

Commercial Space Transportation

# QUARTERLY LAUNCH REPORT

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



1st Quarter 1996

United States Department of Transportation • Federal Aviation Administration

Office of Associate Administrator for Commercial Space Transportation

# Quarterly Launch Report

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## 1st QUARTER 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.*

*The 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, Subsection 9, Section 701 (previously known as the Commercial Space Launch Act), and*
- *certain European launches of Post, Telegraph and Telecommunications payloads on Ariane vehicles.*

**Photo credit:** Lockheed Martin Corporation (1995). Image is of the Atlas 2A launch on December 15, 1995. It successfully orbited a Galaxy 3R commercial communications satellite for Hughes Communications, Inc.

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## SUMMARY

### Fourth Quarter 1995 Launch Events

- The U.S. successfully conducted two Delta, three Atlas, two Shuttle, and two Titan launches. The first flight of the small Conestoga vehicle was a failure.
- Arianespace conducted three successful launches.
- China resumed launch activities, after an eleven-month hiatus, with two successful Long March launches.
- Russia conducted nine successful launches using one Cosmos, one Cyclone, one Molniya, three Proton, two Soyuz, and one Zenit rockets.

### First and Second Quarter 1996 Scheduled Launch Events

- The U.S. expects to conduct 24 launches during the next two quarters, of which nine launches are commercial.
- Arianespace plans to launch eight times in the next six months, with seven of these being commercial launches.
- China intends to launch two Long March vehicles, both of which are commercial.
- Russia has 19 scheduled launches for the next two quarters, including its first two dedicated commercial launches.
- India will launch its third PSLV.

## SUMMARY

### Commercial Products and Services

The following satellites are being deployed by launches licensed by the FAA Office of Commercial Space Transportation. They will provide commercial products and services to the general public.

#### Galaxy 9 (Delta 2 7925) and GE 1 (Atlas 2A)

Video services provided by these systems represent the greatest overall use of transponder capacity. Satellite use by the video sector has been increasing steadily as specialized video services such as direct-to-home and pay-per-view have developed. More substantial growth in demand for satellite capacity likely will come from corporations, schools, and other large institutions establishing private networks for video, voice and data communications.

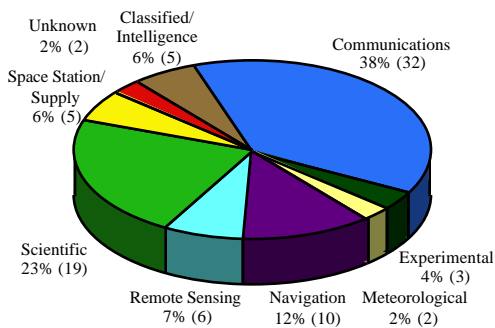
#### Inmarsat 3 F2 (Atlas 2A)

This satellite will ensure continuity of maritime service, while maintaining reliability, redundancy and connectivity. The increased capacity will be sufficient both for existing maritime services and for new and innovative maritime services that will benefit customers including critical distress and safety communication.

### Payload Use Analysis

For the period October 1995 through June 1996, communications (38%), scientific (23%), and navigation (12%) satellites make up the vast majority (73%) of all payloads delivered to orbit. Russia's high level of activity in replenishing its Glonass navigation series accounts for much of the high navigation percentage.

When only commercial launches are considered, communications satellites make up 85% of payloads. The remaining satellites perform scientific or remote sensing functions.



