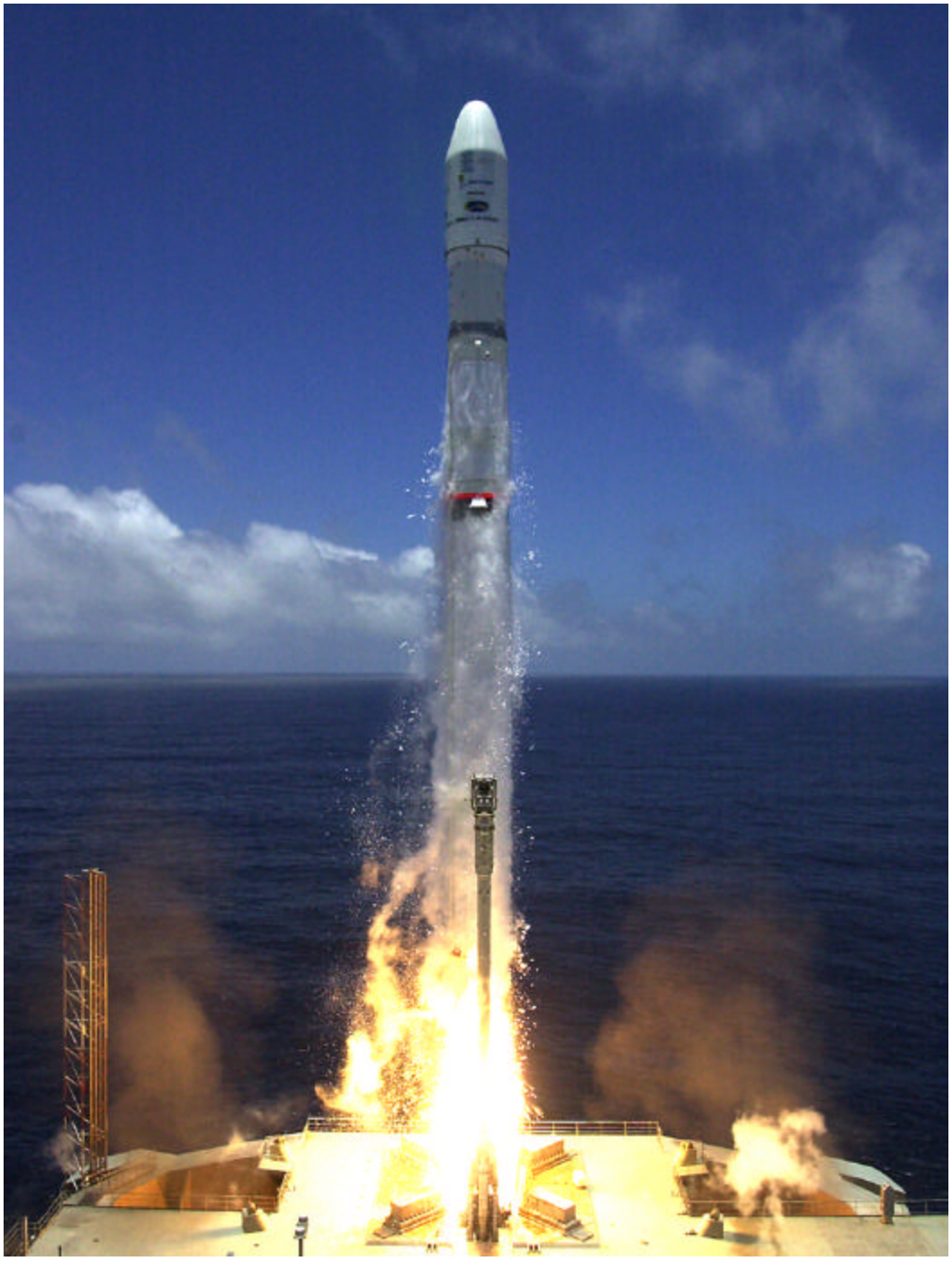
Commercial Space Transportation

QUARTERLY LAUNCH REPORT

Featuring the launch results from the 1st quarter 2001 and forecasts for the 2nd and 3rd quarter 2001

Quarterly Report Topic:

Selecting a Launch Vehicle: What Factors Do Commercial Satellite Customers Consider?



2nd Quarter 2001

United States Department of Transportation • Federal Aviation Administration

Associate Administrator for Commercial Space Transportation

800 Independence Ave. SW Room 331

Washington, D.C. 20591

Introduction

The Second Quarter 2001 Quarterly Launch Report features launch results from the first quarter of 2001 (January-March 2001) and launch forecasts for the second quarter of 2001 (April-June 2001) and the third quarter of 2001 (July-September 2001). This report contains information on worldwide commercial, civil, and military orbital space launch events. Projected launches have been identified from open sources, including industry references, company manifests, periodicals, and government sources. Projected launches 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*)*

Contents

Cover: Pacific Ocean, March 18, 2001 - A Sea Launch Zenit 3SL lifts off from the Odyssey launch platform carrying the Boeing-built XM Rock satellite, which it successfully placed into geosynchronous transfer orbit. Courtesy of Sea Launch.

First Quarter 2001 Highlights

X-33 and X-34 Cancelled

A major launch industry event in the first quarter of 2001 was the cancellation of the X-33 and X-34 RLV demonstration vehicles. NASA refocused RLV technology efforts on the new Space Launch Initiative, a program intended to support the development of technologies that will enable the development of RLVs at a later date.

EELV Developments Proceed

Both Boeing and Lockheed Martin continue to develop their Evolved Expendable Launch Vehicles (EELV). Boeing expects to launch its first EELV (Delta 4) for the U.S. Air Force in May 2002. In the first quarter of 2001, Boeing completed the first of a planned series of hot-fire tests of the Delta 4's 298,000-kilogram thrust Rocketdyne RS-68 cryogenic engine. The 15-second test, conducted at NASA's Stennis Space Center in Mississippi, will lead to full duration burns mimicking the first-stage ascent of the vehicle on its maiden flight.

