Featuring the launch results from the 4th quarter 2000 and forecasts for the 1st and 2nd quarter 2001

Quarterly Report Topic:

The Anatomy of a Launch Vehicle

Commercial Space Transportation

QUARTERLY LAUNCH REPORT

First 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 First Quarter 2001 Quarterly Launch Report features launch results from the fourth quarter of 2000 (October-December 2000) and launch forecasts for the first quarter of 2001 (January-March 2001) and the second quarter of 2001 (April-June 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

Highlights from Fourth Quarter 2000	2
Fourth Quarter 2000 Launch Events Summary	3
First Quarter 2001 Projected Launch Events Summary	4
Second Quarter 2001 Projected Launch Events Summary	5
Historical Commercial Launch Trends	6
Quarterly Report Topic: The Anatomy of a Launch Vehicle	QRT-1
Appendix A: Fourth Quarter Launch Events	A-1
Appendix B: First Quarter Projected Launch Events	B-1
Appendix C: Second Quarter Projected Launch Events	C-1

Cover: Pacific Ocean, October 21, 2000 - A Sea Launch Zenit 3SL lifts off from the Odyssey launch platform carrying the Boeing-built Thuraya 1 satellite, which it successfully placed into geosynchronous transfer orbit. Courtesy of Sea Launch.

Highlights from Fourth Quarter 2000

Russian Launch Quotas Expire

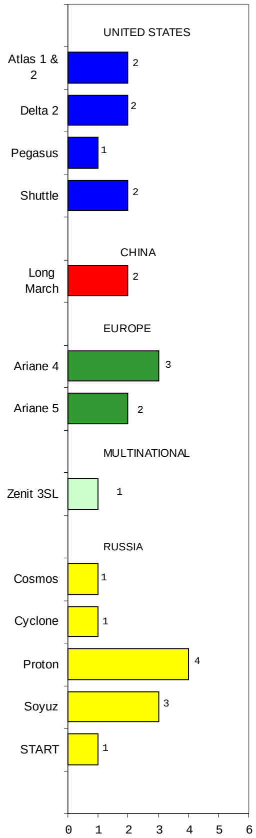
During the fourth quarter of 2000, the U.S. government allowed quotas limiting Russian commercial launches of Western satellites to expire. During the 1993 – 2000 period such launches were limited by the U.S.-Russian Launch Trade Agreement. This agreement was designed to guide the entry of formerly non-market companies into the Western launch market. In 1993 the quota allowed for the launch of nine Western geosynchronous satellites; the quota increased to 16 in 1996 and to 20 in 1999. Russian launch providers will now be able to perform as many launches as they are able to sell.

Chinese Satellite Export Licensing Resumes

Another significant event in the fourth quarter of 2000 was the decision by the U.S. State Department to resume processing export licenses for U.S. satellites to be launched on Chinese rockets. Up to 20 such launches are allowed through 2001 under an agreement between the U.S. and Chinese governments. The processing of such export licenses had been halted pending the resolution of technology transfer issues that had concerned the U.S. government.

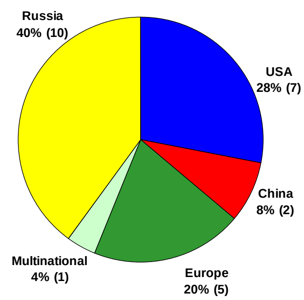
Fourth Quarter 2000 Launch Events Summary
(October – December 2000)

Figure 1: Total Launch Vehicle Use



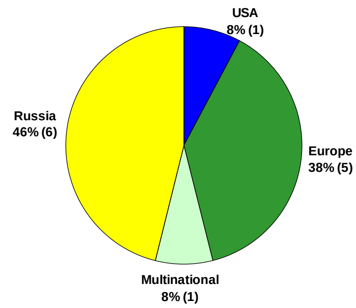
Total = 25

Figure 2: Total Launch Events by Country



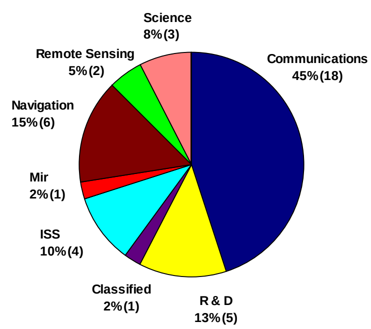
Total = 25

Figure 3: Commercial Launch Events by Country



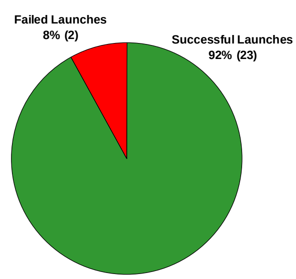
Total = 13

Figure 4: Total Payload Use Summary



Total = 40

Figure 5: Total Launch Successes vs. Failures



Total = 25

Figure 1 shows the total number of launches (commercial and government) of each launch vehicle in the fourth quarter of 2000. The 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.

