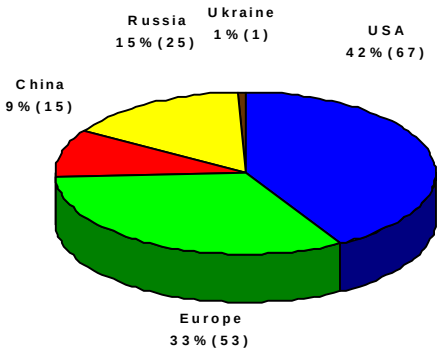
Europe plans a total of seven commercial launches, all on the intermediate Ariane 4 and large Ariane 5 vehicles. The six Ariane 4 launches will carry six communications satellites to GEO, while the single Ariane 5 flight will deploy two GEO communications satellites.

Russia plans a total of 11 commercial launches. Six of these are commercial flights of the Proton, which will loft two MEO and four GEO communications satellites. The Soyuz will launch commercially three times, each time carrying a set of Globalstar satellites to LEO. In addition, the small launch vehicle Cosmos will make a commercial flight to place a scientific and communications payload in orbit, and the START 1 vehicle will also carry a scientific payload.

China plans one commercial launch. A Long March is scheduled to carry two Iridium satellites to LEO.

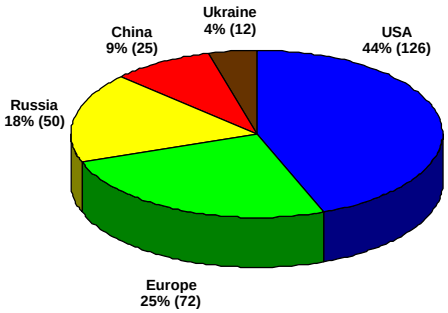
LAUNCH REPORT

Commercial Launch Trends



Commercial Launch Market Trend
January 1994 - September 1999

(small vehicles excluded)



Internationally Competed Payloads
Market Trend
January 1994 - September 1999

(small vehicles excluded)

One hundred sixty-one commercial launch events (excluding small launch vehicles) are projected for the period between January 1994 and September 1999. The United States has a 42-percent share, or 67, of these launches. In terms of internationally competed payloads on commercial launches (excluding small launch vehicles), the United States will have launched 126 of 285 payloads, for a 44-percent share of payloads.

Europe's portion of the total is 53 launches, for a 33-percent share of launches, and 72 payloads or 25 percent of total payloads.

China will have 15 launches for nine percent of launches, and 25 payloads for nine percent of the total.

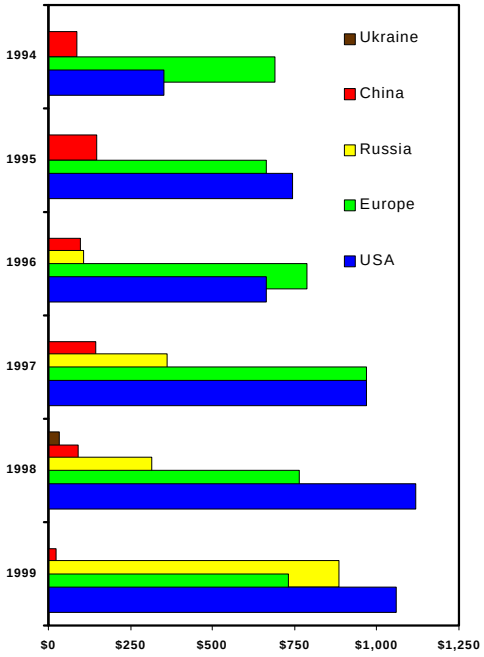
Russia will have conducted 25 commercial launches for a 15-percent share and deployed 50 internationally competed payloads or 18 percent of the total.

Ukraine will have 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.

Twenty-nine commercial launches (excluding small launch vehicles) are planned worldwide for the second and third quarters of 1999; these launches are expected to carry 59 internationally competed payloads. The United States plans 12 of these launches (41 percent), which will carry 31 (53 percent) internationally competed payloads. Europe's share of this launch market is 24 percent (7 launches), carrying 14 percent of the internationally competed payloads (8 satellites). China's single commercial launch will capture 3 percent of the internationally competed market (2 satellites). Russia's nine planned commercial launches (31 percent) will place 18 internationally competed payloads (30 percent) into orbit.

LAUNCH REPORT

Commercial Launch Revenues



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

January 1994 - September 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 September 1999 are expected to be approximately $11.8 billion. United States launch providers will achieve a 42-percent share of these revenues with about $4.9 billion, and European launch providers will capture 39 percent with about $4.6 billion. Russian launch providers hold an estimated 14-percent share with about $1.7 billion, and launch service revenues from China will consist of about $588 million for a five percent share. Ukraine's single launch will account for less than one percent of revenues at roughly $33 million.

For the first three quarters of 1999, revenues from commercial launch events are projected to approach $2.7 billion. In this period United States launch service providers will have about $1.06 billion (39 percent) of the total. Europe plans to use both Ariane 4 and Ariane 5 vehicles for commercial launches in the new year. European revenues are expected to reach $731 million (27 percent) through September of 1999. An increase in Russian launch service revenues is expected in 1999 with $884 million through September compared to $313 million for all of 1998. 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 lunch valued at about $23 million, and Ukraine have no publicly announced plans for commercial launches in 1999.