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**LAUNCH  
SCHEDULE**  
  
Scheduled Launch  
Events

Vehicle	Payload	Site
<b>JANUARY 1996</b>		
Ariane 44L	Measat 1 and PAS 3R	Kourou
Cosmos SL-8	Kosmos 2327	Plesetsk
Proton SL-12	Gorizont 31	Tyuratam
Atlas 2AS	Palapa C1	CCAS
Delta 2 7925	Koreasat 2	CCAS
MSLS A *	not available	VAFB
Endeavor STS 72	SFU Retrieval	KSC
<b>FEBRUARY 1996</b>		
Long March 3B	Intelsat 7A F8	Xichang
Ariane 44P	N-Star B	Kourou
Ariane 44LP	Intelsat 7A F7	Kourou
Texus *	not available	Esrangle
PSLV	IRS P3	Sriharikota
J-1 *	Hyflex	Tanegashima
Proton SL-12	Raduga 33	Tyuratam
Soyuz SL-4	Soyuz TM-23	Tyuratam
Delta 2 7925	NEAR	CCAS
Delta 2 7925	Polar	VAFB
Pegasus XL	Rex 2	VAFB
Columbia STS 75	TSS 1R/USMP	KSC
<b>MARCH 1996</b>		
Ariane 42P	MSAT Canada	Kourou
Proton SL-12	Astra 1F	Tyuratam
Delta 2 7925	Navstar GPS 2-25	CCAS
Atlantis STS 76	Spacehab/Mir #3	KSC
Starfire 1 *	Conquest 1	White Sands

\* Denotes a suborbital launch.

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	Vehicle	Payload	Site
<b>LAUNCH SCHEDULE</b>	<b>APRIL 1996</b>		
Scheduled Launch	Ariane 4	AMOS 1A and Italsat 2	Kourou
Events	Soyuz SL-4	Progress M-31	Tyuratam
	Atlas 2A	Inmarsat 3 F2	CCAS
Continued	Atlas 1	SAX	CCAS
	Delta 2 7920	MSX	VAFB
	Delta 2 7925	Galaxy 9	CCAS
	DC-XA *	not available	White Sands
	Pegasus 1	MSTI 3	VAFB
	Titan 4/Centaur	Classified	CCAS
	<b>MAY 1996</b>		
	Ariane 5	Cluster 1 - 4	Kourou
	Ariane 4	Palapa C2	Kourou
	Atlas 2A	GE 1	CCAS
	Atlantis STS 77	Spacelab	KSC
	<b>JUNE 1996</b>		
	Ariane 44LP	Intelsat 8 F1	Kourou
	Proton SL-12	Tempo 1	Tyuratam
	Soyuz SL-4	Progress M-32	Tyuratam
	Delta 2 7925	Navstar GPS 2-26	CCAS
	LMLV	Clark	VAFB
	Pegasus XL	TOMS 1	VAFB
	Columbia STS 79	Spacelab	KSC
	Titan 4	Classified	VAFB

\* Denotes a suborbital launch.

# Quarterly Launch Report

## LAUNCH SCHEDULE

### Additional Launch Events<sup>†</sup>

## For the First and Second Quarter of 1996

Vehicle	Payload	Site
<b>FIRST QUARTER OF 1996</b>		
Long March 2E	APStar 1A	Xichang
Cyclone SL-14	GEO-IK 2	Plesetsk
Cyclone SL-14	Coronas F	Plesetsk
Molniya SL-6	Molniya 3-48	Plesetsk
Proton SL-12	Ekran 21	Tyuratam
Proton SL-12	Kosmos Glonass (3)	Tyuratam
Zenit SL-16	Kosmos	Tyuratam
<b>SECOND QUARTER OF 1996</b>		
Proton SL-13	Priroda	Tyuratam
Proton SL-12	Express 2	Tyuratam
Soyuz SL-4	Foton 11/Mirka	Plesetsk
Zenit SL-16	Okean 5	Tyuratam
Zenit SL-16	Kosmos	Tyuratam
Titan 2	DMSP 5D-3	VAFB
Titan 2	NOAA K	VAFB

<sup>†</sup> This section summarizes launches and payloads which are expected to occur during the next two quarters. Exact launch dates were not available prior to issuance of this report.

\* Denotes a suborbital launch.



