Commercial Space Transportation

QUARTERLY LAUNCH REPORT

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

2nd Quarter 1998

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

2ND QUARTER 1998 REPORT

Objectives

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

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

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

Photo credit: Globalstar (1998). Image is of the Delta 2 7420 launch on February 14, 1998, from Cape Canaveral Air Station. This was Globalstar's inaugural launch initiating the deployment of the Globalstar system.

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This document was released on April 27, 1998.

SUMMARY

First Quarter 1998 Launch Events

- In the first quarter of 1998, United States vehicles made 11 launches. Nine of these launches were commercial (four Delta, two Atlas, and one each of Pegasus, Taurus and Athena) with two non-commercial launches of a Shuttle and an Atlas vehicle. All of these launches were conducted successfully.
- There were three Russian launches in this period; all of these were successful non-commercial launches of Soyuz launch vehicles.
- Europe's Ariane 4 made three flights: two commercial and one non-commercial. All of these launches were successful.
- China successfully launched a single commercial Long March vehicle.
- Japan experienced the first unsuccessful launch of its H 2 launch vehicle, when the COMETS communication satellite failed to reach its proper orbit after a premature engine cut-off.
- Israel failed to launch the Offeq 4 satellite on a Shavit launch vehicle when the vehicle failed during launch and was destroyed.

Second and Third Quarter 1998 Scheduled Launch Events

- The United States plans to make 24 launches in the next two quarters. Of these, 12 launches will be commercial including four Atlas, four Delta, one Athena, and three Pegasus launches. Non-commercial launches will consist of one Atlas, two Delta, and two Pegasus launches as well as three Shuttle, one Taurus, one Titan 2, and two Titan 4 launches.
- Russian launch vehicles are to make 10 launches, of which six are commercial. These commercial launches are on one START-1 and five Proton launch vehicles. Non-commercial launches will include two Soyuz, one Proton, and one Zenit vehicle.
- Two Ukrainian Zenit launch vehicles are to be launched from Baikonur on commercial missions.
- Europe plans four commercial Ariane 4 launches with five satellites and the first flight of a commercial Ariane 5 with an ESA developmental payload and a commercial communications satellite.
- China intends to launch four Long March vehicles, of which one will be commercial.
- India will make a non-commercial launch of the PSLV.
- Japan is preparing to launch a non-commercial science payload on an M-5 launch vehicle.

SUMMARY

Commercial Products and Services

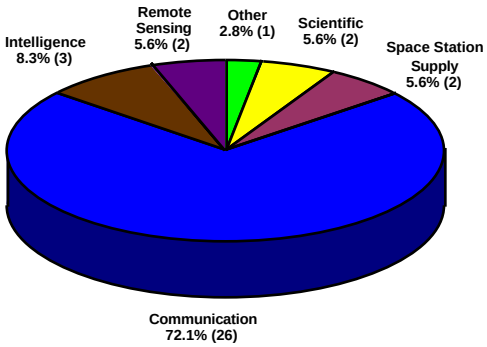
Second and Third Quarter 1998

Iridium Deployment Nears Completion

The Iridium LEO communication constellation is scheduled to be fully deployed by the end of April 1998. The system of 66 low earth-orbiting satellites will provide mobile telephone, data, and messaging services worldwide beginning in September 1998. The total deployment of the system has taken almost exactly one year since the launch of the first five Iridium satellites on a Boeing Delta 2 vehicle on May 5, 1997. Of the 58 satellites deployed through the end of March 1998, two satellites have failed. The Iridium system was deployed using three different launch vehicles from three different countries: the Delta 2 of the United States, the Proton of Russia, and the Long March 2C of China. Through the end of March 1998, eight launches of the Delta 2 deployed five satellites each, two launches of the Proton deployed seven satellites each, and two launches of the Long March 2C deployed two satellites each. In addition, a test flight of the Long March 2C deployed two Iridium payload mass simulators on September 1, 1997 prior to the launches of the operational satellites. The Iridium system is led by Motorola, and the satellites are built by Lockheed Martin.

Payload Use Analysis

First Quarter 1998



In the first quarter of 1998, there were 36 payloads launched worldwide. These payloads were divided between communication (72.1 percent), intelligence (8.3 percent), scientific (5.6 percent), remote sensing (5.6 percent), space station supply (5.6 percent), and other (2.8 percent).

Communication payloads constituted all but one (95 percent) of the 22 internationally competed payloads on commercial launches. The remaining payload was a Celestis funerary payload, classified here as “other”.

LAUNCH SCHEDULE

Scheduled Launch Events

Vehicle	Payload	Site
APRIL 1998		
Ariane 44L	BSAT 1 B Nilesat 1	Kourou
Delta 2 7420	Globalstars 5-8	CCAS
Delta 2 7920	Iridiums 71-75	VAFB
Long March 2C	Iridium 69 Iridium 70	Taiyuan
Proton (SL-13)	Iridiums 62-68	Baikonur
Shuttle Columbia	STS 90	KSC
MAY 1998		
Ariane 44L	ST 1A	Kourou
Athena 2	IKONOS 1	VAFB
Long March 3B	ChinaStar 1A	Xichang
Long March 4	Sirius 2 SACI 1	Taiyuan
Proton (SL-12)	Astra 2A	Baikonur
Proton (SL-12)	EchoStar 4	Baikonur
Shuttle Discovery	STS 91	KSC
Soyuz	Progress M-39	Baikonur
Titan 2	NOAA K	VAFB
Titan 4B/Centaur	USA 1998-05	CCAS
Zenit 2	Resurs-01 N4 SAFIR 2 FASat-Bravo TechSat 2 TMSAT 1 Iris R1	Baikonur
JUNE 1998		
Atlas 2AS	Intelsat 8A F5	CCAS
Delta 2 7925	Thor 3	CCAS
Delta 3	Galaxy 10	CCAS
Proton (SL-12)	PAS 8	Baikonur

LAUNCH SCHEDULE

Scheduled Launch Events

(Continued)

Vehicle	Payload	Site
JULY 1998		
Atlas 2AS	JCSAT 6	CCAS
Delta 2 7326	Deep Space 1	CCAS
Titan 4/Centaur	USA 1998-06	CCAS
Zenit 2	Globalstars 9-20	Baikonur
AUGUST 1998		
Ariane 4-TBA	Sirius	Kourou
Atlas 2AS	Eutelsat 3 F1	CCAS
M 5	Planet B	Kagoshima
Proton (SL-13)	FGB	Baikonur
Soyuz	Soyuz TM-28	Baikonur
SEPTEMBER 1998		
Ariane 5	Hot Bird Plus 5 ARD	Kourou
Atlas 2AS	EOS AM 1	VAFB
Delta 2 7326	Navstar GPS 2R-3	CCAS
Proton (SL-12)	Telesat DTH-1	Baikonur
Shuttle Endeavour	STS 88 MightySat 1 Node 1 Pressurized Mating A 1&2 SAC A	KSC
Zenit 2	Globalstars 21-32	Baikonur