Lockheed Martin is completing assembly of its first EELV (Atlas 5 AV-001) at its Denver, Colorado, factory. The company says that the initial launch of the Atlas 5 will be from Pad 41 at Cape Canaveral Air Force Station in early 2002.

New Australian Launch Site Proposed

The Asia Pacific Space Centre (APSC), a Russian-Australian consortium, has proposed a commercial satellite launch site to be based on Christmas Island. This site will be used for commercial launches of the Aurora launch vehicle (a Soyuz-derivative). Three- and four-stage Aurora models are expected to place payloads of up to 12 metric tons into low-Earth orbit and two metric tons into geosynchronous transfer orbit.

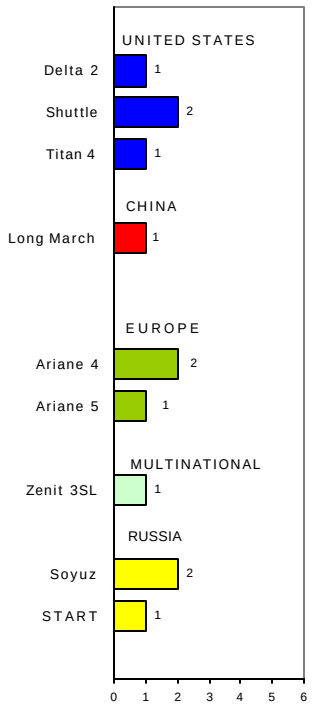
Russian Air Launched Vehicle Announced

The Russian Air Launch company says that its new launch vehicle, air-launched from an An-124 Ruslan aircraft, will begin operation in 2003. According to Air Launch, the "Air Launch Space Transportation System" will carry payloads of up to four metric tons to 2,000- to 10,000-kilometer circular or elliptical orbits. Launches may take place from any site with a three-kilometer-long runway.

Vehicle Use

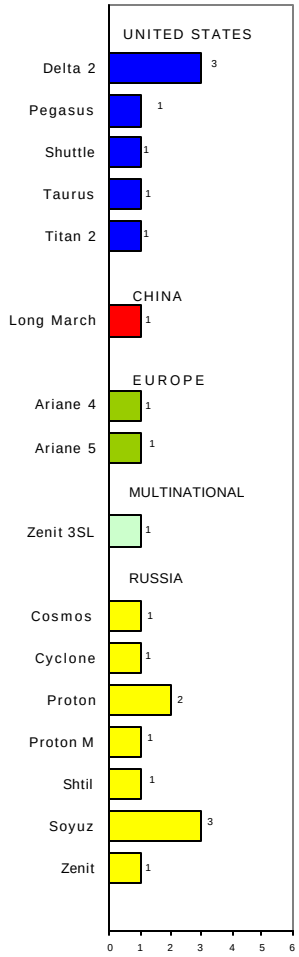
(January 2001 – September 2001)

Figure 1: First Quarter 2001 Total Launch Vehicle Use



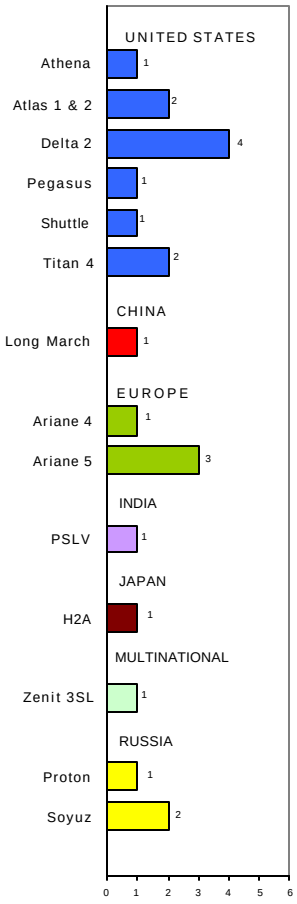
Total = 12

Figure 2: Second Quarter 2001 Total Projected Launch Vehicle Use



Total = 21

Figure 3: Third Quarter 2001 Total Projected Launch Vehicle Use

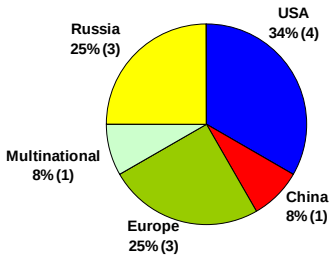


Total = 22

Figures 1-3 show the total number of orbital launches (commercial and government) of each launch vehicle that occurred in the first quarter of 2001 and that are projected for the second and third quarters of 2001. These launches are grouped by the country in which the primary vehicle manufacturer is based. Exceptions to this grouping are launches performed by Sea Launch, which are designated as multinational.

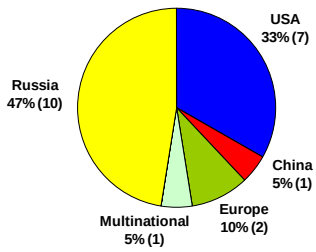
Total Launch Events by Country (January 2001 – September 2001)

Figure 4: First Quarter 2001 Total Launch Events by Country



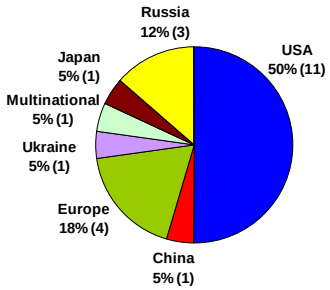
Total = 12

Figure 5: Second Quarter 2001 Total Projected Launch Events by Country



Total = 21

Figure 6: Third Quarter 2001 Total Projected Launch Events by Country

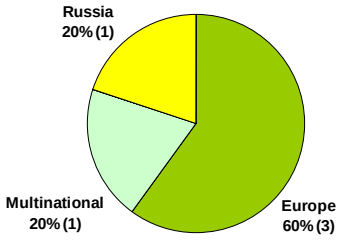


Total = 22

Figures 4-6 show all orbital launch events (commercial and government) that occurred in the first quarter of 2001 and that are projected for the second and third quarters of 2001.