# Quarterly Launch Report

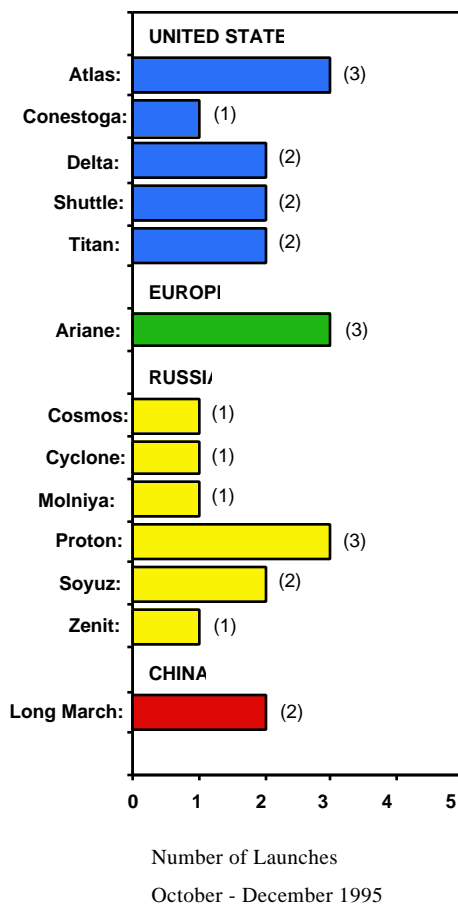
## LAUNCH REPORT

### Launch Events

### Fourth Quarter 1995

Twenty-four launch events took place in the fourth quarter of 1995, of which seven were commercial. As usual, the United States and Russia were responsible for the majority of launches (ten and nine launches respectively).

Of the ten U.S. launches, one was dedicated to commercial communications, three to military applications, four to scientific purposes, one to remote sensing, and one to space station Alpha assembly preparation. The only launch failure in this quarter was the maiden voyage of the Conestoga 1620, a U.S. commercial launch. (This launch is discussed in more detail in the Special Report on Small Launch Vehicles, on page 14.)



The Galaxy 3R telecommunications replacement satellite, to serve the Latin American region, was successfully deployed by an Atlas 2A vehicle. Other communications satellites launched last quarter included an Ultra High Frequency Follow-On (UFO 6), launched by an Atlas 2, and the second Milstar (1B), deployed by a Titan 4/Centaur, for the U.S. military. A third military classified satellite was also deployed by a Titan 4. Scientific payloads included the Solar and Heliospheric Observer, orbited by an Atlas 2AS; the X-Ray Timing Explorer, deployed by a Delta 2; and the United States Microgravity Laboratory, housed by the Shuttle Columbia. An additional Shuttle flight allowed the second U.S. rendezvous with the Russian Mir space station. Also, a Canadian radar remote sensing satellite, along with a secondary student payload, was successfully deployed by a Delta 2.

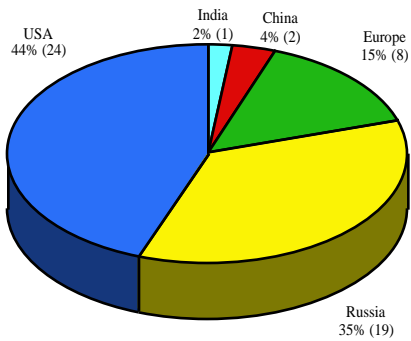
China resumed launch activities last quarter, after an eleven-month hiatus, with two successful commercial launches for Hong Kong and American customers. This ends a schedule delay created by a Long March vehicle failure in January 1995. With three launches, Arianespace deployed four satellites, two of which were internationally competed contracts. A civil/scientific payload, the Infrared Solar Observatory was deployed for the European Space Agency. Russia/CIS conducted nine launches, one of which deployed a remote-sensing satellite for India, in addition to a collaborative U.S./Russian military experimental satellite, Skipper.

# Quarterly Launch Report

## LAUNCH REPORT

### Scheduled Launch Events

### First and Second Quarter 1996



Scheduled Launch Events,  
by Region  
January - June 1996

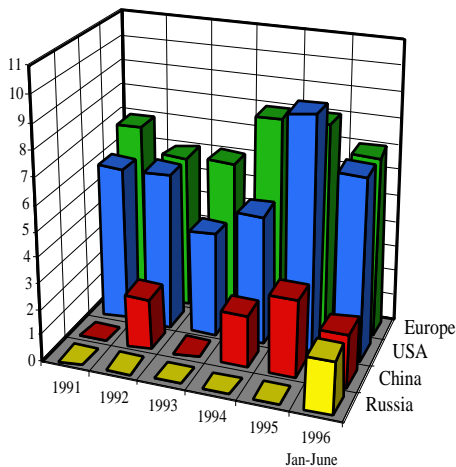
The Russian Republic and the United States lead all space-faring nations in the total number of launches, with 19 and 24 launches respectively, scheduled for the first and second quarters of 1996. Deployment of another module for the Mir space-station is planned for a Proton rocket in the second quarter of 1996.