FAA's Second Annual Commercial Space Transportation Forecast Conference, February 9-10, 1999

OVERVIEW

The Federal Aviation Administration (FAA) hosted the second annual Commercial Space Transportation Forecast Conference on Tuesday, February 9th and Wednesday, February 10th, at the Washington Plaza Hotel, located in downtown Washington, DC. The conference featured four major addresses including the opening keynote address by Ms. Jane F. Garvey, FAA Administrator. Another major address was delivered by Dr. William Gaubatz, President, Space Clipper International, who presented an update of his concept of Spaceways, originally presented at the first Forecast Conference in 1998. Mr. Tidal McCoy, Chairman, Board of Directors for the Space Transportation Association was the guest speaker at the Conference Luncheon. Mr. McCoy provided a lively discussion on the need for the United States to achieve dominance in commercial space transportation and the vision necessary for this achievement. Dr. Marshall Kaplan, Chairman, Launchspace Publications, Inc., opened the second day of the conference with a presentation entitled "Basic Laws of Reusable Launch Vehicle Design."

The conference was officially opened by Patricia G. Smith, FAA Associate Administrator for Commercial Space Transportation. Ms. Smith welcomed participants and introduced Administrator Garvey. Ms. Garvey presented an overview of commercial space transportation developments occurring over 1998, including the one hundredth U.S.-licensed commercial launch[1] and the FAA's newly-acquired authority to license reentry operations under the Commercial Space Launch Act of 1998. She highlighted the FAA's efforts to develop a Space and Air Traffic Management System (SATMS), a concept for the seamless and efficient integration of commercial launch operations into the existing air traffic management system. Ms. Garvey referred to the work on SATMS as developing the "commercial space transportation regulatory infrastructure of the 21st century," and noted that the FAA has organized a team of experts from Commercial Space Transportation, Air Traffic Services, and the Aircraft Certification Service to work on this important issue. Ms. Garvey also announced the initiation of a White House-led interagency review that will incorporate the views of FAA, NASA and the Air Force on critical space launch range issues. Ms. Garvey called conference participants "visionaries" and emphasized the FAA's commitment to commercial space transportation, safety for all commercial space transportation activities, and collaboration with industry and other organizations to ensure success for the industry.

Seven panels (discussed below) presented a cross-section of ideas and perspectives on the major issues facing the U.S. commercial space transportation industry. These panels covered a broad range of topics, from the FAA's role as regulator of the commercial

[1] The launch of an Iridium satellite on the Delta 7920-10 launch vehicle (Boeing), from Vandenberg AFB, on September 8, 1998.

space industry, to the Air Force as it faces a change in its traditional role and responsibilities at U.S. launch ranges, and to the American people, who stand to reap tremendous benefits from the developments brought about by safe, successful, and economical space transportation in the 21st century.

The conference concluded with closing remarks from Mr. Joseph Hawkins, newly appointed Deputy Associate Administrator for Commercial Space Transportation.

PANEL 1: THE HUMAN ROLE IN SPACE

The first panel explored safety, medical, technology, and economic issues for humans traveling to space, whether for recreation, exploration, or work. For insight on actual experience in space, the panel included two American heroes: former Apollo astronauts Pete Conrad and Buzz Aldrin. Pete Conrad outlined some of the professional qualifications he felt would be required for future flights into space. Dr. Aldrin discussed his efforts to make space travel accessible to all people through his work with the Share Space Foundation. The Foundation examines ways to lower the costs of transport to space through various means, including the use of current NASA Shuttle technology for recreational and adventure travel.

Dr. Melchor Antuñano, President of the Aerospace Medical Association and representing the FAA's Office of Aviation Medicine, provided a fascinating examination of the vast number of medical issues that arise as a result of humans travelling to space, especially those who lack the level of physical fitness and training required for the rigors of an on-orbit environment, such as the typical tourist. He cited a number of risks, including acceleration, solar and cosmic radiation exposure, the effects of weightlessness, in-flight exposure to noise and vibration, and other hazards.

Gary Hudson, Chief Executive Officer for the Rotary Rocket Company, rounded out the panel with his discussion of the development of the Roton reusable launch vehicle. He noted that the Roton will be the only commercial, orbital, piloted launch system in the world when it becomes operational in two years. Rotary Rocket is proposing the use of the Roton for carrying passengers into space for tourism.

PANEL 2: SPACE AND AIR TRAFFIC MANAGEMENT SYSTEM

The SATMS panel provided a discussion of the operational needs and requirements for a future National Airspace System that integrates all space launch traffic, including reentry operations. Panelist Michael Kelly, Chairman, Kelly Space and Technology, Inc., compared current launch vehicle operations with proposed reusable launch vehicle (RLV) operations, indicating his belief that future RLV activities would have very little negative impact on air traffic. Lt. General Roger DeKok, Deputy Chief of Staff for Plans and Programs, U.S. Air Force Headquarters, discussed the role of the Air Force in current air traffic management, including the scheduling of launches, collision avoidance for ascent, and tracking and cataloging manmade objects in space. General DeKok also discussed how the Air Force's role would change in future air traffic management operations. Finally, Ronald Morgan, Director of Air Traffic for the FAA, provided a comparison of current air traffic control services with those required for space transportation operations in the future, especially flight over populated areas and reentry.