Figure 2 shows all orbital launch events that occurred in the fourth quarter of 2000 by country.

Figure 3 shows all *commercial* orbital launch events that occurred in the fourth quarter of 2000 by country. The definition of "commercial" can be found on Page 1.

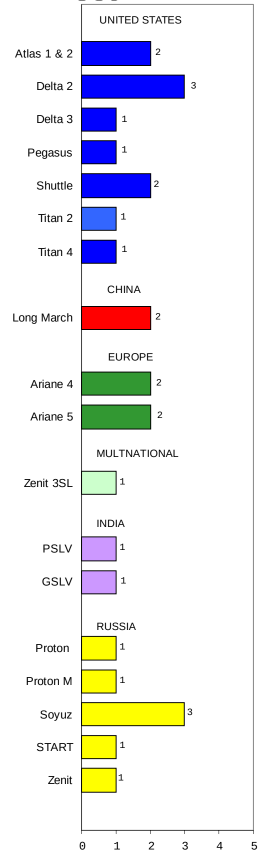
Figure 4 shows the payloads launched into orbit in the fourth quarter of 2000 by the mission of the payload. The total number of payloads launched does not equal the total number of launches due to multi-manifesting, i.e., the launching of more than one payload by a single launch vehicle.

Figure 5 shows launch outcome for all orbital launch events that occurred in the fourth quarter of 2000.

First Quarter 2001 Projected Launch Events Summary

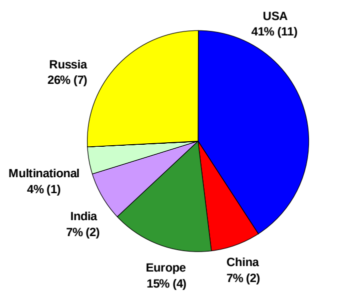
(January – March 2001)

Figure 6: Total Projected Launch Vehicle Use



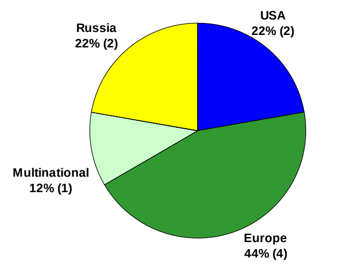
Total = 27

Figure 7: Total Projected Launch Events by Country



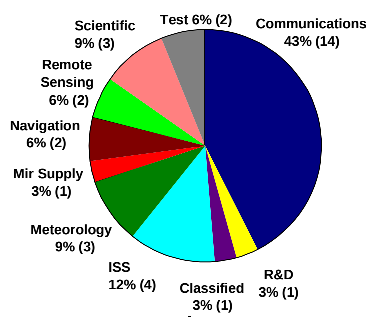
Total = 27

Figure 8: Projected Commercial Launch Events by Country



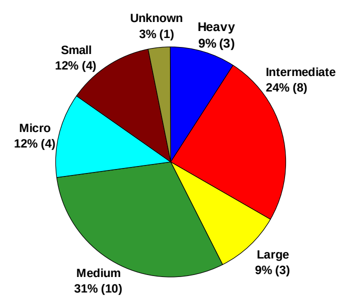
Total = 9

Figure 9: Total Projected Payload Use Summary



Total = 33

Figure 10: Total Projected Payload Mass Class Summary



Total = 33

Figure 6 shows the total number of projected launches (commercial and government) of each launch vehicle in the first quarter of 2001.

Figure 7 shows all orbital launch events projected to occur in the first quarter of 2001 by country.

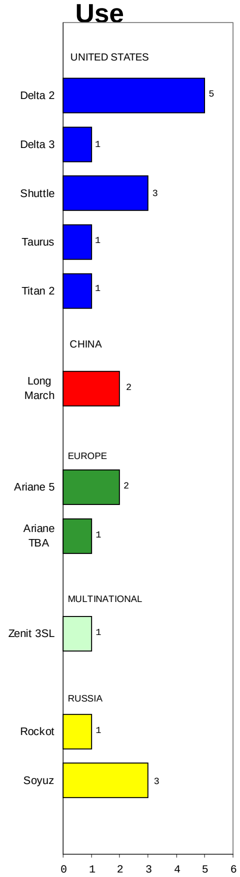
Figure 8 shows all *commercial* orbital launch events projected to occur in the first quarter of 2001 by country.