Of the 18 U.S. non-competed launches, NASA plans to conduct five shuttle missions in addition to deploying four scientific satellites, including: the second Tethered Satellite System, a joint NASA/Italian Space Agency experiment; the Near-Earth Asteroid Fly-by (NEAR); TOMS, a remote sensing satellite; and Polar a scientific satellite. The DoD will orbit and operate eight satellites, including two navigation, one classified, three experimental, one meteorological and one intelligence satellite.

Arianespace plans to introduce the heavy-capacity Ariane 5 vehicle in May with the non-commercial launch of four scientific satellites. The Ariane 5 vehicle is capable of delivering 44,000 pounds to low Earth orbit. Future Ariane 5 flights will accommodate commercial customers. Japan intends to conduct a suborbital test of the J-1, its upcoming small orbital vehicle, to be capable of deploying almost 2,000 lbs. to LEO. India has scheduled the launch of its next PSLV vehicle for February.

## LAUNCH REPORT

### Scheduled Commercial Launch Events First and Second Quarter 1996



Commercial Launch Events  
January 1991-June 1996  
(Small Vehicles Excluded)

International Launch Services, a joint U.S./Russian commercial venture between Lockheed Martin, Khrunichev State Research and Production Space Center, and RSC Energia intends to conduct Russia's first two dedicated commercial launches. Two Proton rockets will deploy SES's Astra 1F and Space Systems/Loral's Tempo 1 telecommunications satellites in March and June 1996, respectively.

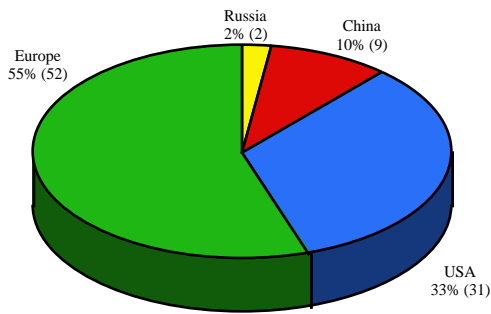
China also plans to conduct two commercial launches of the Intelsat 708 and APStar 1A satellites. The first Long March with a 3B configuration, the heaviest capacity vehicle in China's inventory (capable of lifting over 26,000 pounds to LEO orbit), is slated to launch in February.

The U.S. and Europe continue to lead in the number of scheduled commercial launches for the next two quarters. Eight Arianespace launches, including seven Ariane 4s and the first Ariane 5, are slated to launch 13 satellites, eight of which were internationally competed contracts. Ariane customers include organizations from Malaysia, United States, Japan, Canada, Israel, and Indonesia. Arianespace will also launch two Intelsat payloads. Four Lockheed Martin commercial Atlas vehicles will deploy satellites for customers from Italy, Indonesia, and the United States. Lockheed Martin will also deploy an Inmarsat satellite using an Atlas 2A. McDonnell Douglas plans to conduct three commercial Delta 2 launches in the next two quarters for South Korea and the United States.

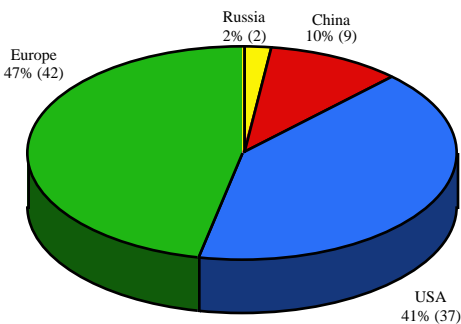
In the next two quarters Orbital Sciences plans to resume operation of its Pegasus vehicle with three flights, including one NASA remote sensing satellite and two DoD experimental satellites. After the failure of the first LMLV flight, Lockheed Martin plans to resume flight activity in June 1996 with the deployment of the Clark satellite as part of NASA's small spacecraft technology initiative program.