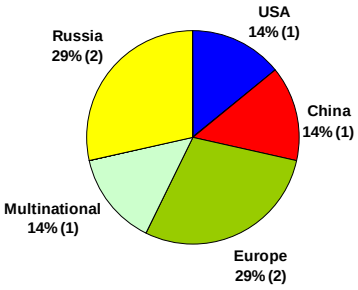
Commercial Launch Events by Country (January 2001 – September 2001)

Figure 7: First Quarter 2001 Commercial Launch Events by Country



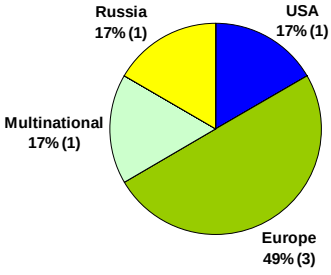
Total = 5

Figure 8: Second Quarter 2001 Projected Commercial Launch Events by Country



Total = 7

Figure 9: Third Quarter 2001 Projected Commercial Launch Events by Country



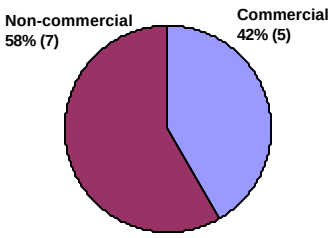
Total = 6

Figures 7-9 show all *commercial* orbital launch events that occurred in the first quarter of 2001 and that are projected for the second and third quarters of 2001.

Commercial vs. Non-commercial Launch Events

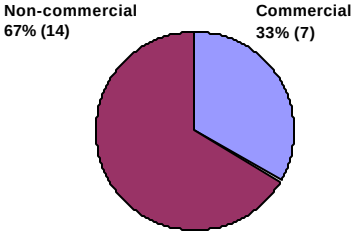
(January 2001 – September 2001)

Figure 10: First Quarter 2001 Commercial vs. Non-commercial Launch Events



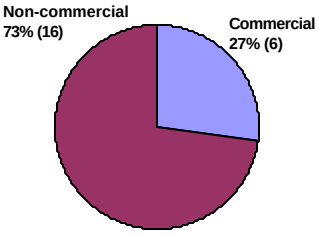
Total = 12

Figure 11: Second Quarter 2001 Commercial vs. Non-commercial Projected Launch Events



Total = 21

Figure 12: Third Quarter 2001 Commercial vs. Non-commercial Projected Launch Events



Total = 22

Figures 10-12 show commercial vs. non-commercial orbital launch events that occurred in the first quarter of 2001 and that are projected for the second and third quarters of 2001.

First Quarter 2001 Launch Successes vs. Failures

(January 2001 – March 2001)

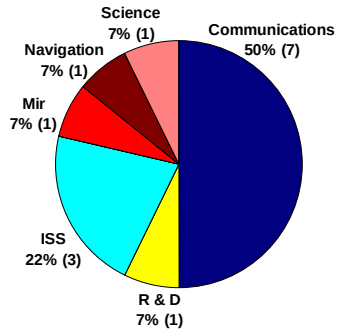
Figure 13: Total Launch Successes vs. Failures

Total = 12

Figure 13 shows successful vs. failed orbital launch events that occurred in the first quarter of 2001.

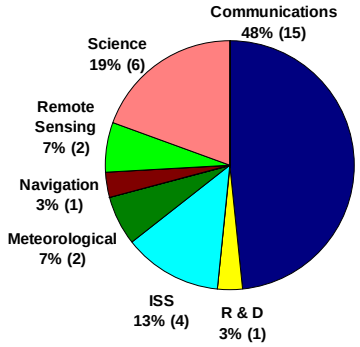
Payload Use
(January 2001 – September 2001)

Figure 14: First Quarter 2001 Payload Use



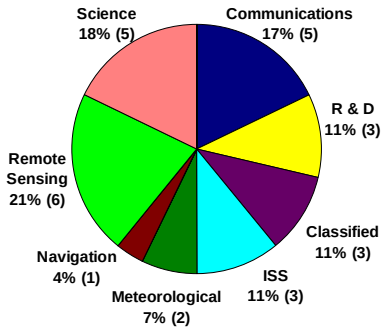
Total = 14

Figure 15: Second Quarter 2001 Projected Payload Use



Total = 31

Figure 16: Third Quarter 2001 Projected Payload Use

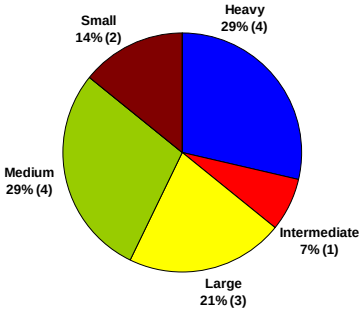


Total = 28

Figures 14-16 show total payload use (commercial and government), actual for the first quarter of 2001 and projected for the second and third quarters of 2001. The total number of payloads launched does not equal the total number of launches due to multi-manifesting, i.e., the launching of more than one payload by a single launch vehicle.