Figure 9 shows the payloads projected to launch into orbit in the first quarter of 2001 by the mission of the payload. 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.

Figure 10 shows payloads projected to launch in the second quarter of 2001 by mass class: Micro (0 to 200 lbs.), Small (201 to 2,000 lbs.), Medium (2,001 to 5,000 lbs.), Intermediate (5,001 lbs. to 10,000 lbs.), Large (10,001 lbs. to 20,000 lbs.), and Heavy (over 20,000 lbs.).

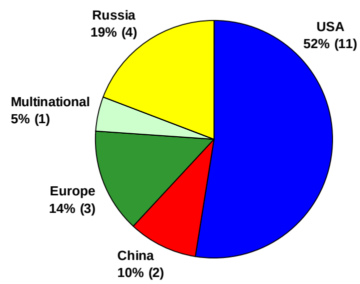
Second Quarter 2001 Projected Launch Events Summary
(April – June 2001)

Figure 11: Total Projected Launch Vehicle Use



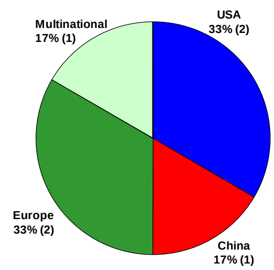
Total = 21

Figure 12: Total Projected Launch Events by Country



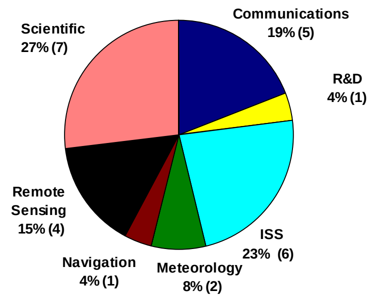
Total = 21

Figure 13: Projected Commercial Launch Events by Country



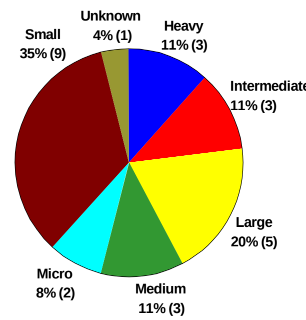
Total = 6

Figure 14: Total Projected Payload Use Summary



Total = 26

Figure 15: Total Projected Payload Mass Class Summary



Total = 26

Figure 11 shows the total number of projected launches (commercial and government) of each launch vehicle in the second quarter of 2001.

Figure 12 shows all orbital launch events projected to occur in the second quarter of 2001 by country.

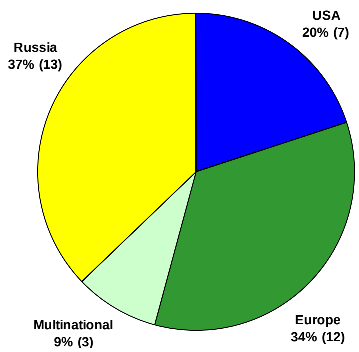
Figure 13 shows all *commercial* orbital launch events projected to occur in the second quarter of 2001 by country.

Figure 14 shows the payloads projected to launch into orbit in the second quarter of 2001 by the mission of the payload. 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.

Figure 15 shows payloads projected to launch in the second quarter of 2001 by mass class: Micro (0 to 200 lbs.), Small (201 to 2,000 lbs.), Medium (2,001 to 5,000 lbs.), Intermediate (5,001 lbs. to 10,000 lbs.), Large (10,001 lbs. to 20,000 lbs.), and Heavy (over 20,000 lbs.).