## LAUNCH REPORT

### Commercial Launch Trends



Commercially Launched Payloads  
Market Trend  
January 1991-June 1996  
(Small Vehicles Excluded)



Commercial Launch Market Trend  
January 1991-June 1996  
(Small Vehicles Excluded)

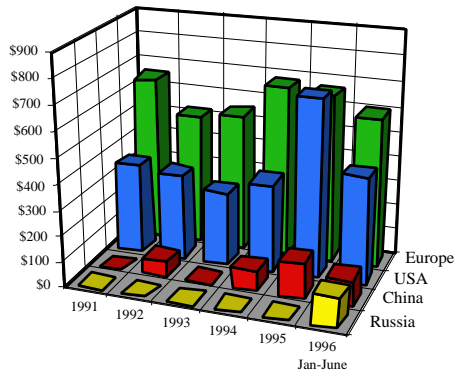
Payloads which correspond to internationally competed launches over the last five years, including those payloads associated with actual and scheduled launches cited in this report, reflect an average market share of 55% for Arianespace. This is because some Arianespace launches carry more than one spacecraft.

When number of launches are compared, U.S. firms have about 41% of the market to Arianespace's 47% over the period 1991 through mid 1996. Projections for large orbital launch vehicles in the first two quarters of 1996 show seven launches for U.S. firms and seven for Arianespace. Russia will launch its first two commercial flights in the first half of 1996 and China will continue its commercial Long March launches with its eighth and ninth launches.

Arianespace's share of the commercial space launch market is largest when the market is defined by number of payloads delivered to orbit.

## LAUNCH REPORT

### Commercial Launch Revenues



Commercial Launch Revenues by Region  
(in U.S. \$ Millions)\*  
January 1991 - June 1996

\* Approximate revenues based on actual price quotes and historical price averages. Figures shown in constant 1994 dollars.

The expected launch service revenue from the U.S., European, Russian,

and Chinese scheduled launches for the next two quarters will total approximately \$1260 million, of which 35% will be realized as commercial launch revenue for American companies. Leading communications satellite manufacturers, most notably Hughes Communications and Lockheed Martin Astro Space, have received the majority of contract awards for payloads in this period.

Since 1991, Arianespace commercial launch revenue has averaged \$615 million per year for an average annual launch rate of seven. By comparison, the United States has averaged \$410 million in annual revenues, with approximately six launches per year. Over the last ten years, Arianespace has maintained a relatively robust launch revenue base despite growth in the U.S. industry. Arianespace's dual manifesting practice and its focus on the geostationary market segment account for its relatively large ratio of revenues to launches.

## U.S. Small Launch Vehicles

1995 was an ambitious and difficult year for the United States small launch vehicle market. A total of five small launch vehicles were launched from the United States, two of which were successful (Atlas E and Pegasus 1) and three of which resulted in failure

(Pegasus XL, LMLV, and Conestoga). A total of four payloads were successfully deployed.

Note that a small launch vehicle is defined as one capable of lifting no more than 5,000 pounds to low

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Earth orbit. See the table below for a summary of currently operational U.S. small launch vehicles.

Three of last year's five launches were commercial launches (Pegasus 1, LMLV, and the Conestoga). Last year, two new U.S. small launch vehicles were introduced: Lockheed's LMLV and EER's Conestoga. The initial flights of both these vehicles resulted in failure.

Industry analysts predict that the drive for wireless mobile communications systems, like Iridium and Globalstar, will significantly increase demand for small launch vehicles over the next ten years.

## Atlas E

An Atlas E was launched on March 24, successfully orbiting a military meteorological satellite for the Defense Meteorological Satellite Program (DSMP). The DMSP 5D-3-F15 was manufactured by Lockheed Martin Astro Space.

The March 24 launch was the last and the 26th consecutive successful launch of the Atlas E booster. There are no remaining Atlas E launch vehicles in the U.S. Air Force inventory.

## Pegasus 1

Orbital Sciences Corporation's Pegasus 1 flight on April 3 successfully orbited two small Orbcomm communications satellites as well as a NASA scientific payload. The Orbcomm commercial communications satellites, Orbcomm FM1 and FM2, were the first two satellites to be deployed as part of the Orbcomm 26 satellite constellation. The Orbcomm system will provide customers with mobile data communication services. NASA's Microlab1, a scientific satellite, will study the distribution of lightning on the Earth. All three payloads were manufactured by Orbital Sciences Corporation.