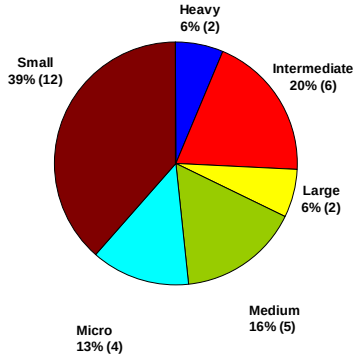
Payload Mass Class
(January 2001 – September 2001)

Figure 17: First Quarter 2001 Payload Mass Class



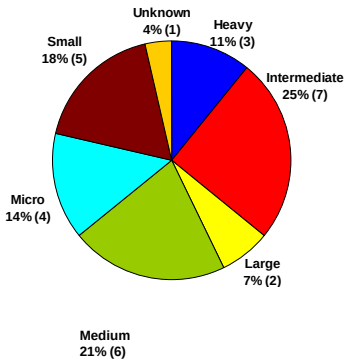
Total = 14

Figure 18: Second Quarter 2001 Projected Payload Mass Class



Total = 31

Figure 19: Third Quarter 2001 Projected Payload Mass Class

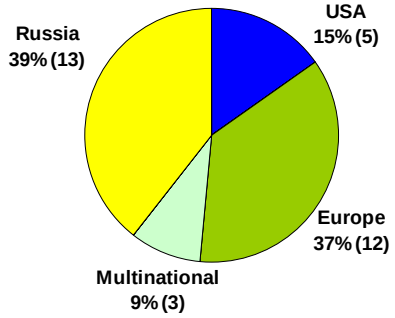


Total = 28

Figures 17-19 show total payloads by mass class (commercial and government), actual for the first quarter of 2001 and projected for the second and third quarters of 2001. The total number of payloads launched does not equal the total number of launches due to multi-manifesting, i.e., the launching of more than one payload by a single launch vehicle. Payload mass classes are defined as Micro: 0 to 91 kg (0 to 200 lbs.); Small: 92 to 907 kg (201 to 2,000 lbs.); Medium: 908 to 2,268 kg (2,001 to 5,000 lbs.); Intermediate: 2,269 to 4,536 kg (5,001 to 10,000 lbs.); Large: 4,537 to 9,072 kg (10,001 to 20,000 lbs.); and Heavy: over 9,073 kg (20,000 lbs.).

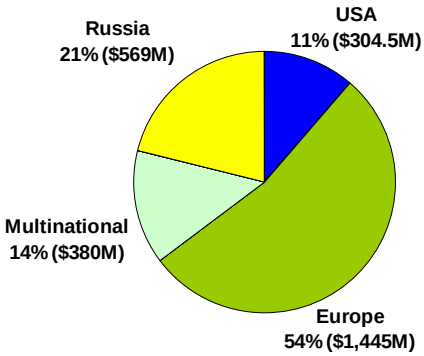
Commercial Launch Trends

Figure 20: Commercial Launch Events, Last 12 Months



Total = 33

Figure 21: Commercial Launch Revenue, Last 12 Months



Total = $2,698.5M

Figure 20 shows commercial launch events for the period April 2000 to March 2001 by country.

Figure 21 shows commercial launch revenue for the period April 2000 to March 2001 by country.

Figure 22: Commercial Launch Events by Country, Last Five Years

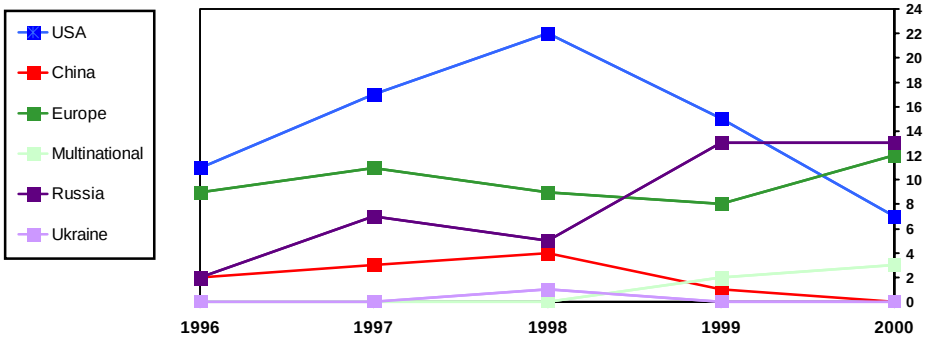


Figure 22 shows commercial launch events by country for the last five full years.

Figure 23: Commercial Launch Revenue (in $ million) by Country, Last Five Years

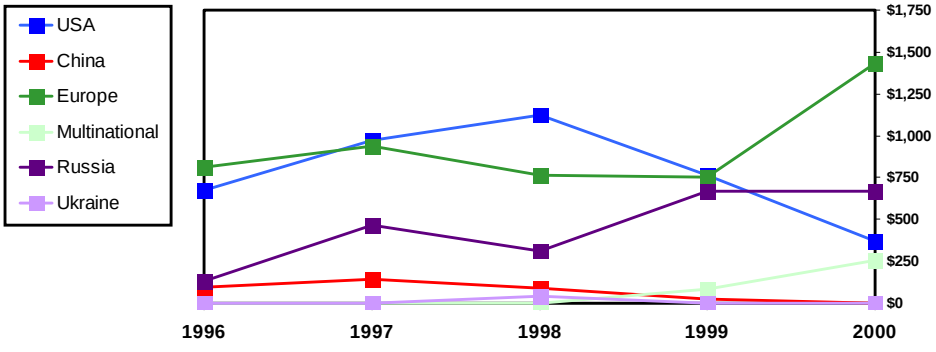


Figure 23 shows commercial launch revenue by country for the last five full years.