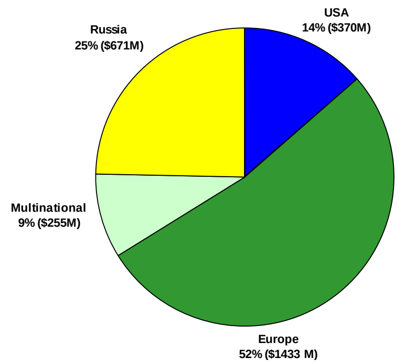
Historical Commercial Launch Trends

Figure 16: Commercial Launch Events, Last 12 Months



Total = 35

Figure 17: Commercial Launch Revenue, Last 12 Months



Total = $2,729M

Figure 18: Commercial Launches by Country, Last Five Years

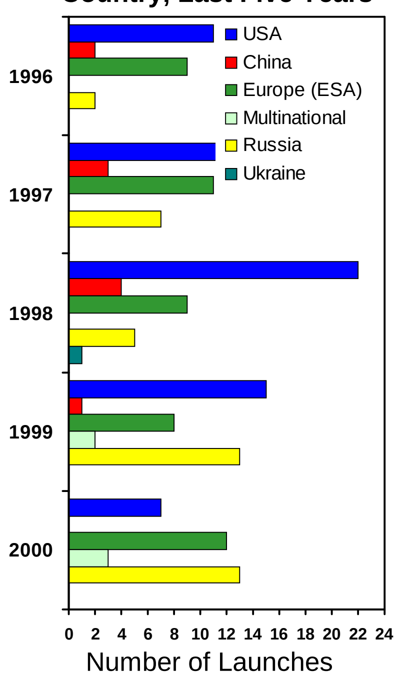


Figure 19: Commercial Launch Revenue by Country, Last Five Years

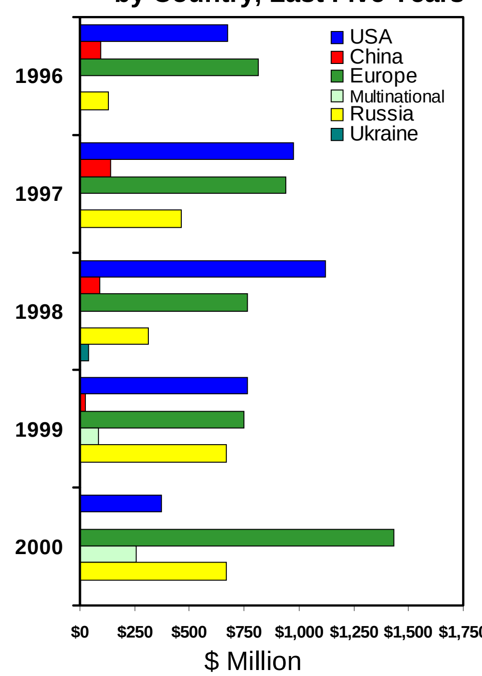


Figure 16 shows commercial launch events for the period January 2000 to December 2000 by country.

Figure 17 shows commercial launch revenue for the period January 2000 to December 2000 by country.

Figure 18 shows the trend in commercial launch events by country for the last five full years.

Figure 19 shows the trend in commercial launch revenue by country for the last five full years.

The Anatomy of a Launch Vehicle

INTRODUCTION

Conceptually, a rocket is a simple machine. Following Newton's law that every force has an equal and opposite reaction, a rocket pushes mass in one direction and moves in the other. However, a modern space launch vehicle is a finely tuned and very complex device. This report discusses the basic details of expendable launch vehicles and explores their function and operations.

LAUNCH VEHICLE ELEMENTS

A launch vehicle is composed of a number of separable sections called stages. Each stage contains fuel tankage, propulsion systems, and control systems. As each stage exhausts its fuel (the largest part of its mass), it is discarded to reduce the amount of mass that the next stage must propel. As each stage is discarded the total vehicle mass is reduced, also reducing the amount of energy required to lift the remaining vehicle mass.

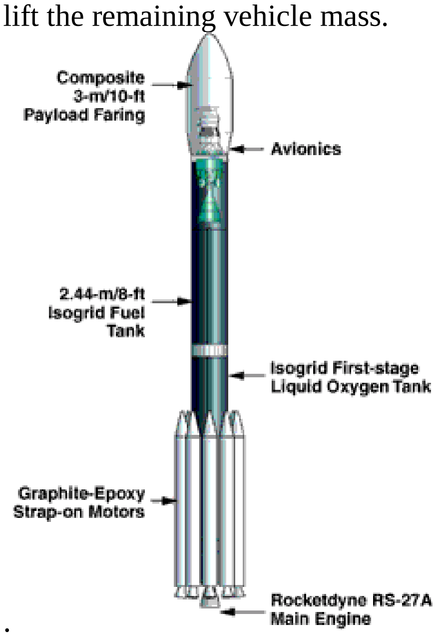


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Figure Q1. Delta 2 Launch Vehicle Structure

Each stage of a vehicle is made up of four basic subsystems. These are as follows:

- Propulsion
- Structure
- Tankage
- Guidance and control

In addition to the components that make up each vehicle stage, the vehicle as a whole must also have a payload fairing in which to carry its payload. See Figure Q1 for a representative breakdown of the Delta 2 launch vehicle.