PANEL 3: CHANGING ROLES AND RESPONSIBILITIES AT U.S. LAUNCH RANGES

The third panel explored the ways that traditional roles and responsibilities at federal launch ranges will evolve as the commercial space industry grows and spaceports without Air Force safety oversight begin operations. This panel provided views from all of the major players--Air Force Space Command, the Eastern and Western ranges, commercial spaceport operators, and the launch services industry. Panelists included Major General Robert Hinson, Director of Operations, Air Force Space Command; Colonel Kenneth Cinal, Operations Group Commander, 30th Space Wing; Edward O'Connor, Executive Director, Florida Spaceport Authority; Robert Rhodus, Director, Engineering Operations, Lockheed Martin Astronautics; and Colonel Philip Benjamin, Commander, 45th Operations Group.

PANEL 4: FINANCIAL ISSUES IN SPACE

Several experts brought their perspectives on the financial risks and incentives in exploration, as well as their views on opportunities for doing business in space, to the fourth panel. Gregory Randolph, Vice President and Co-Head of the Structured Finance Group for Goldman, Sachs & Company, discussed various aspects of financing reusable launch services. He outlined the business risks for the RLV sector, described the current market environment, and predicted continued growth for RLV sector. Omar Jaffrey, a Merrill Lynch specialist in financing for the satellite industry sector, provided a market outlook for the satellite industry, also predicting growth for the RLV sector and a very dynamic year for satellite financing. For space insurance issues, David McKay, Senior Vice President, U.S. Aviation Underwriters, provided an examination of the segment of the insurance market that provides the capacity for launch operations liability. Finally, Gale Schluter, Vice President and General Manager, Expendable Launch Systems, The Boeing Company, provided the industry perspective with a discussion of indemnification for expendable launch vehicle operations.

PANEL 5: THE LAW IN SPACE—A CASE STUDY

Four lawyers specializing in space law participated in a futuristic scenario that highlighted some of the legal issues that could arise over a collision in space. The hypothetical collision involved a reusable launch vehicle operated by a Japanese and British partnership and an unmanned launch vehicle carrying cargo from a space station located between the Earth and the Moon. The scenario was designed to explore the impact of the Outer Space Treaties and other aspects of domestic U. S. law on decision-making and planning for activities in space. The panelists were John Gantt, Partner, Mizrack & Gantt; Franceska Schroeder, Senior Associate, Winthrop, Stimson, Putnam & Roberts; William English, Special Counsel, Iridium LLC; and Pamela Meredith, Law Offices of Pamela Meredith.

PANEL 6: STATE AND PRIVATE INITIATIVES ON THE SPACE FRONT

The sixth panel featured state government officials and representatives from private and grass-roots organizations discussing the ways that these entities support and participate in the growth and development of the U.S. commercial space transportation sector. The Honorable Andrea Seastrand, Executive Director of the California Space and Technology Alliance (CSTA) and

former member of Congress from California's 22nd District, represented state government. She discussed the development of a 21-step, three-year strategic plan to make California the leading state in space transportation, education, research, services, and manufacturing. Also representing state government support was James Pagliosotti, Director of Government Relations, Aerospace States Association (ASA). Mr. Pagliosotti talked about the work ASA is doing to support commercial space transportation activities at the state government level and the economic development that states are experiencing as a result of these activities. Two space advocacy organizations were also represented on this panel: Craig Dickman presented the goals and activities of Space Explorers, Inc., an organization which has developed a space education program designed specifically for the classroom; and Charles Miller, Chairman of ProSpace Citizens Space Lobby, discussed the efforts of this advocacy group to open the space frontier for all humans.

PANEL 7: ADVANCING LAUNCH TECHNOLOGY

The last panel featured industry and military experts who are working on the development of new and improved launch vehicle technology. Discussion focused on the ways in which these developments can further improve commercial transportation services. Jerry Rising, President, VentureStar, LLC, Lockheed Martin Corporation, talked about his vision for the development of X-33 and VentureStar and the technological advances associated with that effort. Steve Wurst, President, Space Access, LLC, discussed the actions Space Access is taking to bring about safer, more reliable, and cost-effective access to space through the development of the SA-1 Launch System. Colonel Jose Boluda, Director for the Evolved Expendable Launch Vehicle (EELV), in the Air Force Program Executive Office for Space, discussed the Air Force program for EELV development and the methods that the Air Force proposes to reduce launch costs.