Another Pegasus 1 launch is scheduled for April 1996. It will orbit the Miniature Sensor Technology

Integration satellite, MSTI-3, for the Department of Defense. The satellite is being manufactured by Spectrum Astro.

## Pegasus XL

Orbital Sciences Corporation experienced its second launch and its second failure of the Pegasus XL on June 22. The payload was the Space Test Experiments Platform (STEP) 3 for the Department of Defense. The military payload was lost when the range safety officer destroyed the vehicle after detecting an in-flight anomaly 148 seconds into the mission. Preliminary analysis indicated that the interstage clamping ring failed to release properly after the jettison of the first stage and obstructed the second stage motor. The payload was manufactured by TRW.

The XL increases the Pegasus's LEO capacity from 1100 lbs. to 1800 lbs.

Two additional Pegasus XL launches are scheduled to take place during the next two quarters. In February, the Pegasus XL is scheduled to orbit the REX 2, a military satellite which will measure electron density irregularities in the ionosphere. REX 2 is being manufactured by CTA Space Systems for the Rome Laboratory. In June, another Pegasus XL will orbit NASA's Total Ozone Mapping Spectrometer satellite, TOMS-1. The TOMS spacecraft is being manufactured by TRW.

## Lockheed Martin Launch Vehicle (LMLV)

The maiden flight of the Lockheed Launch Vehicle (LLV), recently renamed the Lockheed Martin Launch Vehicle (LMLV), on August 15 was terminated in mid-flight after uncontrolled oscillations of the rocket were detected. This resulted in the loss of both the vehicle and the payload. There is speculation that the cause of the mishap was a guidance system failure coupled with

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overheating of the booster's first stage steering mechanism. The payload on board was GEMstar 1, a small communications satellite manufactured by CTA, Inc. for Volunteers in Technical Assistance (VITA), a non-profit organization.

The LMLV is currently slated to launch the Lewis and Clark satellites, two NASA science payloads, scheduled for June (Clark) and July (Lewis) of this year.

NASA Administrator, Dan Goldin, announced in September that all new rockets must first complete a successful test flight before they can carry any NASA agency payloads. However, it was announced in December that NASA will not require a demonstration flight of the LMLV prior to the Lewis and Clark flights.

## Conestoga

The Conestoga 1620 launch on October 23, 1995 resulted in failure, disintegrating in midair 46 seconds after launch. This was the maiden flight of the Conestoga 1620 and was the first orbital rocket launched out of NASA's Wallops Flight Facility in 10 years. EER Space Systems, Conestoga's manufacturer, concluded that low frequency noise from an unknown source upset the guidance system on the rocket, causing it to order course corrections when none were needed. The rocket went off course when its first stage steering mechanism ran out of hydraulic fluid and became inoperable. EER Space Systems, NASA, and the Department of Transportation are currently conducting an investigation of the October Conestoga failure.

The destruction of this flight resulted in the loss of the Multiple Experiments to Earth Orbit and Return payload (METEOR 1, formerly the Commercial Experiments Transporter, COMET 1) and the 14 microgravity experiments on board. METEOR 1 was to be a recoverable payload, designed for on-orbit microgravity experiments advancing commercial

applications of materials processing and medical research. The launcher and the spacecraft were designed and developed commercially over a five-year period with NASA and private funding.

## New U.S. Small Launch Vehicles

In the area of new small launch vehicles, McDonnell Douglas plans to develop a smaller derivative of its Delta 2 rocket called the **Delta-Lite**. The three stage Delta-Lite would be able to launch 1,985 to 2,540 kilograms to equatorial low Earth orbit. McDonnell Douglas is developing Delta-Lite as one part of NASA's Med-Lite procurement, awarded to the McDonnell Douglas-Orbital Sciences Corporation team in March 1995. The Med-Lite contract covers five launches of NASA payloads starting in 1998. Other launch vehicles to be used under the Med-Lite program include a three strap-on booster version of the Delta 2 and OSC's Taurus launch vehicle. Delta-Lite's first payload will be NASA's Far Ultraviolet Spectroscopic Explorer (FUSE), scheduled for launch in fall 1998.

Lockheed Martin last year began design work on a three-stage version of the Lockheed Martin Launch Vehicle called the **LMLV-2**. The new rocket builds on the design of the two-stage LMLV-1 but will be capable of lofting payloads in the 1,800 kilogram-range rather than the LMLV-1's 900-kilogram range.