First Quarter 2001 Orbital Launch Events

Date		Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price	L	M
1/10/01	√	Ariane 44P	Kourou	*	Eurasiasat 1	Eurasiasat SM	Communications	$80-100M	S	S
1/10/01		Long March 2F	Jiuquan		Shenzhou 2	China NSA	Development	N/A	S	S
1/24/01		Soyuz	Baikonur		Progress M1-5	RKK Energia	Mir Supply	$35-40M	S	S
1/30/01		Delta 2 7925	CCAFS		Navstar GPS 2R- 7	DoD	Navigation	$50-60M	S	S
2/7/01	√	Ariane 44L	Kourou		Skynet 4F	British MoD	Communications	$100-125M	S	S
					Sicral 1	Italian MoD	Communications			
2/7/01		Shuttle Atlantis	KSC		STS 98	NASA	Crewed	$300M	S	S
					ISS 5A	NASA	ISS			
2/20/01	√	START 1	Svobodny		Odin	Swedish National Space Board	Scientific	$5-10M	S	S
2/26/01		Soyuz	Baikonur		Progress ISS 3P	RKK Energia	ISS	$35-40M	S	S
2/27/01		Titan 4B/Centaur	CCAFS		Milstar II-F2	DoD/USAF	Communications	$350-450M	S	S
3/8/01	√	Ariane 5 G	Kourou	*	EUROBIRD	Eutelsat	Communications	$150-180M	S	S
					BSat 2A	BSAT	Communications			
3/8/01		Shuttle Discovery	KSC		STS 102	NASA	Crewed	$300M	S	S
					ISS 5A.1	NASA	ISS			
3/18/01	√ +	Zenit 3SL	Sea Launch Platform	*	XM Rock	XM Radio	Communications	$75-95M	S	S

√ Denotes commercial launch, defined as a launch that is internationally competed or FAA licensed.

+ Denotes FAA-licensed launch.

* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.

L and M refer to the outcome of the **L**aunch and **M**ission: S = success, P = partial success, F = failure

Second Quarter 2001 Projected Orbital Launch Events

Date		Vehicle	Site		Payload or Misson	Operator	Use	Vehicle Price
4/6/01		Proton M	Baikonur	*	Ekran M16	Russia/CIS PTT	Communications	$75-95M
4/7/01		Delta 2 7925	CCAFS		2001 Mars Odyssey	NASA	Scientific	$50-60M
4/17/01	√	Shtil (Suborbital)	Barents Sea		Cosmos 1 Deployment Test	The Planetary Society	Development	$0.1-0.3M
4/19/01		Shuttle Endeavour	KSC		ISS 6A	NASA	ISS	$300M
					STS 100	NASA	Crewed	
4/28/01		Soyuz	Baikonur		Soyuz ISS 2S	NASA	ISS	$35-40M
4/XX/01		Shtil	Barents Sea		Kompass	Russia	Scientific	$0.1-0.3M
4/XX/01		Cosmos	Plesetsk		Kosmos TBA 1	Russia	Navigation	$12-14M
5/1/01	√	Proton (SL-12)	Baikonur	*	PAS 10	Pan American Satellite Corp.	Communications	$75-95M
5/7/01	√ +	Zenit 3SL	Sea Launch Platform	*	XM Roll	XM Satellite Radio, Inc.	Communications	$75-95M
5/17/01		Delta 2 7925	CCAFS		GeoLite	NRO	Communications	$50-60M
5/20/01		Soyuz	Baikonur		Progress ISS 4P	RKK Energia	ISS	$35-40M
	√	Long March 3A	Xichang	*	Atlantic Bird 1	Eutelsat	Communications	$45-55M
6/4/01		Pegasus XL	CCAFS		HESSI	NASA	Scientific	$12-15M
6/27/01	√ +	Taurus 1	VAFB	*	OrbView 4	Orbital Imaging Corp. (Orbimage)	Remote Sensing	$18-20M
					QuikTOMS	Orbital Sciences Corp.	Scientific	
6/30/01		Delta 2 7425	CCAFS		MAP	NASA	Scientific	$45-55M
6/XX/01	√	Ariane 44L	Kourou	*	Intelsat 9 F1	Intelsat	Communications	$100-125M
6/XX/01	√	Ariane 5 G	Kourou	*	Atlantic Bird 2	Eutelsat	Communications	$150-180M
				*	BSat 2B	Broadcasting Satellite System Corp. (BSAT)	Communications	
6/XX/01		Cyclone 3	Plesetsk	*	Gonets D1 7	Smolsat (NPO PM, et. al)	Communications	$45-55M
				*	Gonets D1 8	Smolsat (NPO PM, et. al)	Communications	
				*	Gonets D1 9	Smolsat (NPO PM, et. al)	Communications	
					Kosmos TBA 2	Russian MoD	Communications	
					Kosmos TBA 3	Russian MoD	Communications	
					Kosmos TBA 4	Russian MoD	Communications	
6/XX/01	√	Proton (SL-12)	Baikonur	*	Astra 2C	Societe Europeenne des Satellites (SES)	Communications	$75-95M
6/XX/01		Soyuz	Baikonur		ISS 4R	RKA	ISS	$35-40M
6/XX/01		Titan 2	VAFB		DMSP 5D-3-F16	DoD	Meteorological	$30-40M
6/XX/01		Zenit 2	Baikonur		Meteor 3M-1	Russia	Meteorological	$35-50M
					Maroc-Tubsat	TBA	Development	
					Reflector	USAF	Scientific	
					Badr 2	SUPARCO	Remote Sensing	

√ Denotes commercial launch, defined as a launch that is internationally competed or FAA licensed.

+ Denotes FAA-licensed launch.

* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.