LAUNCH SCHEDULE

Additional Launch Events to be Announced*

* 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

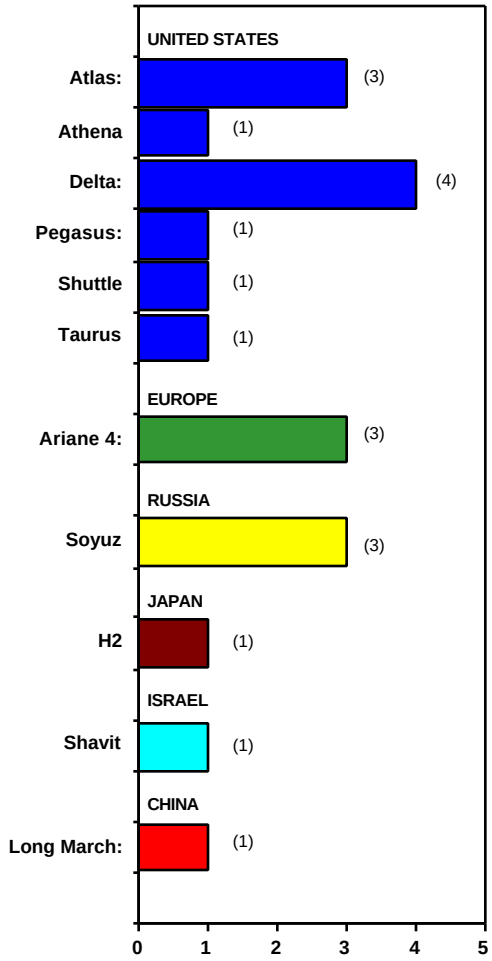
For the Second and Third Quarter 1998

Vehicle	Payload	Site
SECOND QUARTER OF 1998		
Long March 3B	Sinosat 1	Xichang
Pegasus XL	SCD 2	CCAS
Pegasus XL	TRACE	VAFB
Pegasus XL/HAPS	Orbcomms 13-20	VAFB
THIRD QUARTER OF 1998		
Ariane 4-TBA	Eutelsat 3 F2	Kourou
Atlas 2	GBS 9	CCAS
Pegasus XL	TERRIERS	VAFB
	MUBLCOM	
Pegasus XL	WIRE	TBA
PSLV	IRS P4	Sriharikota
	Kitsat 3	
	Tubsat C-DLR	
START 1	Odin	Svobodny
Taurus 1	STEX 1	VAFB

LAUNCH REPORT

Launch Events

First Quarter 1998



Number of Launches
January - March 1998

The United States made 11 of the 20 worldwide launches in the first quarter of 1998. Of these launches, nine were commercial. Delta vehicles made four commercial launches, orbiting two sets of five Iridium satellites, a set of four Globalstar satellites, and a GEO communication payload. Two GEO communication satellites were launched on separate Atlas launches. A scientific and a communication payload were launched on a Pegasus and a scientific payload on an Athena. Finally, a Taurus launched a remote sensing, two communications, and a funerary payload. Non-commercial launches included an Atlas launch for the DoD and a NASA Shuttle launch.

The European Ariane 4 family made three launches, two of them commercial. The commercial payloads consisted of three GEO communications satellites and the remaining non-commercial payload was a remote sensing satellite.

Russia launched three non-commercial Soyuz launch vehicles with a crewed, a remote sensing, and a space station supply payload for Mir.

A Japanese H 2 failed in an attempt to place the COMETS developmental communications satellite into a GEO orbit when its engines shut down early. Efforts are being made to continue some of the experiments planned for COMETS despite its lower-than-planned orbit.

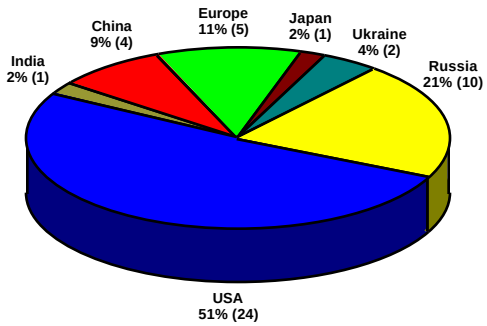
A single launch of the Chinese Long March vehicle put two Iridium satellites into a LEO orbit.

Israel attempted to orbit the Offeq 4 intelligence satellite with a Shavit vehicle but the vehicle failed after launch and was destroyed.

LAUNCH REPORT

Scheduled Launch Events

Second and Third Quarter 1998



Scheduled Launch Events, by Region
April - September 1998

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

In the second and third quarters of 1998, forty-eight launch events are scheduled. The United States will conduct 24 of these launches. Five Atlas vehicles will be launched with four communication satellites and a remote sensing payload. Five Delta 2 vehicles will carry ten communication satellites, one navigation satellite, and one scientific payload. The first flight of a Delta 3 will launch a GEO communications satellite. An Athena 2 will carry a remote sensing satellite and two Titan 4 flights will have classified payloads. Pegasus will launch five times with ten communication and two scientific payloads. Taurus will be used once to launch a developmental payload. There will also be three shuttle missions. One of these will carry two ISS components and two developmental satellites. There will also be one Titan 2 launched with a meteorological satellite.

Russia plans 10 launches with five Proton launches of communication satellites and one International Space Station module, one crewed and one supply flight to Mir on Soyuz vehicles. A Zenit launch vehicle will launch multiple small satellites and a START 1 will launch a remote sensing payload.

Ukraine will launch two Zenit vehicles with LEO communication satellites from the Russian launch site at Baikonur.

Europe's Ariane 5 will make its first commercial launch with a communications and a developmental payload. There will also be four Ariane 4 launches orbiting five GEO communication satellites.

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

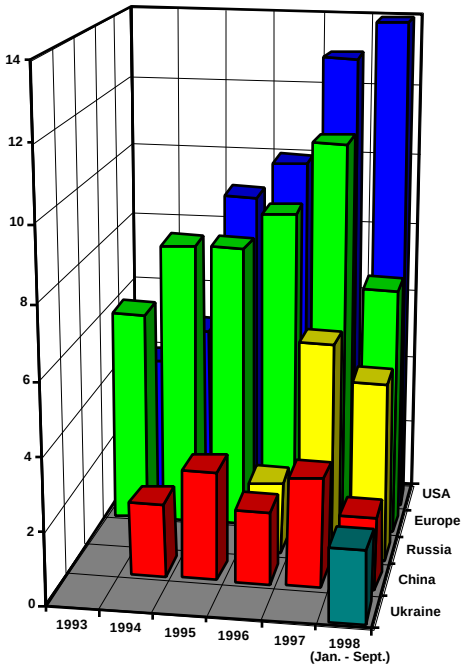
Japan will launch a scientific payload on an M 5 launch vehicle.

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

LAUNCH REPORT

Scheduled Commercial Launch Events

Second and Third Quarter 1998



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

Internationally, excluding small launch vehicles, 38 launches are planned for the next two quarters. If small launch vehicles are counted as well the total increases to 47. Of these, 21 (including small launch vehicles, 26) will be commercial launches. The United States will make over a third of these with 8 commercial launches. Three Delta 2 vehicles will be launched with communication payloads of which one will be a GEO communications satellite and two will be multiple communication satellite payloads to LEO orbits. The first launch of the Delta 3 will carry another GEO communications payload and four Atlas launches will carry communication satellites to GEO. Commercial small vehicle launches will include an Athena 2 launch, which will loft a remote sensing satellite and three Pegasus launches which will carry 10 communication payloads and a science satellite.

All of Europe's five scheduled launches are commercial. Four will be launches of Ariane 4 vehicles carrying five GEO communication satellites and the fifth will be an Ariane 5 launch with a GEO communications satellite and a development payload.

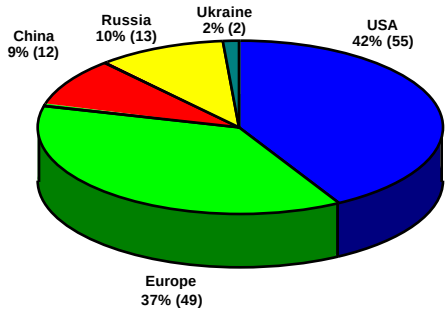
Russia intends to conduct five commercial launches (six, if small launch vehicles are counted). Four of these launches will be Proton launches of GEO communications satellites. The fifth, another commercial Proton launch, will carry a set of seven Iridium LEO communications satellites. The small commercial launch will use a START 1 launch vehicle to orbit the Swedish Odin scientific satellite.