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
ARPA Advanced Research Projects Agency
CBERS China-Brazil Earth Remote Sensing
CCAS Cape Canaveral Air Station
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
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	$113-143 M	Kourou
Long March 3B	4/5|80%	29900 lb 13600 kg	9900 lb 4500 kg	4950 lb 2250 kg	N/A	$50-70 M	Xichang
Proton (SL-12)	205/228|89.9%	46297 lb 21000 kg	12100 lb 5500 kg	4850 lb 2200 kg	N/A	$75-95 M	Baikonur
Proton (SL-13)	25/28|89.3%	46000 lb 20900 kg	16535 lb 7500 kg	N/A	N/A	$65-85 M	Baikonur
Sea Launch	1/1|100%	35000 lb 15876 kg	11050 lb 5000 kg	N/A	N/A	$90-100 M	Sea Launch Platform
Shuttle Columbia	25/25|100%	47300 lb 21455 kg	13007 lb 5900 kg	5203 lb 2360 kg	N/A	$300 M	KSC
Shuttle Discovery	27/27|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	0/0|0%	47300 lb 21455 kg	19000 lb 8618 kg	N/A	N/A	$300 M	VAFB
Titan 4B/Centaur	2/2|100%	N/A	N/A	N/A	N/A	$300 M	CCAS, VAFB
Titan 4B/IUS	1/1|100%	47800 lb 21727 kg	N/A	12700 lb 5773 kg	N/A	$300 M	CCAS, VAFB
Zenit 2	25/31|80.7%	30300 lb 13740 kg	N/A	N/A	N/A	$30-40 M	Baikonur
Intermediate							
Ariane 42P	10/11|91%	13400 lb 6100 kg	6260 lb 2840 kg	N/A	N/A	$60-75 M	Kourou
Ariane 44L	27/28|96%	21100 lb 9600 kg	9965 lb 4520 kg	N/A	N/A	$90-110 M	Kourou
Ariane 44LP	18/19|95%	18300 lb 8300 kg	8950 lb 4060 kg	N/A	N/A	$80-95 M	Kourou
Ariane 44P	14/14|100%	15200 lb 6900 kg	7320 lb 3320 kg	N/A	N/A	$70-85 M	Kourou
Atlas 2A	14/14|100%	16050 lb 7280 kg	6700 lb 3039 kg	3307 lb 1500 kg	N/A	$62-85 M	CCAS, VAFB
Atlas 2AS	16/16|100%	19050 lb 8640 kg	8150 lb 3688 kg	4604 lb 2090 kg	N/A	$90-105 M	CCAS, VAFB
Atlas 3A	0/0|0%	19097 lb 8641 kg	8940 lb 4055 kg	N/A	N/A	$45-85 M	CCAS
Delta 3	0/1|0%	18408 lb 8350 kg	8360 lb 3800 kg	N/A	N/A	$75-90 M	CCAS
Soyuz	955/962|99.3%	15400 lb 7000 kg	N/A	N/A	N/A	$35-40 M	Baikonur, Plesetsk
Medium							
Cyclone 3	112/114|98.3%	8818 lb 4000 kg	N/A	N/A	N/A	$20-23 M	Baikonur, Plesetsk
Delta 2 7320	0/0|0%	4370 lb 1982 kg	2100 lb 952 kg	N/A	N/A	$44-55 M	CCAS, VAFB
Delta 2 7420	2/2|100%	N/A	N/A	N/A	N/A	$44-55 M	CCAS, VAFB
Delta 2 7425	2/2|100%	5160 lb 2340 kg	2430 lb 1102 kg	N/A	N/A	$44-55 M	CCAS, VAFB
Delta 2 7426	1/1|100%	N/A	N/A	N/A	N/A	$44-55 M	CCAS, VAFB
Delta 2 7920	16/16|100%	11330 lb 5139 kg	2800 lb 1270 kg	N/A	N/A	$44-55 M	CCAS, VAFB
Delta 2 7925	40/41|97.6%	11330 lb 5139 kg	3965 lb 1799 kg	2000 lb 907 kg	N/A	$44-55 M	CCAS, VAFB
Long March 2C	20/20|100%	7040 lb 3200 kg	2200 lb 1000 kg	860 lb 390 kg	N/A	$20-25 M	Jiuquan, Taiyuan
Long March 4	2/2|100%	8818 lb 4000 kg	2430 lb 1100 kg	1220 lb 550 kg	N/A	$15-30 M	Taiyuan
M 5	2/2|100%	5500 lb 2500 kg	2680 lb 1215 kg	1080 lb 490 kg	N/A	$41-47 M	Kagoshima

Characteristics of Cited Vehicles

Vehicle	(Success + Partials) / Attempts	LEO 28 Degrees	GTO	GEO	SUB	Price per Launch (Approx.)	Launch Sites
Medium (cont.)							
PSLV	3/4|75%	6400 lb 2900 kg	990 lb 450 kg	N/A	N/A	$15 M	Sriharikota Range
Titan 2	19/19|100%	7900 lb 3583 kg	N/A	N/A	N/A	$41-47 M	CCAS, VAFB
Small							
Athena 1	2/3|66.7%	1755 lb 800 kg	N/A	N/A	N/A	$16 M	Spaceport Florida, VAFB, Wallops (proposed)
Athena 2	1/1|100%	4390 lb 1990 kg	N/A	N/A	N/A	$21-28 M	Spaceport Florida, VAFB, Wallops (proposed)
Cosmos	410/414|99%	3100 lb 1400 kg	N/A	N/A	N/A	$10-12 M	Baikonur, Plestesk, Kasputin Yar
Pegasus XL	11/14|78.6%	1015 lb 460 kg	322 lb 146 kg	181 lb 82 kg	N/A	$12-15 M	VAFB, Wallops
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	$6.5 M	Alcantara