Other small launch vehicles currently proposed or in development in the United States include Pac Astro's PA-2 launch vehicle, Kistler Aerospace Corporation's K-1 launch vehicle, Microcosm's Scorpius launch vehicle, and E'Prime Aerospace Corporation's Eagle S launch vehicle. A number of U.S. launch vehicle families are also currently being expanded, including EER Space Systems' Conestoga, Orbital Science Corporation's Taurus and Pegasus, and Lockheed Martin Corporation's MSLS launch vehicle families.

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<b>U.S. Operational Small Vehicles</b>	<b>Manufacturer</b>	<b>Pounds to LEO Orbit</b>
Atlas E	Lockheed Martin Corporation (General Dynamics)	1750 lbs.
LMLV 1	Lockheed Martin Corporation	1800 lbs.
MSLS A*	Lockheed Martin Corporation	300 lbs.
Conestoga 1620	EER Space Systems	2600 lbs.
Pegasus 1	Orbital Sciences Corporation	635 lbs.
Pegasus XL	Orbital Sciences Corporation	840 lbs.
Taurus 1	Orbital Sciences Corporation	3000 lbs.

\* Scheduled for 1st Quarter 1996 sub-orbital launch



## 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.

## GLOSSARY

Continued

**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.

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

## ACRONYMS

ASI	Italian Space Agency	Milstar	Military Strategic & Tactical Relay
APT	Asia Pacific Telecommunications	MoD	Ministry of Defense
CCAS	Cape Canaveral Air Station	MSAT	Mobile Satellite Communications System
CIS	Commonwealth of Independent States	MSLS	Multi-Service Launch System
CIT	California Institute of Technology	MSTI	Miniature Sensor Technology Integration
DASA	Deutsche Aerospace	MSX	Midcourse Sensor Experiment
DGA	Delegation Generale pour l'Armement	NASA	National Aeronautics and Space Administration
DMSP	Defense Meteorological Satellite Program	NASDA	National Space Development Agency (Japan)
DoD	Department of Defense	NEAR	Near-Earth Asteroid Rendezvous
DoT	Department of Transportation	NIVR	Netherlands Agency for Aerospace Programs
DSP	Defense Support Program	nMI	Nautical Mile
ELI	Elliptical	NOAA	National Oceanic and Atmospheric Administration
ESA	European Space Agency	NPO	Scientific Production Organization
EXT	Extra-Orbital	OCST	Office of Commercial Space Transportation
FAA	Federal Aviation Administration	OSC	Orbital Sciences Corporation
G-G	Gravity-gradient	PAS	Pan American Satellite
GE	General Electric	PSLV	Polar Satellite Launch Vehicle
GEMStar	Global E-Mail Satellite	PTT	Post, Telegraph and Telecommunications
GEO	Geosynchronous Orbit	REX	Radiation Experiment
GTO	Geosynchronous Transfer Orbit	SAX	X-ray Astronomy Satellite
IAI	Israel Aircraft Industries	SES	Societe Europeene des Satellites
IKI	Space Research Institute	SOHO	Solar and Heliospheric Observer
INMARSAT	International Maritime Satellite Organization	STS	Space Transportation System
INTELSAT	International Telecommunications Satellite Organization	TMI	Telesat Mobile, Inc.
IRS	Indian Remote Sensing	TOMS	Total Ozone Mapping Spectrometer
ISO	Infrared Space Observatory	TSS	Tethered Satellite System
ISRO	Indian Space Research Organization	UFO	Ultra-high frequency Follow-On
JPL	Jet Propulsion Laboratory	VAFB	Vandenberg Air Force Base
KSC	Kennedy Space Center	X	Experimental
LEO	Low Earth Orbit	XA	Experimental Advanced
LLV	Lockheed Launch Vehicle	XL	Extra Long
LMLV	Lockheed Martin Launch Vehicle	XTE	X-Ray Timing Explorer
MAI	Moscow Aviation Institute		
Measat	Malaysian East Asia Satellite		
MEO	Middle Earth Orbit		
METEOR	Multiple Experiment Transporter to Earth Orbit		

## APPENDIX