Ukraine will enter the commercial launch arena with the launch of 24 Globalstar LEO communications satellites on two Zenit launch vehicles.

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

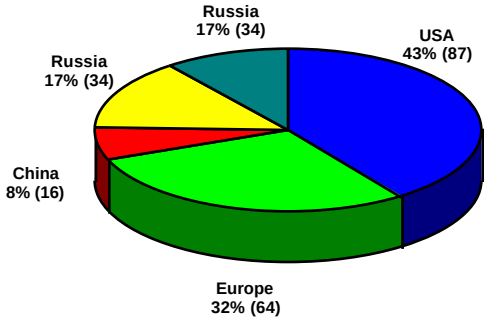
LAUNCH REPORT

Commercial Launch Trends



Commercial Launch Market Trend
January 1993 - September 1998

(Small Vehicles Excluded)



Internationally Competed Payloads
Market Trend
January 1993 - September 1998

(Small Vehicles Excluded)

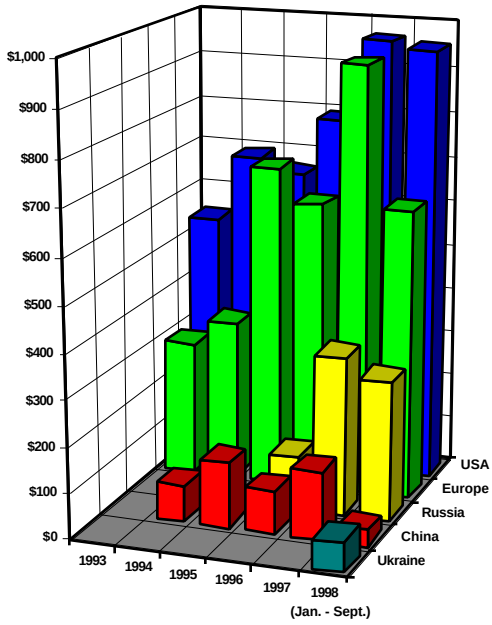
Between January 1993 and September 1998, 131 commercial launch events (excluding small launch vehicles) are projected. The United States has a 42 percent share or 55 of these launches. In internationally competed payloads, the United States will have launched 91 of 228, for a 40 percent share.

Europe's portion of the total is 49 launches, for a 37 percent share, and 66 payloads or 29 percent of the total. China has 12 launches with 15 payloads for nine percent of commercial launches and seven percent of internationally competed payloads. Russia will have conducted 13 commercial launches for a ten-percent share and deployed 32 internationally competed payloads or 14 percent of the total. Ukraine will make its first two commercial launches from Russia's launch site at Baikonur in the third quarter of 1998 with 24 internationally competed payloads for 10% of payloads and two percent of launches in this period.

In the period covered by this report, January 1998 through September 1998, there are expected to be 30 commercial launches (excluding small launch vehicles) worldwide. It is expected that there will be 83 internationally competed payloads (excluding small launch vehicles). The United States will launch 14 times for 46 percent of these launches and will loft 34 internationally competed payloads for 41 percent of such payloads. Europe plans seven launches (23 percent) and nine payloads (11 percent). China's share is two launches (7 percent) and four payloads (five percent) while Russia's plans include 12 payloads on five vehicles for 14 percent of payloads and 17 percent of launches. Ukraine's two launches will account for seven percent of commercial launches and their 24 payloads will constitute 29 percent of total internationally competed payloads in the first three quarters of 1998.

LAUNCH REPORT

Commercial Launch Revenues



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

January 1993 - September 1998

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

In the first three quarters of 1998, revenues for commercial launch events are expected to total about $2 billion. Revenues for the period from January 1993 and March 1998 are projected to be about $9.5 billion. The United States will have a 48-percent share of these five-year revenues with about $4.6 billion and Europe will have 37 percent with about $3.7 billion. Russia holds an estimated eight-percent share with about $7.8 billion and China will have a five-percent share with about $5 billion. Ukraine will gain a one-percent share with about $65 million in commercial launch revenues.

United States commercial launch revenues have grown to nearly half of worldwide commercial launch revenue totals. This shows the continued growth of its commercial launch sector. However, the entry of Ukraine with commercially marketed Zenit launch vehicles and the first commercial flight of the European Ariane 5 show that these are evolving markets and that they will increase significantly over the next few years.

FAA'S FIRST NATIONAL COMMERCIAL SPACE TRANSPORTATION FORECAST CONFERENCE (FEBRUARY 10-11, 1998)

The Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (AST) convened the first national commercial space transportation forecast conference on February 10-11, 1998. For the theme, ***Commercial Space Transportation in the 21st Century: Technology and Environment, 2001-2025,*** conference topics covered a variety of issues concerning the commercial space transportation industry for the next century. The conference brought together leaders in the commercial launch, satellite, and telecommunication industries; government and military officials; and academia to explore the future of the rapidly growing U.S. commercial space transportation industry and future industry developments, both domestic and international. Participants shared their visions on technology development, international competitiveness and cooperation, business opportunities, and government oversight requirements.

The conference opened with welcoming remarks and an update of AST activities by Ms. Patricia G. Smith, Acting Associate Administrator for Commercial Space Transportation. Ms. Smith provided an overview of the technology, market, and policy trends shaping the U.S. commercial launch industry, as well as the evolving regulatory and policy processes which AST is implementing to keep pace with industry.

Ms. Smith set the stage for the conference by noting that:

> …Communications has been the big driver of space commerce, with first GEO and then LEO satellites offering seamless global transmission of voice data and video signals, but what comes next? Space manufacturing, power generation, tourism, even mining of the moon, planets, or asteroids. . .I am certain that there are many other uses of space that …we cannot even imagine… [During this conference] we are seeking to understand and project the coming changes, tomorrow and beyond, into the next century. We have an opportunity to make this conference a defining moment in the history of commercial space launch, and I hope we take advantage of that opportunity. We intend for the knowledge and understanding gained here to be an important element in planning for the future activities and resource requirements for the FAA and other government agencies involved in space activities.

KEYNOTE PRESENTATIONS

The conference featured three distinguished keynote speakers. The opening keynote address for the conference was presented by Lt. General Lance W. Lord, Vice Commander, Air Force Space Command. General Lord stressed three major issues for the space systems of the future:

- Space systems as vital national security interests for warfighting, information/ intelligence gathering, global positioning (GPS), natural disaster warning, and strategic and theater warning;
- The development and maintenance of dynamic partnerships to ensure cooperation across and between all sectors of America's space endeavors; and
- The vital importance of lowering launch costs and raising launch reliability.

General Lord provided an overview of the steps already being taken by Air Force Space Command to address these critical issues.

Dr. Dan Mulville, NASA Chief Engineer, presented the keynote address for the Conference luncheon on Tuesday, February 10th. He provided conference attendees with information on NASA's future space transportation architecture. His remarks highlighted NASA's work to ensure lower cost, more reliable access to space through a number of ways, including the proposed privatization of the Shuttle and the development of the X-33 and X-34 reusable launch vehicles.

Wednesday, February 11th, the second day of the Conference, began with ***A Vision of the Future,*** provided by Conference Futurist, Dr. William Gaubatz, Director of Market Development, The Boeing Company. Dr. Gaubatz provided an exhilarating vision of a "fundamental new transportation infrastructure" which he called Spaceways, designed to provide services to space industries and the traveling public. He described the Spaceways as "…more than vehicles for getting to low earth orbit… [but infrastructure] which must include elements such as the space traffic control systems, ground support systems, the navigation and weather systems, the collision avoidance systems, the refueling stations and spaceports." Dr. Gaubatz's futuristic vision included an outline of how Spaceways should be planned, regulated, and controlled to support future space markets including space tourism. He also provided several near-term recommendations to industry and government on ways to start now to make Spaceways a reality for the future. Dr. Gaubatz concluded his futuristic presentation by stating that "…the vision of space as a place is tantalizingly close to being fulfilled. For this to happen, we must open the Spaceways to provide routine, low cost, safe transportation to, from, and through space, and engage the public in opening the space frontier for business and pleasure… Science and technologies can make its opening to the public feasible. Vision, public spirited, entrepreneurial leadership will make it happen."