Characterisitcs of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in Orbit	Freq. Bands & Trans.	Stab.	Power
Classified										
USA 1999-04	Classified	Unknown	TBA	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Communications										
Arabsat 3A	Communications	Unknown	GEO	19400 nMi	19400 nMi	5967 lb 2700 kg	N/A	20 Ku	N/A	N/A
AsiaSat 3S	Communications	Unknown	GEO 105.5E	19400 nMi	19400 nMi	7656 lb 3480 kg	N/A	28C, 16 Ku	N/A	N/A
Astra 1H	Communications	Unknown	GEO 19.2E	19400 nMi	19400 nMi	7260 lb 3300 kg	N/A	32 Ku, 2 Ka	3-axis	N/A
Astra 2B	Communications	Unknown	GEO 28.2E	19400 nMi	19400 nMi	7040 lb 3200 kg	N/A	30 Ku	N/A	7 W
ChinaSat 8	Communications	$92.7 M	GEO 115.5E	19400 nMi	19400 nMi	N/A	N/A	36 C, 16 Ku	N/A	N/A
DSCS III 3-11	Communications	Unknown	GEO	19326 nMi	19323 nMi	2475 lb 1125 kg	N/A	6 SHF	3-axis	1240 W
Eutelsat W3	Communications	Unknown	GEO 7E	19332 nMi	19305 nMi	6599 lb 3000 kg	N/A	24 Ku	N/A	N/A
Eutelsat W4	Communications	Unknown	GEO 36E	19400 nMi	19400 nMi	N/A	N/A	N/A	N/A	N/A
Garuda 1	Communications	$377.5 M	GEO 123E	19400 nMi	19400 nMi	5986 lb 2721 kg	N/A	1 L, 6 C	N/A	N/A
GBS 10	Communications	$190 M	GEO	19400 nMi	19400 nMi	6305 lb 2866 kg	N/A	UHF	N/A	2500 W
Globalstars 21-60	Communications	Unknown	LEO	764 nMi	764 nMi	988 lb 449 kg	N/A	L, C, S	N/A	875 W
ICO 1, 2, 4	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 83E	19400 nMi	19400 nMi	5500 lb 2500 kg	N/A	3 Ku, 18 C	N/A	N/A
Intelsat K-TV	Communications	Unknown	GEO 95E	19400 nMi	19400 nMi	7150 lb 3250 kg	N/A	30 Ku	N/A	N/A
Iridiums 88-101	Communications	Unknown	LEO	419 nMi	419 nMi	1496 lb 680 kg	N/A	N/A	N/A	N/A
JCSAT 6	Communications	Unknown	GEO 124E	19400 nMi	19400 nMi	N/A	N/A	32 Ku	N/A	N/A
KoreaSat 3	Communications	Unknown	GEO 116E	19400 nMi	19400 nMi	2895 lb 1316 kg	N/A	30 Ku	N/A	N/A
LMI 1	Communications	Unknown	GEO 75E	19400 nMi	19400 nMi	N/A	N/A	28 C, 16 Ku	N/A	N/A
MegSat 0	Communications	Unknown	LEO	N/A	N/A	111 lb 50 kg	N/A	N/A	N/A	N/A
Milstar II-F1	Communications	Unknown	GEO	19400 nMi	19400 nMi	N/A	N/A	N/A	N/A	N/A
MUBLCOM	Communications	Unknown	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nimiq 1	Communications	$210 M	GEO 269E	19400 nMi	19400 nMi	7956 lb 3600 kg	N/A	32 Ku	N/A	N/A
Orbcomms 37-44	Communications	Unknown	LEO	446 nMi	446 nMi	87 lb 40 kg	N/A	N/A	N/A	N/A
Orion F2	Communications	Unknown	GEO 348E	19400 nMi	19400 nMi	8398 lb 3800 kg	N/A	38 Ku	3-axis	N/A
Orion F3	Communications	Unknown	GEO 139E	19400 nMi	19400 nMi	7072 lb 3200 kg	N/A	10 C, 25 Ku	N/A	N/A
PAS 1R	Communications	Unknown	GEO 315E	19400 nMi	19400 nMi	8840 lb 4000 kg	N/A	36 C, 36 Ku	3-axis	N/A
Raduga 34	Communications	Unknown	GEO	19400 nMi	19400 nMi	N/A	N/A	N/A	3-axis	N/A
Skynet 4E	Communications	Unknown	GEO 53E	19400 nMi	19400 nMi	3321 lb 1510 kg	N/A	3 X	3-axis	N/A
TBA 1999-08	Communications	Unknown	GEO	19400 nMi	19400 nMi	N/A	N/A	N/A	N/A	N/A
TDRS F8	Communications	Unknown	GEO 319E	19400 nMi	19400 nMi	6485 lb 2948 kg	3675lb 1670 kg	1 Ku, 1 S	N/A	N/A
Telkom 1	Communications	$78.4 M	GEO 108E	19400 nMi	19400 nMi	5525 lb 2500 kg	N/A	36 C	N/A	N/A
Telstar 6	Communications	Unknown	GEO 267E	19400 nMi	19400 nMi	7683 lb 3492 kg	N/A	28 Ku	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.)										
Telstar 7	Communications	Unknown	GEO 231E	19400 nMi	19400 nMi	7683 lb 3492 kg	N/A	28 Ku	N/A	N/A
Crewed										
Soyuz TM-29	Crewed	Unknown	LEO	221 nMi	213 nMi	15587 lb 7070 kg	14969lb 6790 kg	N/A	N/A	N/A
Development										
Argos	Development	Unknown	LEO	450 nMi	450 nMi	6011 lb 2720 kg	N/A	N/A	N/A	N/A
Deep Space 2	Development	Unknown	EXT	N/A	N/A	9 lb 4 kg	N/A	N/A	N/A	N/A
Rocsat 1	Development	$61 M	LEO	324 nMi	324 nMi	878 lb 399 kg	N/A	N/A	3-axis	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	N/A	N/A	N/A	N/A	N/A
Intelligence										
DSP 19	Intelligence	Unknown	GEO	19400 nMi	19400 nMi	5171 lb 2340 kg	N/A	N/A	N/A	N/A
Meteorological										
DMSP 5D-3-F15	Meteorological	$60 M	LEO	462 nMi	462 nMi	2539 lb 1154 kg	N/A	N/A	3-axis	N/A
GOES L	Meteorological	Unknown	GEO	19330 nMi	19323 nMi	3991 lb 1814 kg	N/A	N/A	N/A	N/A
Meteor 3M-1	Meteorological	Unknown	LEO	500 nMi	500 nMi	1980 lb 900 kg	N/A	N/A	N/A	N/A
Navigation										
Glonass Replacements 1-3	Navigation	Unknown	MEO	10338 nMi	10322 nMi	N/A	N/A	L	N/A	N/A
Navstar GPS 2R- 3	Navigation	Unknown	MEO	10899nMi	10899 nMi	4470 lb 2032 kg	N/A	1 L	N/A	N/A
Remote Sensing										
Badr 2	Remote Sensing	Unknown	LEO	540 nMi	540 nMi	N/A	155lb 70 kg	N/A	N/A	N/A
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	1216lb 550 kg	N/A	3-axis	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
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	N/A	N/A	N/A	N/A	N/A
Scientific										
Abrixas	Scientific	$32.4 M	LEO	324 nMi	324 nMi	990 lb 450 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
Coronas F	Scientific	Unknown	LEO	270 nMi	270 nMi	4752 lb 2160 kg	N/A	N/A	N/A	N/A
Oersted	Scientific	Unknown	LEO	459 nMi	459 nMi	136 lb 62 kg	N/A	N/A	N/A	44 W