Propulsion

There are two basic types of rocket fuel, solid and liquid. Both types of fuel are used on commercial launch vehicles, but generally solid fuel is used as a primary propellant on smaller vehicles such as the Taurus and Pegasus. In the case of larger launch vehicles, solid rocket motors are generally used in the form of strap-on boosters. Strap-on boosters are attached to the side of a launch vehicle and burn in parallel with the vehicle main engines. This allows the thrust of the vehicle's main engine to be supplemented by that of the strap-on booster without replacing the stage to be supplemented.

Solid rocket engines can not be throttled and often provide a more stressful launch than liquid fueled systems. However, they are more robust, cheaper to design and build, and can be stored for long periods. Liquid fueled systems offer better control and possibly more energy, but they are more fragile and cannot be held on the pad for as long a period as a solid fueled vehicle.

As mentioned above, strap-on boosters are used to increase the lift capacity of a launch vehicle without redesigning the entire vehicle system. The Ariane 4 family is an example of a single common core vehicle that can be used for different payload masses by the addition of varied types of strap-on. In the case of the Ariane 4, the strap-on boosters are either liquid or solid fueled (or both) according to the specific characteristics desired. In the case of the Titan 4, the strap-ons are solid fueled and only come in one version (the vehicle is tailored by the use of different upper stages).

The term "upper stage" is generally used to describe the final stage of a vehicle. The upper stage is the portion of the launch vehicle that places the vehicle's payload in a higher orbit than the vehicle itself reaches. Although it is not the only way to place a payload into a high orbit most launch vehicles place their payloads in a transfer orbit. From the transfer orbit the upper stage (or in some cases a small device attached to the payload called a kick motor) will take the payload to a final higher orbit.

Another function of an upper stage is to inject a number of payloads into differing orbits from the same launch vehicle. A restartable upper stage was used on the Delta 2 to place each of five different Iridium satellites into different orbits.

Upper stages are generally liquid fueled, but in some cases they use solid rocket motors. The Block-DM used on the Proton and the Centaur upper stage used on the Atlas and Titan 4 are liquid fueled (Block-DM uses liquid oxygen (LOX) and kerosene as a fuel and the Centaur uses LOX/liquid hydrogen (LH_2)). However, the Inertial Upper Stage (used with the Titan 4 and Space Shuttle) is a two-stage solid fueled design.

Structure

Structures vary, in some cases there is a separate skin and structure that surrounds the tanks and engines (Soyuz is an example) and in other cases, the skin of the stage is actually the outside of the fuel tanks (as in the Delta 2). In other cases (Atlas 2 and Atlas 3), only the pressure of the fuel on the skin/tank provides the strength that keeps the skin from buckling under the weight of the vehicle and payload.

Tankage

Launch vehicles using liquid fuel must use vessels and plumbing to contain and direct the liquid fuel. These vessels differ according to the fuel for which they are used. In a Titan 2, the fuel is hypergolic (it burns when it is mixed) and the vehicle hardware must resist its particularly corrosive effects. With cryogenic (super cold) fuels like LOX, or the much colder LH_2, the greatest design challenge is to deal with the effects of extreme cold on vehicle hardware. The easiest fuels to use are those at room temperature such as hydrogen peroxide and kerosene.

A common compromise between the demands for an energetic fuel and one that is easy to handle is the LOX/kerosene combination used by the first stages of the Delta 2 and Delta 3. However, even vehicles that use this combination in lower stages may use a fully cryogenically fueled upper stage.

Guidance and control

The final element of a launch vehicle is the guidance and control system. This is the seat of a launch vehicle's intelligence. The system tells the engines when to fire and for how long, initiates stage separation, can sense a fatal problem with the launch, and can initiate a self destruct sequence.

Guidance and control systems are the final resort when some other sub-system fails. A sufficiently capable guidance and control system may be able to compensate for a failed system elsewhere in the vehicle. An example of this occurred in the launch of two European Cluster II scientific satellites. When main engine cut-off occurred prematurely, the control system of the Soyuz launch vehicle's Fregat upper stage kept the upper stage engines firing for longer than planned to achieve the correct final orbit.