CONFERENCE PANELS

The conference featured six panels over a two-day period.

Panel 1: Reusable Launch Vehicle Development

The first panel, ***"Reusable Launch Vehicle Development,"*** included industry executives from four of the growing number of entrepreneurial companies working on the development of reusable launch vehicle (RLV) technology and ways that this technology can bring about more frequent and economical space transportation services. Panel members included Charles Lauer, Vice President for Business Development, Pioneer Rocketplane Corporation; Gary Hudson, CEO for Rotary Rocket Company; Michael Kelly, President and CEO, Kelly Space and Technology, Inc.; and Dan Brandenstein, Executive Vice President, Kistler Aerospace Corporation.

Panel 2: Technologies of the Future

The second panel***, "Technologies of the Future,"*** included two top government scientists who discussed research on cutting-edge space propulsion technology for the future. John Cole, Space Transportation Research Manager for Marshall Space Flight Center, NASA, provided a comprehensive overview of future propulsion systems including beamed energy, fission and fusion concepts, advanced reusable technologies, low-cost upper stages, and exotic fuels. Michael Jacox, Program Manager for the Solar Orbit Transfer Vehicle Program, Air Force Research Lab, discussed the plans and proposals for a reusable orbit transfer vehicle which would focus

sunlight into a cavity and propel the vehicle into orbit, as well as power the satellite once on orbit.

Panel 3: Overview of Space in the 21st Century

The ***"Overview of Space in the 21st Century"*** panel provided an overview of economic and technological trends in the commercial launch business. The panelists were Ray Johnson, Principal Director for the Engineering and Technology Group for The Aerospace Corporation, and Shubber Ali, Senior Consultant with KPMG Peat Marwick. Mr. Johnson discussed the report on long-range future spacelift requirements completed by The Aerospace Corporation for NASA and the Air Force. Mr. Johnson explained that the report consisted of a near-term assessment up to the year 2010 which looks at the weight growth of commercial GEO satellites, Big LEO constellations, and the increase of satellite lifetimes; and a long-term assessment (to the year 2020 and beyond), examining such innovative applications as space-based lasers, space tourism, and manufacturing facilities in space. Shubber Ali provided an historical overview of the work that KPMG has provided to the space industry over the past 20 years. He also provided an assessment of how the launch market will develop over the next century, based on the present-day launch costs, and how the market could change as a result of revolution in the cost of space transportation.

Panel 4: The International Market

Panel 4, ***"The International Market,"*** was concerned with the changing scene of the international market, which has evolved from a market once characterized by a small number of international launch providers competing for market share to one where joint ventures and partnerships among U.S. and international launch providers led to 35 internationally-competed launches in 1997 with revenues exceeding $2.4 billion. Panel members included Greg Gilmore, Vice President for Marketing & Sales, International Launch Services (ILS); Marc Nance, Design Manager, Boeing Sea Launch; Marshall Kaplan, Chairman of Launchspace; and Doug Heydon, President, Arianespace. The panel members discussed their respective international ventures, as well as their views on the impact of increased globalization and international partnerships within the international launch market and how such trends will affect the future of the market. Highlights from the panel included the planned launch from the Baikonur Cosmodrome in Kazakhstan by ILS, the first Boeing Sea Launch mission from the Pacific Ocean scheduled for October, the second qualification flight of the Ariane 5 scheduled for July, and a revenue projection of $100 billion for the international launch market by the year 2000.

Panel 5: Space Commerce Beyond the Communications Era

"Space Commerce Beyond the Communications Era" featured three panelists who discussed new space applications for the future which fall outside of the successful communications satellite industry. Panelist Gregg Maryniak, Senior Scientist for the Futron Corporation, discussed potential energy sources for propulsion and space-based operations such as electric motors, lunar resources, and solar power. John Mankins, Director of the Advanced Programs Office, NASA Office of Space Flight presented his views on the development of an industry for LEO and GEO solar power satellites and a modularized architectural approach for space hardware. Tom Rogers, President of the Space Transportation Association discussed the enormous market potential for new industries in space tourism, sports, and biomedical research.

Panel 6: Other Perspectives

Panel 6, ***"Other Perspectives,"*** provided perspectives from representatives of academia, the media, and an industry insider on the future developments which could impact the U.S. commercial space transportation industry. Panel members included Brenda Forman, Director of Academic Liaison and Federal Technology Policy for Lockheed Martin Corporation; Dr. John Logsdon, Chairman of George Washington University's Space Policy Institute; Lewis Franklin, Visiting Scholar, Stanford University Center for International Security and Arms Control; and James Banke, Space Journalist for Florida Today.

The Conference concluded with a special public session on Flight Safety in a Commercial Environment.

The first national Commercial Space Forecast Conference is just the first step in providing the Department of Transportation and the Federal Aviation Administration critical knowledge and information in order to plan for the types of resources and capabilities that will be required to successfully accomplish oversight and regulatory responsibilities for the U.S. commercial space transportation industry, as well as the context for future policy decisions. With each annual conference, the future vision for the U.S. industry and the DOT/FAA role for the industry will become sharper and more focused.

> Imagine a world where access to space is as common, safe, and affordable as air travel is, where people can travel to the mountains of the moon with as little fanfare as we visit the Rockies at the end of the 20th century, where new products and perhaps new medical treatments arise as a result of commercial launch companies routinely placing both government and private sector experiments in space, while military uses of space are achieved via commercial space launch providers. This conference is about laying the groundwork for the advances in space transportation and technology that will support such a world.[1]

Another U.S. Government RLV development program is the Military Spaceplane. This program is intended to provide quick access to space to perform a variety of military missions in the second quarter of the next century.

[1] Excerpt from the Remarks of Patricia G. Smith, Acting Associate Administrator for Commercial Space Transportation for the First National Commercial Space Transportation Forecast Conference: "Commercial Space Transportation in the 21st Century: Technology and Environment, 2001-2025."

GLOSSARY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ACRONYMS

BSAT Broadcast Satellite System Corp. Satellite
CBERS China/Brazil Earth Resources Satellite
CCAS Cape Canaveral Air Station
COMETS - Communications and Broadcasting and Tech Satellite
DARA German Space Agency
DASA Deutsche Aerospace
DoD Department of Defense
DoT Department of Transportation
ELI Elliptical
ELINTS Electronic intelligence satellites
ELV Expendable Launch Vehicle
EOS Earth Observation System
ESA European Space Agency
ETS Engineering Test Satellite
EXT Extra-Orbital
FAA Federal Aviation Administration
FGB Control Module (formally Functional Cargo Block)
GBS Global Broadcast System
GEO Geosynchronous Orbit
GTO Geosynchronous Transfer Orbit
INMARSAT - International Maritime Satellite Organization
INPE National Institute for Space Research
INTA Instituto Nacional de Tecnica Aeroespacial
INTELSAT - International Telecommunications Satellite Organization
IRS Indian Resource Satellite
ISAS Institute of Space and Astronautical Science
ISRO Indian Space Research Organization
JCSAT Japan Communications Satellite Co. Satellite
JPL Jet Propulsion Laboratory
JSAT Japan Satellite Systems, Inc.
KB Design Bureau
KSC Kennedy Space Center
LEO Low Earth Orbit
MEO Middle Earth Orbit
MoD Ministry of Defense
MUBLCOM - Multiple Beam Beyond Line-of-Sight Communications
NASA National Aeronautics and Space Administration
NASDA National Space Development Agency (Japan)
NEC Nippon Electric Corp.
nMI Nautical Mile
NOAA National Oceanic and Atmospheric Administration
NPO Scientific Production Organization
NSAB Nordiska Satellit AB
OSC Orbital Sciences Corporation
PAS Pan American Satellite
PSLV Polar Satellite Launch Vehicle
PTT Post Telegraph and Telecommunications
RKK Energia - Rocket and Space Company Energia
SACI Satellite Cientifico
SCD Satellite de Coleta de Dados
SES Societe Europeene des Satellites
SLV Satellite Launch vehicle
STEX Sensor Test Experiement
STS Space Transportation System
SNOE Student Nitric Oxide Explorer
TERRIERS - Tomographic Experiment using Radiative Recombinative Ionospheric EUV and Radio Sources
TRACE Transition Region and Coronal Explorer
TRMM Tropical Rainfall Measuring Mission
USMP United States Microgravity Payload
VAFB Vandenberg Air Force Base
VLS Veiculo Lancador de Satellites
WIRE Wide-Field Infrared Explorer
XL Extra Long