Characterisitcs of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in Orbit	Freq. Bands & Trans.	Stab.	Power
Scientific (cont.)										
FUSE	Scientific	$100 M	LEO	432 nMi	432 nMi	2992 lb 1360 kg	N/A	N/A	N/A	N/A
Lunar A	Scientific	Unknown	EXT	N/A	N/A	1199 lb 545 kg	N/A	N/A	N/A	N/A
Mars Polar Lander	Scientific	Unknown	EXT	N/A	N/A	1362 lb 618 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	$36.1 M	LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stardust	Scientific	$75.1 M	EXT	N/A	N/A	840 lb 380 kg	N/A	N/A	3-axis	N/A
Sunsat	Scientific	Unknown	LEO	464 nMi	464 nMi	132 lb 60 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
WIRE	Scientific	$74.6 M	LEO	270 nMi	270 nMi	649 lb 295 kg	N/A	N/A	N/A	N/A
Space Station										
Service Module 1	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
Test										
DemoSat	Test	Unknown	GEO	19400 nMi	19400 nMi	10498 lb 4750 kg	N/A	N/A	N/A	N/A

Launch Events
January-March 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
Europe (ESA)								
			Ariane 4					
February 26, 1999	Ariane 44L	Arabsat 3A Skynet 4E	Arabsat British Defense Ministry	DASA Matra Marconi	Yes	Commercial	Success	Success
Russia								
			Proton					
February 15, 1999	Proton	Telstar 6	Skynet	Space Systems/Loral	Yes	Commercial	Success	Success
February 28, 1999	Proton	Raduga 34	Russia/CIS PTT	NPO Prikladnoi Mekhaniki	No	Non-Commercial	Success	Success
March 21, 1999	Proton	AsiaSat 3S	Asia Sat. Telecomm. Co Ltd	Hughes	Yes	Commercial	Success	Success
			Soyuz					
February 9, 1999	Soyuz	Globalstars 21-24	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Success	Success
February 20, 1999	Soyuz	Soyuz TM-29	RKK Energia	RKK Energia	No	Non-Commercial	Success	Success
March 15, 1999	Soyuz	Globalstars 25-28	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Success	Success
USA								
			Athena					
January 26, 1999	Athena 1	Rocsat 1	NSPO	TRW	Yes	Commercial	Success	Success
			Atlas					
February 15, 1999	Atlas 2AS	JCSAT 6	JSAT	Hughes	Yes	Commercial	Success	Success

*High-profile suborbital launch events included.