Table Q1. Atlas Component Suppliers*

Supplier	Component
BF Goodrich	Digital acquisition system.
Boeing Rocketdyne	MA-5/5A propulsion system.
CASA	Conical interstage adapters on the Atlas 5.
Contraves Space	Expanded payload fairing for the Atlas 5.
GenCorp Aerojet	Strap-on solid rocket boosters for Atlas 5.
Honeywell Space Systems	Inertial Navigation Unit (INU).
RD AMROSS	RD-180 propulsion system.
Saab Ericsson Space	Payload separation systems for Atlas 3 and Atlas 5.
Thiokol Propulsion	Castor 4A solid rocket boosters.
United Technologies Pratt & Whitney	RL10 rocket engines for the Centaur upper stage.

*Data from International Launch Services http://www.ilslaunch.com/atlas/majorsupplier/

LAUNCH VEHICLE MANUFACTURING

Launch vehicle manufacturers generally do not produce all components of an entire vehicle on their own. Instead they assemble parts made all over the country or even in other countries.

In the case of a large, new integrated production facility like the Boeing Delta 4 plant in Decatur, Alabama, major portions of the vehicle come from other Boeing facilities or different companies altogether. In the case of the Delta 4, the main engines are designed and built by Rocketdyne. Alliant Techsystems builds the rocket's strap-ons and L3 Communications Space & Navigation builds the Redundant Inertial Flight Control Assembly. In the cases of Lockheed Martin's Atlas 3 and Atlas 5, Khrunichev in Russia manufactures the engines. For a list of primary component suppliers for Atlas vehicles see Table Q1.

This is not a paradigm limited to launch vehicles. The same conditions hold true in the aviation, automotive, and electronics industries. For even the largest launch vehicle manufacturer, the role of integrating components from other manufacturers is at least as important as that of producing components in house.

VEHICLE CONFIGURATIONS AND VARIANTS

Different launch vehicle variants are optimized for different tasks. A vehicle designed to carry a payload into low earth orbit (LEO) is generally not a good choice to place a satellite into geosynchronous orbit (GEO). This is true because the energy requirement and profile required to put a payload into LEO differs greatly from that needed for GEO. Because of these considerations, launch vehicles are generally produced in a number of different variations and are optimized for different flight profiles. For a representative list of Delta 2 variants see Figure Q2.

In the case of the Proton launch vehicle, a version known in the West as the SL-13 is traditionally used to place large payloads into LEO. This is the vehicle that placed the major components of the Russian space station Mir into orbit. The version of the Proton used for launches to GEO is called the SL-12 and differs from the SL-13 by the addition of the Block-DM upper stage. Without this upper stage, the Proton cannot launch payloads to GEO.

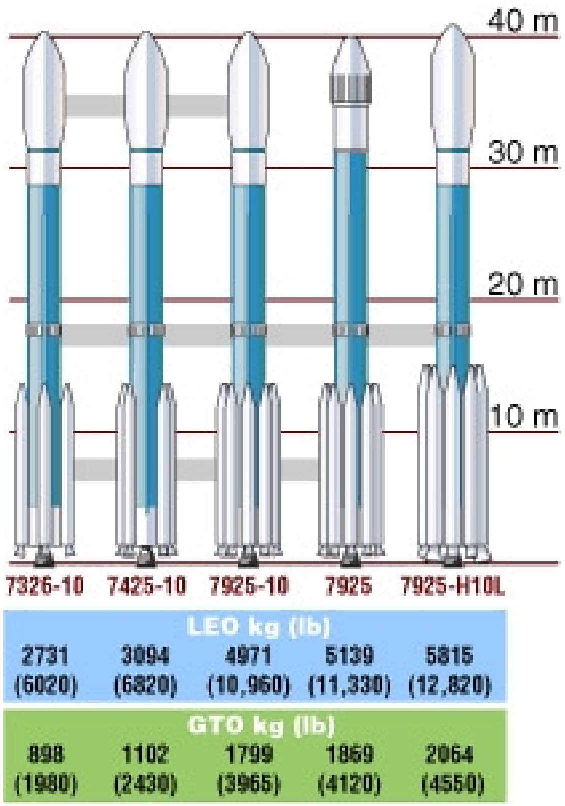

Figure Q2. Delta 2 Launch Vehicle Family

An exception to this rule is the case of multiple satellites being placed into different LEO orbits. In this case, the upper stage provides the energy to place each payload in a different orbit after the launch vehicle has reached LEO. This is why the GEO-capable SL-12 version of the Proton was used to launch seven Iridium satellites to LEO simultaneously while the SL-13 version is used for single large space station components going to a similar LEO location.