Characteristics of Cited Vehicles

Vehicle	(Success + Partials) / Attempts	LEO 28 Degrees	GTO	GEO	SUB	Price per Launch (Approx.)	Launch Sites
Heavy							
Ariane 5	1/2|50%	39600 lb. 18000 kg	15000 lb. 6800 kg	N/A*	N/A	$115-143 M	Kourou
Long March 3B	2/3|66.7%	29900 lb. 13600 kg	9900 lb. 4500 kg	4950 lb. 2250 kg	N/A	$60-70 M	Xichang
Proton (SL-12)	196/219|89.5%	46297 lb. 21000 kg	12100 lb. 5500 kg	4850 lb. 2200 kg	N/A	$50-70 M	Baikonur
Proton (SL-13)	24/27|88.9%	46000 lb. 20900 kg	16535 lb. 7500 kg	N/A	N/A	$50-70 M	Baikonur
Shuttle Columbia	24/24|100%	47300 lb. 21455 kg	13007 lb. 5900 kg	5203 lb. 2360 kg	N/A	$161-215 M	KSC
Shuttle Discovery	25/25|100%	47300 lb. 21455 kg	13007 lb. 5900 kg	5203 lb. 2360 kg	N/A	$161-215 M	KSC
Shuttle Endeavour	12/12|100%	47300 lb. 21455 kg	13007 lb. 5900 kg	5203 lb. 2360 kg	N/A	$161-215 M	KSC
Titan 4/Centaur	8/8|100%	39100 lb. 17736 kg	14000 lb. 6350 kg	10200 lb. 4627 kg	N/A	$240-270 M	CCAS
Titan 4B/Centaur	1/1|100%	N/A	N/A	N/A	N/A	N/A	CCAS
Zenit 2	23/28|82.1%	30300 lb. 13740 kg	N/A	N/A	N/A	$25-40 M	Baikonur
Intermediate							
Ariane 42P	10/11|90.9%	13400 lb. 6100 kg	6260 lb. 2840 kg	N/A	N/A	$60-75 M	Kourou
Ariane 44L	24/25|96%	21100 lb. 9600 kg	9965 lb. 4520 kg	N/A	N/A	$90-110 M	Kourou
Ariane 44LP	17/18|94.4%	18300 lb. 8300 kg	8950 lb. 4060 kg	N/A	N/A	$80-95 M	Kourou
Ariane 44P	12/12|100%	15200 lb. 6900 kg	7320 lb. 3320 kg	N/A	N/A	$75-90 M	Kourou
Ariane 4-TBA	N/A	N/A	N/A	N/A	N/A	$85 M	Kourou
Atlas 2	10/10|100%	14500 lb. 6580 kg	6200 lb. 2810 kg	3086 lb. 1400 kg	N/A	$60-70 M	CCAS
Atlas 2A	13/13|100%	16050 lb. 7280 kg	6700 lb. 3039 kg	3307 lb. 1500 kg	N/A	$65-80 M	CCAS
Atlas 2AS	13/13|100%	19050 lb. 8640 kg	8150 lb. 3688 kg	4604 lb. 2090 kg	N/A	$90-100 M	CCAS, VAFB
Delta 3	N/A	18408 lb. 8350 kg	8360 lb. 3800 kg	N/A	N/A	N/A	CCAS
H 2	5/6|83.3%	23000 lb. 10500 kg	8800 lb. 4000 kg	4800 lb. 2200 kg	N/A	$182-201 M	Tanegashima
Soyuz	947/954|99.3%	15400 lb. 7000 kg	N/A	N/A	N/A	$12-25 M	Baikonur, Plesetsk

*GEO capable with kick motor

Characteristics of Cited Vehicles

Vehicle	(Success + Partials) / Attempts	LEO 28 Degrees	GTO	GEO	SUB	Price per Launch (Approx.)	Launch Sites
Medium							
Ariane 40	6/6|100%	10800 lb. 4900 kg	4520 lb. 2050 kg	N/A	N/A	$45-60 M	Kourou
Delta 2 7326	N/A	6320 lb. 2872 kg	N/A	N/A	N/A	$45-50 M	CCAS
Delta 2 7420	1/1|100%	6970 lb. 3154 kg	N/A	N/A	N/A	$45-50 M	CCAS, VAFB
Delta 2 7920	12/12|100%	11109 lb. 5039 kg	2800 lb. 1270 kg	N/A	N/A	$45-50 M	CCAS, VAFB
Delta 2 7925	38/39|97.4%	11330 lb. 5150 kg	4060 lb. 1840 kg	2000 lb. 907 kg	N/A	$45-50 M	CCAS
Long March 2C	17/17|100%	7040 lb. 3200 kg	2200 lb. 1000 kg	860 lb. 390 kg	N/A	$15-20 M	Jiuquan
Long March 4	2/2|100%	8818 lb. 4000 kg	2430 lb. 1100 kg	1220 lb. 550 kg	N/A	$20-30 M	Taiyuan
M 5	1/1|100%	5500 lb. 2500 kg	N/A	N/A	N/A	$41-47 M	Kagoshima
PSLV	3/4|75%	6400 lb. 2900 kg	990 lb. 450 kg	N/A	N/A	$15 M	Sriharikota
Titan 2	18/18|100%	7900 lb. 3583 kg	N/A	N/A	N/A	$41-47 M	VAFB
Small							
Athena 2	1/1|100%	4390 lb. 1990 kg	N/A	N/A	N/A	$19-21 M	CCAS, VAFB
Pegasus XL	9/11|82%	1015 lb. 460 kg	322 lb. 146 kg	181 lb. 82 kg	N/A	$12-14 M	VAFB, Wallops Island
Pegasus XL/HAPS	1/1|100%	1015 lb. 460 kg	322 lb. 146 kg	181 lb. 82 kg	N/A	$12-14 M	VAFB
Rockot	1/1|100%	4100 lb. 1850 kg	N/A	N/A	N/A	$5-8 M	Plesetsk, Svobodny
Shavit	3/4|75%	350 lb. 160 kg	N/A	N/A	N/A	$12-18 M	Palmachim AFB
START 1	3/3|100%	790 lb. 360 kg	N/A	N/A	N/A	$5-10 M	Plesetsk, Svobodny
Taurus 1	2/2|100%	3100 lb. 1400 kg	990 lb. 450 kg	N/A	N/A	$18-20 M	VAFB