Third Quarter 2001 Projected Orbital Launch Events

Date		Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price
7/4/01		Soyuz	Baikonur		Progress ISS 5P	RKK Energia	ISS	$30-40M
7/12/01		Shuttle Discovery	KSC		ISS 7A.1	NASA	ISS	$300M
					STS 105	NASA	Crewed	$300M
7/12/01		Atlas 2AS	CCAFS		GOES M	NOAA	Meteorological	$90-105M
7/22/01		H 2A 202	Tanegashima		Vehicle Evaluation	NASDA	Development	$75-95M
7/30/01		Delta 2 7326	CCAFS		Genesis	NASA/ JPL	Scientific	$45-55M
7/31/01		Atlas 2AS	VAFB		NRO A1	NRO	Classified	$90-105M
7/XX/01		Long March 4B	Taiyuan		FY 1D	China Meteorological	Meterological	$25-35M
					Haiyang 1	China Meteorological Administration	Remote Sensing	$25-35M
7/XX/01	√	Ariane 44L	Kourou	*	Intelsat 9 F2	Intelsat	Communications	$100-125M
7/XX/01		PSLV	Sriharikota		TES	India	Remote Sensing	$15-25M
					PROBA	European Space Agency (ESA)	Scientific	$15-25M
8/2/01		Titan 4B/IUS	CCAFS		DSP 21	DoD	Classified	$350-450M
8/10/01		Delta 2 7920	VAFB		TIMED	NASA	Scientific	$50-60M
					Jason 1	NASA/CNES	Remote Sensing	
8/16/01		Delta 2 7925	CCAFS		Navstar GPS 2R- 8	DoD	Navigation	$50-60M
					ProSEDS 2001A	NASA	Development	
8/31/01		Athena 1	Kodiak Launch Complex		PICOSAT 1	USAF	Development	$16-17M
					Starshine 3	NASA	Scientific	
					SAPPHIRE	USA	Scientific	
9/20/01		Delta 2 7920	VAFB		Aqua	NASA	Remote Sensing	$50-60M
9/25/01		Titan 4	VAFB		NRO T3	NRO	Classified	$350-450M
9/XX/01		Soyuz	Baikonur		Progress ISS 6P	RKK Energia	ISS	$30-40M
9/XX/01		Ariane 5 G	Kourou		Envisat 1	European Space Agency (ESA)	Remote Sensing	$150-180M
3rd Quarter	√	Zenit 3SL	Sea Launch Platform	*	Galaxy 3C	Pan American Satellite Corp.	Communications	$75-95M
3rd Quarter	√	Proton (SL-12)	Baikonur	*	Intelsat 9 F3	Intelsat	Communications	$75-95M
3rd Quarter	√	Ariane 5 G	Kourou	*	AmeriStar 1	WorldSpace, Inc.	Communications	$150-180M
3rd Quarter	√	+ Pegasus XL	VAFB	*	OrbView 3	Orbital Imaging Corp. (Orbimage)	Remote Sensing	$12-15M
3rd Quarter	√	Ariane 5 G	Kourou	*	WildBlue 1	KaSTAR	Communications	$150-180M

√ Denotes commercial launch, defined as a launch that is internationally competed or FAA licensed.

+ Denotes FAA-licensed launch.

* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.

Selecting a Launch Vehicle: What Factors Do Commercial Satellite Customers Consider?

Introduction

Commercial satellite owners and operators clearly have the luxury of choice when it comes to selecting a launch vehicle to transport their assets into orbit. Whether the final destination is low-earth orbit (LEO), geostationary orbit (GEO), or somewhere in between, the world supply of launchers able to deliver satellites to orbit has exceeded demand each year for more than a decade. While established launch companies in the United States, France, Russia, and China work to introduce increasingly capable versions of their rockets, new players such as Japan, India, and Israel continue to make headway in the development of their own launchers with the hope of offering commercial services.

While the wide assortment of launch vehicles available today affords satellite owners and operators numerous deployment options, this situation has created an extremely competitive business environment for launch companies worldwide. Indeed, the competitive market has had a major impact on U.S. share of commercial launches. Commanding about 50 percent of commercial launches during the mid-1990s, U.S. launch providers' share of the market now hovers around the 20 percent level (Figure 1).

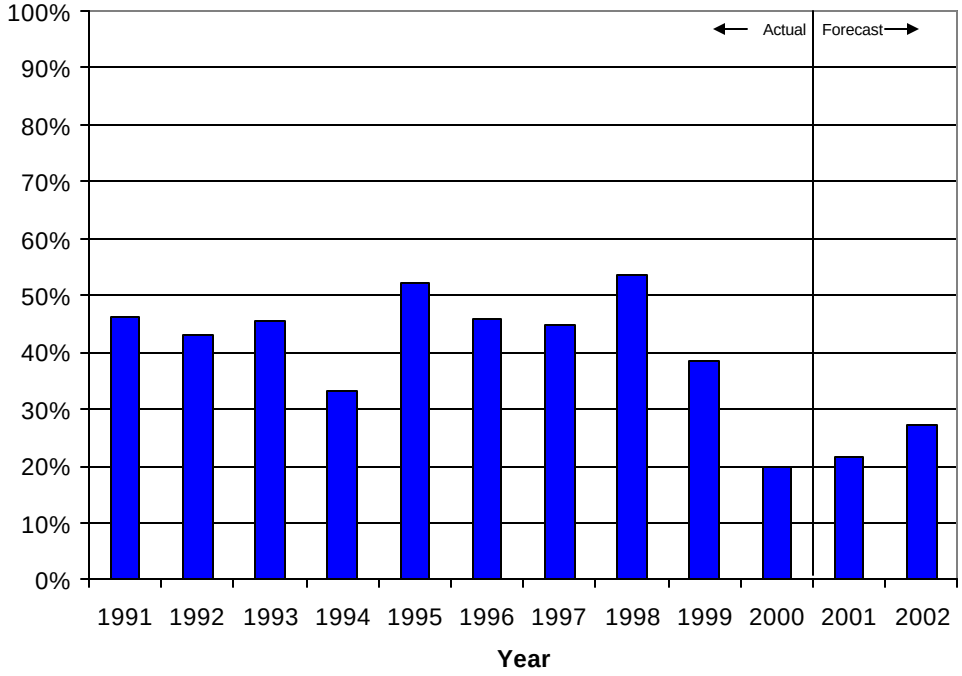


Figure 1. U.S. Share of Worldwide Commercial Launches

U.S. vehicles carried into orbit 38 percent of U.S. commercial satellites and just 8 percent of foreign commercial satellites that rode on commercial launches in the year 2000.[1,2]

How can U.S. launch companies capture a greater share of the worldwide commercial satellite launch market in the upcoming years? The answer requires a solid understanding of the criteria commercial satellite owners and operators value and follow most often when evaluating launch vehicle choices. This report considers a number of those selection factors, as offered by a variety of commercial companies owning and operating satellites.