VEHICLE CAPACITY

Launch vehicles come in all sizes. The smallest may only be able to place a few hundred pounds into LEO, while the Apollo program's Saturn 5 could lift close to 300,000 pounds (136,363 kilograms) to that altitude and send an entire crewed spacecraft to the moon. The FAA divides launch vehicles into a series of different mass classes based on the mass of the payload that they can place in a LEO equatorial orbit. For a list of these definitions see Table Q2.

Table Q2. FAA Vehicle Classes

Suborbital	Not capable of putting any mass in orbit.
Small	Maximum mass capacity 5,000 lbs (2273 kg) to LEO.
Medium	Mass capacity is in the range of 5,001 (2274 kg) to 12,000 lbs (5454 kg) to LEO.
Intermediate	Mass capacity is in the range of 12,001 (5455 kg) to 25,000 lbs (11363 kg) to LEO.
Heavy	Mass capacity is greater than 25,000 lbs (11364 kg) to LEO.

An important factor in determining vehicle capacity is the location of the vehicle's launch site. Sites closer to the equator are more efficient for launches into GEO because they are aided by the Earth's rotational speed. This means that a vehicle launched from the equator could carry more to GEO than the same vehicle launched from a site closer to the Earth's poles.

Table Q3 shows how the capacity of a vehicle changes from differing launch sites. A vehicle with a capacity of 1000 pounds (455 kilograms.) at the equator would have its capacity reduced to the values in Table Q3 for the given launch site.

Table Q3. Vehicle Capacity from Different Launch Sites

Site	Payload to GEO (lbs.)	Payload to GEO (kg)
Equator	1000	455
CCAFS	883	401
Baikonur	731	332

Beyond the pure physics of launch efficiency, there are other factors that affect vehicle flight path. Vehicles are often launched on paths that are less than optimal because of safety and political concerns. Some launch paths are chosen to keep the vehicles over uninhabited areas so that a failure does not result in casualties or property damage. Even in the Pacific Ocean, Sea Launch has added “dog legs” to some of their flight paths to ensure that vehicles will avoid inhabited islands. In Japan, the Tanegashima launch site is only used for part of the year because of agreements with the local fishermen’s union. Perhaps the most extreme example of the effects of political considerations on launch paths is the policy at the Israeli launch site at Palmachim Air Force Base. In order to keep rockets from passing over their neighbors, the Israelis make all launches in a westward, or retrograde, direction, against the direction of the Earth’s rotation (the most inefficient direction possible).