Characteristics of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in Orbit	Freq. Bands & Trans.	Stab.	Power
Classified										
USA 1998-05	Classified	N/A	Unknown	N/A	N/A	N/A	N/A		N/A	N/A
USA 1998-06	Classified	N/A	Unknown	N/A	N/A	N/A	N/A		N/A	N/A
Communication										
Astra 2A	Communication	N/A	GEO 28.2 E	19400 nMi	19400 nMi	7260 lb. / 3300 kg	5467 lb. / 2485 kg	32 Ku	3-axis	8000 W
Brazilsat B3	Communication	N/A	GEO 293 E	19330 nMi	19305 nMi	3850 lb. / 1750 kg	2314 lb. / 1052 kg	27 C, 1 C,	Spin	1650 W
BSAT 1 B	Communication	N/A	GEO 110 E	19330 nMi	19305 nMi	2750 lb. / 1250 kg	N/A	4 Ku	Spin	N/A
ChinaStar 1A	Communication	$ 87 M	GEO 87.5 E	19400 nMi	19400 nMi	6600 lb. / 3000 kg	N/A	16 Ku, 4 Ku	N/A	N/A
COMETS 1	Communication	N/A	GEO 121 E	19400 nMi	19400 nMi	7583 lb. / 3447 kg	N/A	1 S, 2 Ka	N/A	N/A
EchoStar 4	Communication	N/A	GEO 185 E	19400 nMi	19400 nMi	6600 lb. / 3000 kg	N/A	16 Ku	3-axis	N/A
Eutelsat 3 F 1	Communication	N/A	GEO 10 E	19332 nMi	19305 nMi	6599 lb. / 3000 kg	3696 lb. / 1680 kg	24 Ku	3-axis	5840 W
Eutelsat 3 F2	Communication	N/A	GEO 16 E	19332 nMi	19305 nMi	6599 lb. / 3000 kg	3696 lb. / 1680 kg	24 Ku	3-axis	5840 W
Galaxy 10	Communication	N/A	GEO 237 E	19330 nMi	19322 nMi	7683 lb. / 3492 kg	3730 lb. / 1692 kg	16 Ku, 8 Ku	N/A	4700 W
GBS 8	Communication	N/A	GEO	19400 nMi	19400 nMi	6305 lb. / 2866 kg	N/A	EHF, UHF	N/A	N/A
GBS 9	Communication	N/A	GEO	19400 nMi	19400 nMi	6305 lb. / 2866 kg	N/A	EHF, UHF	N/A	N/A
Globalstars 1-32	Communication	N/A	LEO	764 nMi	764 nMi	988 lb. / 449 kg	N/A	1 L	N/A	N/A
Hot Bird Plus 4	Communication	N/A	GEO 13 E	19400 nMi	19400 nMi	6380 lb. / 2900 kg	N/A	17 Ku, 2 Ku	N/A	N/A
Hot Bird Plus 5	Communication	N/A	GEO 13 E	19400 nMi	19400 nMi	6380 lb. / 2900 kg	N/A	19 Ku, 2 Ku	N/A	N/A
Inmarsat 3 F5	Communication	N/A	GEO	19400 nMi	19400 nMi	4352 lb. / 1978 kg	2420 lb. / 1100 kg	2 C, 1 L,	3-axis	2800 W
Intelsat 8A F5	Communication	N/A	GEO 110.5 E	19400 nMi	19400 nMi	8122 lb. / 3692 kg	3498 lb. / 1590 kg	9 Ku, 28 C	3-axis	N/A
Intelsat 8A F6	Communication	N/A	GEO 318.5 E	19400 nMi	19400 nMi	8122 lb. / 3692 kg	N/A	9 Ku, 28 C	N/A	N/A
Iridiums 50-75	Communication	N/A	LEO	419 nMi	419 nMi	1496 lb. / 680 kg	N/A	1 L, 1 Ka	N/A	N/A
IRIS R1	Communication	N/A	LEO	540 nMi	540 nMi	144 lb. / 65 kg	N/A	UHF	N/A	22 W
JCSAT 6	Communication	N/A	GEO 124 E	19400 nMi	19400 nMi	6820 lb. / 3100 kg	4004 lb. / 1820 kg		3-axis	5200 W
MUBLCOM	Communication	N/A	LEO	N/A	N/A	N/A	N/A		N/A	N/A
Nilesat 1	Communication	N/A	GEO 353 E	19400 nMi	19400 nMi	3894 lb. / 1770 kg	N/A	12 Ku	N/A	N/A
Orbcomms 3, 4, 13-20	Communication	N/A	LEO	419 nMi	411 nMi	87 lb. / 40 kg	N/A		N/A	N/A
PAS 8	Communication	N/A	GEO 194 E	19400 nMi	19400 nMi	7920 lb. / 3600 kg	N/A	24 Ku, 24 C	3-axis	9000 W
SAFIR 2	Communication	N/A	LEO	N/A	N/A	132 lb. / 60 kg	N/A		N/A	N/A
SCD 2	Communication	N/A	LEO	427 nMi	392 nMi	253 lb. / 115 kg	N/A		N/A	N/A
Sinosat 1	Communication	N/A	GEO	19400 nMi	19400 nMi	7683 lb. / 3492 kg	N/A	14 Ku, 24 C	N/A	N/A
Sirius 3	Communication	N/A	GEO 5 E	19400 nMi	19400 nMi	3190 lb. / 1450 kg	N/A		N/A	N/A
Skynet 4D	Communication	N/A	GEO 326 E	19400 nMi	19400 nMi	3152 lb. / 1433 kg	N/A	3 X	3-axis	N/A
ST 1A	Communication	N/A	GEO 88 E	19400 nMi	19400 nMi	6600 lb. / 3000 kg	N/A	12 Ku, 12 C	N/A	N/A

Characteristics of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in Orbit	Freq. Bands & Trans.	Stab.	Power
Communication (cont.)										
Teledesic T1	Communication	N/A	LEO	313 nMi	289 nMi	N/A	N/A		N/A	N/A
Telesat DTH-1	Communication	N/A	GEO 269 E	19400 nMi	19400 nMi	N/A	N/A	Ku	N/A	N/A
Thor 3	Communication	N/A	GEO	19400 nMi	19400 nMi	N/A	N/A		N/A	N/A
Crewed										
Soyuz TM-27	Crewed	N/A	LEO	221 nMi	213 nMi	15587 lb. / 7070 kg	14969 lb. / 6790 kg		N/A	N/A
Soyuz TM-28	Crewed	N/A	LEO	221 nMi	213 nMi	15587 lb. / 7070 kg	14969 lb. / 6790 kg		N/A	N/A
Development/Experimental										
ARD	Development	N/A	LEO	N/A	N/A	5890 lb. / 2665 kg	N/A		N/A	N/A
MightySat 1	Development	N/A	LEO	N/A	N/A	150 lb. / 68 kg	N/A		N/A	N/A
SAC A	Development	N/A	LEO	N/A	N/A	N/A	N/A		N/A	N/A
STEX 1	Development	N/A	LEO	N/A	N/A	N/A	N/A		N/A	N/A
TechSat 2	Experimental	N/A	LEO	N/A	N/A	N/A	N/A		N/A	N/A
Tubsat C_DLR	Experimental	N/A	LEO	540 nMi	540 nMi	N/A	N/A		N/A	N/A
Intelligence										
Offeq 4	Intelligence	N/A	LEO	N/A	N/A	616 lb. / 280 kg	N/A		N/A	N/A
SM II 98-01	Intelligence	N/A	TBA	N/A	N/A	N/A	N/A		N/A	N/A
Meteorological										
NOAA K	Meteorological	N/A	LEO	473 nMi	459 nMi	4915 lb. / 2234 kg	3205 lb. / 1454 kg		N/A	1400 W
Navigation										
Navstar GPS 2R- 3	Navigation	N/A	MEO	10899 nMi	10899 nMi	4470 lb. / 2032 kg	N/A	1 L	N/A	N/A
Other										
Celestis 2	Other	N/A	LEO	N/A	N/A	N/A	N/A		N/A	N/A
Remote Sensing										
CBERS/Ziyuan 1	Remote Sensing	$ 69 M	LEO	420 nMi	420 nMi	3190 lb. / 1450 kg	N/A		3-axis	N/A
EOS AM 1	Remote Sensing	N/A	LEO	381 nMi	381 nMi	N/A	N/A		N/A	N/A
FASat-Bravo	Remote Sensing	N/A	LEO	N/A	N/A	N/A	N/A		N/A	N/A
Geosat Follow-On 1	Remote Sensing	N/A	LEO	432 nMi	422 nMi	748 lb. / 340 kg	N/A		N/A	N/A
IKONOS 1	Remote Sensing	N/A	LEO	367 nMi	367 nMi	1797 lb. / 817 kg	N/A		N/A	N/A
IRS P4	Remote Sensing	N/A	LEO	497 nMi	481 nMi	2970 lb. / 1350 kg	N/A		N/A	N/A
Kitsat 3	Remote Sensing	N/A	LEO	470 nMi	470 nMi	220 lb. / 100 kg	N/A		N/A	N/A
Resurs-O1 N4	Remote Sensing	N/A	LEO	451 nMi	451 nMi	6160 lb. / 2800 kg	N/A		N/A	N/A
SACI 1	Remote Sensing	N/A	LEO	420 nMi	420 nMi	132 lb. / 60 kg	N/A		N/A	N/A
Spin 2	Remote Sensing	N/A	LEO	119 nMi	119 nMi	N/A	N/A		N/A	N/A
SPOT 4	Remote Sensing	N/A	LEO	446 nMi	443 nMi	5500 lb. / 2500 kg	N/A	1 X	N/A	N/A