Launch Events
January-March 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
USA (cont.)								
			Delta 2					
January 3, 1999	Delta 2 7425	Deep Space 2 Mars Polar Lander	NASA NASA	JPL Lockheed Martin	No	Non-Commercial	Success	Success
February 7, 1999	Delta 2 7426	Stardust	NASA	Lockheed Martin	No	Non-Commercial	Success	Success
February 23, 1999	Delta 2 7920	Argos Oersted Sunsat	Space Test Prog. Office Danish Space Rsrch. Inst. University of Stellenbosch	Boeing Comp. Res. Int'l. University of Stellenbosch	No	Non-Commercial	Success	Success
			Pegasus					
March 4, 1999	Pegasus XL	WIRE	NASA	NASA Goddard	No	Non-Commercial	Success	Failure
			Sea Launch					
March 27, 1999	Sea Launch	DemoSat	Sea Launch	Hughes	No	Commercial	Success	Success

*High-profile suborbital launch events included.

Launch Events
April 1999 - September 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
Brazil							
			VLS				
June 1999	VLS	SACI 2	INPE	INPE	No	Non-Commercial	Alcantara
China							
			Long March				
April 1999	Long March 3B	ChinaSat 8	Chinese Broadcasting Sat. Corp.	Space Systems/Loral	No	Non-Commercial	Xichang
2nd Qtr 1999	Long March 2C	Iridium 100 Iridium 101	Iridium, Inc. Iridium, Inc.	Lockheed Martin Lockheed Martin	Yes	Commercial	Taiyuan
July 1999	Long March 4	CBERS/Ziyuan 1 SACI 1	China/Brazil INPE	China Acad. of Space Tech. INPE	No	Non-Commercial	Taiyuan
Europe (ESA)							
			Ariane 4				
April 2, 1999	Ariane 42P	Insat 2E	ISRO	ISRO	Yes	Commercial	Kourou
April 28, 1999	Ariane 44P	Intelsat K-TV	New Skies Satellites, N.V.	Matra Marconi	Yes	Commercial	Kourou
2nd Qtr 1999	Ariane 44L	PAS 1R	PanAmSat	Hughes	Yes	Commercial	Kourou
July 1999	Ariane 4-TBA	Astra 2B	Societe Europeenne des Satellites (SES)	Matra Marconi	Yes	Commercial	Kourou
August 1999	Ariane 4-TBA	KoreaSat 3	Korea Telecom	Lockheed Martin Corp.	Yes	Commercial	Kourou
3rd Qtr 1999	Ariane 44LP	Orion F2	Orion Network Services	Space Systems/Loral	Yes	Commercial	Kourou
			Ariane 5				
June 1999	Ariane 5	Eutelsat W4 Telkom 1	Eutelsat PT Telekom	NPO Prikladnoi Mekhaniki Lockheed Martin	Yes	Commercial	Kourou

Launch Events
April 1999 - September 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
India							
			PSLV				
May 5, 1999	PSLV	IRS P4 Kitsat 3 Tubsat C-DLR	ISRO Korean Adv. Inst. of Science Technical Univ. Berlin	ISRO Surrey Satellite Ltd. Technical Univ. Berlin	No	Non-Commercial	Sriharikota Range
Japan							
			M 5				
3rd Qtr 1999	M 5	Lunar A	ISAS	Inst. of Space & Astronautical Science	No	Non-Commercial	Kagoshima
Russia							
			Cosmos				
April 28, 1999	Cosmos	Abrixas MegSat 0	DLR Meggiorin	OHB System Unknown	Yes	Commercial	Kapustin Yar
			Cyclone				
2nd Qtr 1999	Cyclone 3	Coronas F	Izmiran & Lebedev Phys. Inst.	NPO Yuzhnoye	No	Non-Commercial	Plesetsk
			Proton				
May 1999	Proton	Nimiq 1	Telesat Canada	Lockheed Martin	Yes	Commercial	Baikonur
June 1999	Proton	ICO 2	ICO Global Communications	Hughes	Yes	Commercial	Baikonur
2nd Qtr 1999	Proton	ICO 1	ICO Global Communications	Hughes	Yes	Commercial	Baikonur
2nd Qtr 1999	Proton	Glonass Replacem. 1999-01 - 03	Russian MoD	NPO PM	No	Non-Commercial	Baikonur
2nd Qtr 1999	Proton	Astra 1H	Societe Europeenne des Satellites	Hughes	Yes	Commercial	Baikonur
July 1999	Proton	Garuda 1	ACeS Consortium	Lockheed Martin Corp.	Yes	Commercial	Baikonur
September 20, 1999	Proton	Service Module 1	RKA	RKK Energia	No	Non-Commercial	Baikonur
3rd Qtr 1999	Proton	LMI 1	LMI	Lockheed Martin	Yes	Commercial	Baikonur