Sources and Nature of Data

The data on commercial satellite owners' and operators' launch vehicle selection criteria used to compile this report came from two primary sources. One source was the results of a customer satisfaction survey conducted by a U.S. launch vehicle service provider. This survey reported the responses of 62 launch customers, including NASA, the U.S. Air Force, and domestic and international commercial satellite owners and operators. Several questions focused on factors customers considered most important in evaluating launch vehicles. In addition, the FAA completed eight interviews on this issue with commercial communications satellite owners and operators. The companies interviewed represented a variety of demographics and interests: some were domestic while others were foreign, some were interested in GEO satellites while others focused on LEO constellations, some companies were well-established while others had recently started up, and most had used vehicles from more than one country. An additional interview was conducted with the National Reconnaissance Office (NRO) for comparison to the commercial respondents.

Launch Vehicle Selection Criteria

This section discusses the factors launch vehicle customers consider in evaluating vehicles, based on the responses given in the launch customer satisfaction survey as well as the FAA-conducted interviews. The factors are discussed here in an order that roughly reflects the frequency with which they were cited, starting with those mentioned most often.

Reliability of Launcher

The NRO and six of the eight companies interviewed by the FAA said that a launcher's reliability—its state of having low risk of technical failure based on a history of prior mission success—is one of the most

[1] Commercial launches are defined here as those launches licensed by the FAA, internationally competed, or privately financed.

[2] These percentages omit launches by Sea Launch, a joint venture of the United States, Russia, Ukraine, and Norway.

important factors they consider in evaluating a launch vehicle for use. According to the launch company customer satisfaction survey results analyzed, both U.S. and foreign companies consider reliability to be one of the three most important factors, while reliability by far tops NASA's and the Air Force's lists of selection criteria. Customers sending payloads to both GEO and LEO agree on reliability's significance.

According to several of the commercial entities interviewed, launcher reliability is critical because reliable launch vehicles increase the chances that payloads will reach orbit. In the case of a new satellite venture, a launch failure could substantially delay the time it takes a company to get its satellite(s) deployed and thus enter the market. Business ventures that must replace satellites to operate efficiently or effectively and those that need to deploy satellites to expand business also sense the import of launcher reliability. The NRO explained the criticality of launcher reliability to its goal of 100 percent mission success. In these cases, technical conservatism typically prevails over other factors. In contrast, government or private technology demonstration missions whose failures would not significantly affect a program or business may be more inclined to weigh reliability and costs of launchers more equally.

Prospective satellite customers thus tend to place great emphasis on whether a launch vehicle is "proven"—that is, whether it has a positive record of launch success. One commercial interviewee said that his company's minimum threshold for launch success is 90 percent. Companies also consider the success history of launcher components; some indicated their willingness to fly payloads on new vehicle models using components with strong records of success. The NRO indicated that it would consider flying payloads on an emerging launch system depending on the concept's viability, credibility, and demonstration and risk reduction data. A launch company's longevity in business contributes to at least one satellite owner's sense of a launcher's reliability.

Most companies interviewed said that they are willing to pay more for a high reliability vehicle. Of those, most indicated that they would pay a little, but not a lot more, for reliability; one U.S. company that has bought launchers from several countries expressed its willingness to "pay a premium" for vehicle reliability. Another company warned, however, that it would not purchase the most reliable of rockets if the cost were prohibitive. Several brought up the fact that choosing a vehicle with high reliability translates into reduced insurance rates for companies who choose them.

Launcher Performance and Suitability

Domestic commercial and government respondents to the launch customer survey, the NRO, and seven of the eight commercial interviewees indicated that a

vehicle's performance and suitability to carry the satellite(s) onboard is one of the most important factors in their evaluations of launchers. International respondents to the launch company's survey ranked the combination of performance and suitability fourth in importance.

Performance of a vehicle comprises its capability of lifting a certain payload mass to a desired orbit and its ability to insert its payload(s) into the proper orbit. Launching a satellite into space but failing to deliver it to the correct orbit could effectively render it useless. Suitability refers to both the vehicle's compatibility with various types of payloads and its payload margins. Payload margins equate to "wiggle room" for satellites: a vehicle with wide margins is often desirable because more changes can then be made to a satellite (e.g., it can grow in size or weight) without affecting the satellite's ability to ride on that vehicle.

Both GEO and LEO customers are concerned about the payload weight a vehicle can carry. GEO satellite owners seek heavy-lift vehicles because their satellites are becoming increasingly heavy and need to travel into a high orbit. LEO constellation ventures tend to seek launch vehicles that can accommodate and deploy several satellites into orbit at once. One interviewee explained that paying for a large vehicle could offset the costs of having to miniaturize satellite components to make their satellites fit on smaller vehicles.

Launcher Price

The price of a launch vehicle is one of the top factors in launcher selection for all of the survey respondents and interviewees. This metric, however, ranked highest for international commercial entities and tied with reliability and performance for domestic commercial groups, whereas it fell beneath reliability and performance for the government clients.

Constituting roughly 25 percent or more of a satellite project's total cost, launch price, including insurance, is a major concern of satellite companies and the government for good reason. Virtually all companies interviewed stressed their attraction to launch service providers offering competitive prices. Several expressed that a significant increase in launch prices would have an impact on their rate of expansion or replacement of satellites and could potentially put them out of business.