Characteristics of Cited Payloads

Payload	Use	Price	Orbit	Apogee	Perigee	Launch Mass	Mass in Orbit	Freq. Bands & Trans.	Stab.	Power
Remote Sensing (cont.)										
TMSAT 1	Remote Sensing	N/A	LEO	N/A	N/A	110 lb. / 50 kg	N/A		N/A	N/A
Scientific										
Deep Space 1	Scientific	N/A	EXT	N/A	N/A	946 lb. / 430 kg	N/A		N/A	N/A
Lunar Prospector	Scientific	N/A	EXT	N/A	N/A	513 lb. / 233 kg	N/A		N/A	N/A
Odin	Scientific	N/A	LEO	324 nMi	324 nMi	550 lb. / 250 kg	N/A		N/A	N/A
Planet B	Scientific	N/A	EXT	N/A	N/A	658 lb. / 300 kg	N/A		N/A	N/A
SNOE	Scientific	N/A	LEO	297 nMi	297 nMi	220 lb. / 100 kg	N/A		N/A	N/A
TERRIERS	Scientific	N/A	LEO	297 nMi	297 nMi	268 lb. / 122 kg	N/A		N/A	N/A
TRACE	Scientific	N/A	LEO	378 nMi	378 nMi	491 lb. / 223 kg	N/A		N/A	N/A
WIRE	Scientific	N/A	LEO	270 nMi	270 nMi	649 lb. / 295 kg	N/A		N/A	N/A
Space Staion										
FGB	Space Station	$ 165 M	LEO	N/A	N/A	42500 lb. / 19278 kg	N/A		3-axis	N/A
Node 1	Space Station	N/A	LEO	N/A	N/A	N/A	N/A		N/A	N/A
Pressurized Mating A 1&2	Space Station	N/A	LEO	N/A	N/A	N/A	N/A		N/A	N/A
Supply										
Progress M-38	Supply	N/A	LEO	N/A	N/A	15983 lb. / 7250 kg	N/A		N/A	N/A
Progress M-39	Supply	N/A	LEO	N/A	N/A	15983 lb. / 7250 kg	N/A		N/A	N/A
TBA										
Kosmos Rockot TBA	TBA	N/A	LEO	N/A	N/A	N/A	N/A		N/A	N/A

Launch Events
January - March 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
China								
				Long March				
March 26, 1998	Long March 2C	Iridium 51 Iridium 61	Iridium, Inc. Iridium, Inc.	Lockheed Martin Lockheed Martin	Yes	Commercial	Success	Success
Europe (ESA)								
				Ariane				
February 4, 1998	Ariane 44LP	Brazilsat B3 Inmarsat 3 F5	Embratel Inmarsat	Hughes Lockheed Martin	Yes	Commercial	Success	Success
February 27, 1998	Ariane 42P	Hot Bird Plus 4	Eutelsat	Matra Marconi	Yes	Commercial	Success	Success
March 23, 1998	Ariane 40	SPOT 4	CNES	Matra Marconi	No	Non-Commercial	Success	Success
Israel								
				Shavit				
January 22, 1998	Shavit	Offeq 4	Israel Space Agency	Israel Aircraft Industries	No	Non-Commercial	Failure	Failure
Japan								
				H 2				
February 21, 1998	H 2	COMETS 1	NASDA	Toshiba	No	Non-Commercial	Failure	Failure

Launch Events
January - March 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
Russia								
				Soyuz				
January 29, 1998	Soyuz	Soyuz TM-27	RKK Energia	RKK Energia	No	Non-Commercial	Success	Success
February 17, 1998	Soyuz	Spin 2	Sovinformsputnik	Central Specialised Design Bur.	No	Non-Commercial	Success	Success
March 15, 1998	Soyuz	Progress M-38	RKK Energia	RKK Energia	No	Non-Commercial	Success	Success
USA								
				Athena				
January 6, 1998	Athena 2	Lunar Prospector	NASA	Lockheed Martin	No	Commercial	Success	Success
				Atlas				
January 29, 1998	Atlas 2A	SM II 98-01	DoD	Unknown	No	Non-Commercial	Success	Success
February 27, 1998	Atlas 2AS	Intelsat 8A F6	Intelsat	Lockheed Martin	Yes	Commercial	Success	Success
March 16, 1998	Atlas 2	GBS 8	DoD	Hughes	No	Commercial	Success	Success
				Delta				
January 9, 1998	Delta 2 7925	Skynet 4D	British MoD	Matra Marconi	Yes	Commercial	Success	Success
February 14, 1998	Delta 2 7420	Globalstars 1-4	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Success	Success
February 18, 1998	Delta 2 7920	Iridiums 50, 52-54, 56	Iridium, Inc.	Lockheed Martin	Yes	Commercial	Success	Success
March 29, 1998	Delta 2 7920	Iridiums 55, 57-60	Iridium, Inc.	Lockheed Martin	Yes	Commercial	Success	Success

Launch Events
January - March 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Int'l Comp	Launch Type	Launch Outcome	Mission Outcome
USA (cont.)								
				Pegasus				
February 25, 1998	Pegasus XL	SNOE Teledesic T1	U of Col/NASA Teledesic	Univ. of Colorado OSC	No	Commercial	Success	Success
				Shuttle				
January 22, 1998	Shuttle Endeavour	STS 89	NASA	Rockwell International	No	Non-Commercial	Success	Success
				Taurus				
February 10, 1998	Taurus 1	Geosat Follow-On 1 Orbcomm 3 Orbcomm 4 Celestis 2	DoD Orbcomm Orbcomm Celestis	Ball Aerospace OSC OSC Celestis	No	Commercial	Success	Success