Launch Events
April 1999 - September 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
Russia (cont.)							
			Soyuz				
April 2, 1999	Soyuz	Progress M-41	RKK Energia	RKK Energia	No	Non-Commercial	Baikonur
April 1999	Soyuz	Globalstars 29-32	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur
May 1999	Soyuz	Globalstars 33-36	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur
September 1999	Soyuz	Globalstars 37-40	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur
			START				
July 1999	START 1	Odin	Swedish National Space Board	Swedish Space Corp.	Yes	Commercial	Svobodny
			Zenit				
August 1999	Zenit 2	Badr 2 Meteor 3M-1	SUPARCO Russia	SUPARCO VNII Elektromekhaniki	No	Non-Commercial	Baikonur

Launch Events
April 1999 - September 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
USA							
			Athena 2				
April 27, 1999	Athena 2	IKONOS 1	Space Imaging Inc.	Lockheed Martin Missiles & Space	No	Commercial	VAFB
			Atlas 2				
April 12, 1999	Atlas 2AS	Eutelsat W3	Eutelsat	Aerospatiale	Yes	Commercial	CCAS
May 15, 1999	Atlas 2A	GOES L	NOAA	Space Systems/Loral	No	Non-Commercial	CCAS
July 16, 1999	Atlas 2A	DSCS III 3-11	DoD	Lockheed Martin Corp.	No	Non-Commercial	CCAS
July 28, 1999	Atlas 2AS	Terra	NASA	Lockheed Martin Corp.	No	Non-Commercial	VAFB
August 25, 1999	Atlas 2AS	TDRS F8	NASA	Hughes	No	Non-Commercial	CCAS
3rd Qtr 1999	Atlas 2A	GBS 10	DoD	Hughes	No	Commercial	CCAS
			Atlas 3				
June 15, 1999	Atlas 3A	Telstar 7	Skynet	Space Systems/Loral	Yes	Commercial	CCAS
			Delta 2				
April 15, 1999	Delta 2 7920	Landsat 7	NASA	Lockheed Martin Corp.	No	Non-Commercial	VAFB
April 22, 1999	Delta 2 7925	Navstar GPS 2R- 3	DoD	Lockheed Martin Corp.	No	Non-Commercial	CCAS
May 20, 1999	Delta 2 7320	FUSE	NASA	OSC	No	Non-Commercial	CCAS
May 24, 1999	Delta 2 7920	Iridiums 88-91, 94	Iridium, Inc.	Lockheed Martin	Yes	Commercial	VAFB
June 11, 1999	Delta 2 7420	Globalstars 45-48	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	CCAS
July 1, 1999	Delta 2 7420	Globalstars 49-52	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	CCAS
August 9, 1999	Delta 2 7420	Globalstars 53-56	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	CCAS

Launch Events
April 1999 - September 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
USA (cont.)							
			Delta 2 (cont.)				
August 21, 1999	Delta 2 7420	Iridiums 95-99	Iridium, Inc.	Lockheed Martin	Yes	Commercial	VAFB
September 30, 1999	Delta 2 7920	Globalstars 57-60	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	VAFB
			Delta 3				
April 5, 1999	Delta 3	Orion F3	Orion Network Systems	Hughes	Yes	Commercial	CCAS
July 1999	Delta 3	ICO 4	ICO Global Communications	Hughes	Yes	Commercial	CCAS
			Minotaur				
September 30, 1999	Minotaur	Jawsat	California Spaceport	Air Force Academy	No	Non-Commercial	California Spaceport
			Pegasus				
2nd Qtr 1999	Pegasus XL	TERRIERS MUBLCOM	Boston University/NASA ARPA	AeroAstro OSC	Yes	Commercial	VAFB
2nd Qtr 1999	Pegasus XL	TSX 5	DoD	OSC	No	Non-Commercial	VAFB
3rd Qtr 1999	Pegasus XL	Orbcomms 37-44	Orbcomm	OSC	No	Commercial	TBA
			Sea Launch				
August 15, 1999	Sea Launch	TBA 1999-08	TBA	TBA	Yes	Commercial	Sea Launch Platform
			Shuttle				
May 24, 1999	Shuttle Discovery	STS 96	NASA	Rockwell International	No	Non-Commercial	KSC

Launch Events
April 1999 - September 1999

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Site
USA (cont.)							
			Shuttle (cont.)				
July 9, 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
			Taurus				
3rd Qtr 1999	Taurus 1	Kompsat	Korea Aerospace Research Institute	TRW/KARI	Yes	Commercial	VAFB
			Titan 2				
May 15, 1999	Titan 2	QuickSCAT	NASA	Ball Aerospace	No	Non-Commercial	VAFB
August 18, 1999	Titan 2	DMSP 5D-3-F15	DoD	Locheed Martin	No	Non-Commercial	VAFB
			Titan 4				
April 9, 1999	Titan 4B/IUS	DSP 19	DoD	TRW	No	Non-Commercial	CCAS
April 21, 1999	Titan 4B	USA 1999-04	DoD	Unknown	No	Non-Commercial	VAFB
April 30, 1999	Titan 4B/Centaur	Milstar II-F1	DoD/USAF	Lockheed Martin	No	Non-Commercial	CCAS