Some of the companies interviewed explained that their assessment of launcher price is folded into a larger measure called "present value," which also accounts for the payment schedule a launcher is willing to offer. Small and start-up companies are particularly interested in a flexible payment schedule that allows them to defer expenses as much as possible. Even more established companies view vendor financing as selling points as long as financing rates are acceptable. One commercial interviewee said his company prefers to make payments as the launch provider achieved

various milestones of their contract. A few satellite owners also indicated that launch providers' willingness to invest in their satellite systems factors into their decisions.

Availability and Schedule

Only half of the companies interviewed expressed the importance of choosing a launcher whose availability is compatible with their desired launch schedules. Some of these respondents stressed the importance of finding a launch provider or providers that could meet the special requirements of particular satellite systems; for example, LEO constellations require several launches within a short period of time. The selection of providers for these satellites' deployment often comes down to which launch vehicle(s) can launch several times per year or can meet a demanding timetable; in many cases, this means a satellite customer must end up relying on several different providers. One LEO system owner said that securing a niche in the market and then developing an image as a good and reliable communications service provider is dependent on launching satellites in a short period of time and without delay. A GEO satellite system owner said that time until launch availability is especially relevant for those needing to replace satellites destroyed in a launch failure. Some companies said that another consideration is that different vehicles have different turnaround times and abilities to respond to customers' requests to change a launch date.

One U.S. satellite company interviewed indicated that it was wary of scheduling launches with providers who sometimes bump commercial launches to give priority to government needs. Another interviewee favors vehicles that use mobile launch platforms because they offer relatively great availability and a high range manifest and because vehicle configurations can be changed fairly easily. Several agreed that in spite of the potential cost savings, they prefer to schedule satellite launches independently rather than have them partnered with other spacecraft launching on the same vehicle because such a partnership could result in less control over launch schedule.

U.S. Technology Transfer Safeguards

In concurrence with the responses of international respondents to the launch customer satisfaction survey analyzed, every foreign-based satellite owner that the FAA interviewed expressed that U.S. technology transfer safeguards are a major factor in their evaluations of U.S. launch companies. Before a U.S. launch company can discuss the technical details of a business deal with a foreign satellite customer, it must obtain a marketing license from the State Department. The launch company must get another government license, a Technical Assistance Agreement, to physically work with a foreign company on matters such as integrating the company's payload onto the vehicle.

These licenses can take several months to procure. As a result, working with a U.S. launch provider presents many difficulties for an international satellite owner. These firms must contemplate whether the U.S. launch provider will be able to secure the appropriate licenses to work with their company (a situation that can vary based on international political conditions) and, if so, whether the licensing process will affect their ability to launch when desired. Time is an essential element for companies to fulfill their business plans.

U.S. launch providers must also obtain U.S. government-issued licenses to supply insurance companies, often located abroad, with technical information to determine their rates. This requirement often further delays business dealings between the launch provider and payload customer.

Licensing issues are also a major consideration of U.S. satellite owners in evaluating foreign launch providers. One U.S. satellite operator that uses U.S.-built satellites indicated that current U.S. satellite export controls have made doing business with even those launch providers based in countries with good U.S. relations very difficult. The delays these controls cause, however, have not stopped several companies from engaging in the export licensing process because they believe that a foreign launcher provides the best available value. Export controls also make procuring U.S.-built satellites a challenge for foreign satellite companies.

Customer Relations and Partnerships

Most of the companies interviewed by the FAA said that the quality of the relationship they established with a launch service provider also has an influence on their vehicle selections. Most agreed that they value providers who convey professionalism, are sensitive to their needs, and respond to their needs quickly. Also critical is a good working relationship during both the negotiations and procurement stages, especially when problems arose. The ease with which companies could communicate with launch providers over national and cultural divides is also important. According to one respondent, good rapport between the satellite's manufacturer and potential launch providers is also desirable.

Some satellite companies stressed their interest in developing solid, long-term relationships and partnerships with launch providers. According to one interviewee, developing partnerships with just a few providers is preferable to turning to newcomers: repeat and consistent business can enable both the satellite operator and launch provider to offer each other mutual benefits. Such partnerships can allow the partners to offer each other preferred prices for products and services (Alenia Spazio and Boeing recently created a partnership in which Alenia Spazio would provide fuel tanks for the Delta 2's upper stage in

exchange for Delta launches at discounted prices for its satellite customers). In addition, using the same launcher repeatedly can allow a satellite owner to reap the benefits of bulk buying. The potential for engaging in future collaborative work with the launch company or its parent corporation is often a major consideration for satellite owners as well.

Incidentally, some of the interviewees that agreed on the value of partnerships with launch providers indicated that attractive prices or other enticing factors offered by new launch providers might persuade them to consider options beyond the launch providers they patronized most often.

Terms and Conditions

A few interviewees indicated that the terms and conditions to which a launch provider is willing to agree in a contract is another factor in their selection process. Terms and conditions include issues such as payment schedule, payload integration and launch schedule, liability, and contract termination. The issue of liability is particularly important to those who commented on terms and conditions: these satellite owners made clear that they expect a launch company to share with them the financial risk associated with a launch failure. Specifically, these companies said they expect a launch company to offer a replacement launch at little or no cost, share in the loss of revenue due to their satellites' inability to reach orbit, and/or shoulder the cost of higher insurance premiums on future launches.

Conclusion

While the particular requirements and resources of satellite owners and operators ultimately determine their launch vehicle selections, the above discussion reveals that most commercial operators and at least one government operator consider many common factors, with vehicle reliability, performance and suitability, and price topping the list. The majority of the commercial satellite companies the FAA interviewed and that responded to the launch company customer survey have used multiple types of launchers to deploy their satellites, indicating that launch procurers rarely confine themselves to a single launcher but prefer to diversify their choices. In doing so, a company makes decisions based on not one but many factors, evaluating them and making trade-offs to achieve an optimal combination of technical, programmatic, financial, and contractual factors.