Launch Events
April - September 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Launch Type	Int'l Comp	Site
China							
			Long March				
April , 1998	Long March 2C	Iridium 69 Iridium 70	Iridium, Inc. Iridium, Inc.	Lockheed Martin Lockheed Martin	Yes	Commercial	Taiyuan
May , 1998	Long March 4	CBERS/Ziyuan 1 SACI 1	China/Brazil INPE	INPE INPE	No	Non-Commercial	Taiyuan
May , 1998	Long March 3B	ChinaStar 1A	Chinese Min. of Posts and Com.	Lockheed Martin	No	Non-Commercial	Xichang
2nd Qtr , 1998	Long March 3B	Sinosat 1	SINO-Sat Com Ltd	EuraSpace	No	Non-Commercial	Xichang
Europe (ESA)							
			Ariane				
April 28, 1998	Ariane 44L	BSAT 1 B Nilesat 1	Telecom. Advancement Org. Egyptian Radio and TV Union (ERTU)	Hughes Matra Marconi	Yes	Commercial	Kourou
May 26, 1998	Ariane 44P	ST 1A	Singapore Telecom	Matra Marconi	Yes	Commercial	Kourou
August 15, 1998	Ariane 4-TBA	Sirius 3	Nordiska Satellitaktiebolaget (NSAB)	Hughes	Yes	Commercial	Kourou
September 11, 1998	Ariane 5	Hot Bird Plus 5 ARD	Eutelsat ESA	Matra Marconi Aerospatiale	Yes	Commercial	Kourou
3rd Qtr , 1998	Ariane 4-TBA	Eutelsat 3 F2	Eutelsat	Aerospatiale	Yes	Commercial	Kourou

Launch Events
April - September 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Launch Type	Int'l Comp	Site
India							
			PSLV				
3rd Qtr , 1998	PSLV	IRS P4 Kitsat 3 Tubsat-DLR	ISRO KAIST Technical University of Berlin	ISRO Surrey Satellite Technology Technical University of Berlin	No	Non-Commercial	Sriharikota
Japan							
			M 5				
August , 1998	M 5	Planet B	NASDA	ISAS	No	Non-Commercial	Kagoshima
Russia							
			Proton				
April 2, 1998	Proton (SL-13)	Iridiums 62-68	Iridium, Inc.	Lockheed Martin	Yes	Commercial	Baikonur
May , 1998	Proton (SL-12)	Astra 2A	SES	Hughes	Yes	Commercial	Baikonur
May , 1998	Proton (SL-12)	EchoStar 4	EchoStar Satellite Corp.	Lockheed Martin	Yes	Commercial	Baikonur
June 3, 1998	Proton (SL-12)	PAS 8	PanAmSat	Space Systems/Loral	Yes	Commercial	Baikonur
August , 1998	Proton (SL-13)	FGB	International	Krunichev/Salyut	No	Non-Commercial	Baikonur
September , 1998	Proton (SL-12)	Telesat DTH-1	Telesat Canada	Lockheed Martin	Yes	Commercial	Baikonur

Launch Events
April - September 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Launch Type	Int'l Comp	Site
Russia (cont.)							
			Soyuz				
May 15, 1998	Soyuz	Progress M-39	RKK Energia	RKK Energia	No	Non-Commercial	Baikonur
August 2, 1998	Soyuz	Soyuz TM-28	RKK Energia	RKK Energia	No	Non-Commercial	Baikonur
			START				
3rd Qtr , 1998	START 1	Odin	Swedish National Space Board	Swedish Space Corp.	Yes	Commercial	Svobodny
			Zenit				
May , 1998	Zenit 2	Resurs-O1 N4 FASat-Bravo SAFIR 2 TMSAT 1 TechSat 2 IRIS R1	Russia Chilean Air Force OHB System Thai MicroSatellite Co. Asher Space Research Institute European Space Agency (ESA)	VNII Elektromekhaniki Surrey Satellite Technology Limited OHB System Surrey Satellite Technology Technion Institute of Technology SAIT Systems SA	No	Non-Commercial	Baikonur
Ukraine							
			Zenit				
July 15, 1998	Zenit 2	Globalstars 9-20	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur
September 15, 1998	Zenit 2	Globalstars 21-32	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	Baikonur

Launch Events
April - September 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Launch Type	Int'l Comp	Site
USA							
			Athena				
May 19, 1998	Athena 2	IKONOS 1	Space Imaging Inc.	Locheed Martin	No	Commercial	VAFB
			Atlas				
June 12, 1998	Atlas 2AS	Intelsat 8A F5	Intelsat	Lockheed Martin	Yes	Commercial	CCAS
July 29, 1998	Atlas 2AS	JCSAT 6	Japan Satellite Systems (JSAT)	Hughes	Yes	Commercial	CCAS
August 22, 1998	Atlas 2AS	Eutelsat 3 F 1	Eutelsat	Aerospatiale	Yes	Commercial	CCAS
September , 1998	Atlas 2AS	EOS AM 1	NASA	Lockheed Martin	No	Non-Commercial	VAFB
3rd Qtr , 1998	Atlas 2	GBS 9	DoD	Hughes	No	Commercial	CCAS
			Delta				
April 23, 1998	Delta 2 7420	Globalstars 5-8	Globalstar, Inc.	Space Systems/Loral	Yes	Commercial	CCAS
April 26, 1998	Delta 2 7920	Iridiums 71-75	Iridium, Inc.	Lockheed Martin	Yes	Commercial	VAFB
June 9, 1998	Delta 2 7925	Thor 3	Telenor A.S.	Hughes	Yes	Commercial	CCAS
June 22, 1998	Delta 3	Galaxy 10	PanAmSat	Hughes	Yes	Commercial	CCAS
July, 1998	Delta 2 7326	Deep Space 1	NASA	Spectrum Astro, Inc.	No	Non-Commercial	CCAS
September 14, 1998	Delta 2 7925	Navstar GPS 2R- 3	DoD	Lockheed Martin	No	Non-Commercial	CCAS

Launch Events
April - September 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Launch Type	Int'l Comp	Site
USA (cont.)							
			Pegasus				
2nd Qtr , 1998	Pegasus XL	TRACE	NASA	NASA Goddard	No	Non-Commercial	VAFB
2nd Qtr , 1998	Pegasus XL/HAPS	Orbcomms 13-20	Orbcomm	OSC	No	Commercial	VAFB
2nd Qtr , 1998	Pegasus XL	SCD 2	INPE	INPE	Yes	Commercial	CCAS
3rd Qtr , 1998	Pegasus XL	TERRIERS MUBLCOM	Boston University/NASA TBA	AeroAstro TBA	Yes	Commercial	VAFB
3rd Qtr , 1998	Pegasus XL	WIRE	NASA	NASA Goddard	No	Non-Commercial	VAFB
			Shuttle				
April 16, 1998	Shuttle Columbia	STS 90	NASA	Rockwell International	No	Non-Commercial	KSC
May 28, 1998	Shuttle Discovery	STS 91	NASA	Rockwell International	No	Non-Commercial	KSC
September 3, 1998	Shuttle Endeavour	STS 88 MightySat 1 Node 1 Pressurized Mating A 1&2 SAC A	NASA DoD NASA NASA NASA	Rockwell International CTA (now OSC) NASA NASA Bariloche Company Invap.	No	Non-Commercial	KSC

Launch Events
April - September 1998

Launch Date	Vehicle	Payload	Operator	Manufacturer	Launch Type	Int'l Comp	Site
USA (cont.)							
			Taurus				
3rd Qtr , 1998	Taurus 1	STEX 1	DoD	DoD	No	Non-Commercial	VAFB
			Titan				
May 8, 1998	Titan 4B/Centaur	USA 1998-05	TBA	TBA	No	Non-Commercial	CCAS
May 13, 1998	Titan 2	NOAA K	NOAA	Lockheed Martin	No	Non-Commercial	VAFB
July 25, 1998	Titan 4/Centaur	USA 1998-06	DoD	DoD	No	Non-Commercial	CCAS