Fourth Quarter 2000 Orbital Launch Events

Date		Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price	L	M
10/1/00	√	Proton (SL-12)	Baikonur	*	GE 1A	Americom Asia-Pacific	Communications	$75-95M	S	S
10/6/00	√	Ariane 42L	Kourou	*	NSat 110	JSAT/SCC	Communications	$80-100M	S	S
10/9/00	√ +	Pegasus XL	Kwajalein		HETE-2	MIT	Scientific	$12-15M	S	S
10/11/00		Shuttle Discovery	KSC		STS 92	NASA	Crewed	$300M	S	S
					ISS 3A	NASA	ISS			
10/13/00		Proton (SL-12)	Baikonur		Kosmos 2374	Russian MoD	Navigation	$75-95M	S	S
					Kosmos 2375	Russian MoD	Navigation			
					Kosmos 2376	Russian MoD	Navigation			
10/15/00	√	Soyuz	Baikonur	*	Progress M1-3	MirCorp	Mir	$35-40M	S	S
10/20/00		Atlas 2A	CCAFS		DSCS III 3-12	DoD	Communications	$75-85M	S	S
10/21/00	√	Proton (SL-12)	Baikonur	*	GE 6	GE Americom	Communications	$75-95M	S	S
10/21/00	√ +	Zenit 3SL	Sea Launch Platform	*	Thuraya 1	Thuraya	Communications	$75-95M	S	S
10/29/00	√	Ariane 44LP	Kourou	*	Europe Star 1	Europe Star	Communications	$90-110M	S	S
10/31/00		Soyuz	Baikonur		ISS 2R	NASA	ISS	$35-40M	S	S
10/31/00		Long March 3A	Xichang		Beidou 1A	China	Navigation	$45-55M	S	S
11/10/00		Delta 2 7925	CCAFS		Navstar GPS 2R- 6	DoD	Navigation	$50-60M	S	S
					ProSEDS	NASA	Development			
11/15/00	√	Ariane 5	Kourou	*	PAS 1R	PanAmSat	Communications	$150-180M	S	S
					STRV 1C	British MoD	Development			
					STRV 1D	British MoD	Development			
				*	AMSAT Phase 3-D	AMSAT	Communications		S	S
11/16/00		Soyuz	Baikonur		Progress M-ISS-02	RKK Energia	ISS	$35-40M	S	S
11/21/00		Delta 2 7320	VAFB		Earth Observing 1	NASA	Development	$45-55M	S	S
					Munin	IRF	Scientific		S	S
					SAC C	Argentina	Scientific		S	S
11/21/00	√	Ariane 44L	Kourou	*	Anik F1	Telesat Canada	Communications	$100-125M	S	S
11/21/00	√	Cosmos	Plesetsk	*	QuickBird 1	Earthwatch	Remote Sensing	$12-14M	F	F
11/30/00		Shuttle Endeavour	KSC		STS 97	NASA	Crewed		S	S
					ISS 4A	NASA	ISS	$300M		
11/30/00	√	Proton (SL-12)	Baikonur	*	Sirius Radio 3	Sirius Satellite Radio Inc.	Communications	$75-95M	S	S
12/5/00	√	START 1	Svobodny	*	EROS A1	Israel Space Agency	Remote Sensing	$5-10M	S	S
12/5/00		Atlas 2AS	CCAFS		NRO 2000-1	NRO	Classified	$90-105M	S	S
12/19/00	√	Ariane 5	Kourou	*	GE 8	GE Americom	Communications	$150-180M	S	S
				*	Astra 2D	SES	Communications			
					Ldrex	NASDA	Development			
12/21/00		Long March 3A	Xichang		Beidou 1B	China	Navigation	$20-25M	S	S
12/28/00		Cyclone 3	Plesetsk		Gonets A	Russia/CIS MoD	Communications	$45-55M	F	F
					Gonets B	Russia/CIS MoD	Communications			
					Gonets C	Russia/CIS MoD	Communications			
					Gonets D	RKA	Communications			
					Gonets E	RKA	Communications			
					Gonets F	RKA	Communications			

√ 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

First Quarter 2001 Projected Orbital Launch Events

Date		Vehicle	Site		Payload or Misson	Operator	Use	Vehicle Price
1/10/01		Long March 2F	Jiuquan		Shenzhou 2	China National Space Administration	Test	N/A
36901	√	Ariane 44P	Kourou	*	Eurasiasat 1	Eurasiasat SM	Communications	$80-100M
1/18/01		Titan 2	VAFB		DMSP 5D-3-F16	DoD	Meteorological	$30-40M
1/19/01		Soyuz	Baikonur		Progress M1-5	RKK Energia	Mir	
1/19/01		Shuttle Atlantis	KSC		STS 98	NASA	Crewed	$300M
					ISS 5A	NASA	ISS	
1/30/01		Delta 2 7925	CCAFS		Navstar GPS 2R- 7	DoD	Navigation	
2/1/01		Soyuz	Baikonur		Progress M-ISS-03	RKK Energia	ISS	$35-40M
2/2/01		Titan 4B/Centaur	CCAFS		Milstar II-F2	DoD/USAF	Communications	$350-450M
2/23/01	√	Ariane 5	Kourou	*	EUROBIRD	Eutelsat	Communications	$150-180M
				*	BSat 2A	BSAT	Communications	
2/28/01	√ +	Zenit 3SL	Sea Launch Platform	*	XM Roll	XM Satellite Radio, Inc.	Communications	$75-95M
2/XX/01		Delta 2 7925	CCAFS		Navstar GPS 2R- 8	DoD	Navigation	$50-60M
2/XX/01	√	START 1	Svobodny		Odin	Swedish National Space Board	Scientific	$5-10M
2/XX/01		GSLV	Sriharikota Range (SHAR)		Gramsat 1	ISRO	Communications	$25-45M
3/1/01		Shuttle Discovery	KSC		STS 102	NASA	Crewed	$300M
					ISS 5A.1	NASA	ISS	
3/1/01		Delta 2 7925	CCAFS		GeoLite	NRO	Communications	$50-60M
3/15/01		Atlas 2AS	CCAFS		NRO 2001-1	NRO	Classified	$90-105M
3/28/01		Soyuz	Baikonur		ISS 4R	RKA	ISS	$35-40M
3/28/01		Pegasus XL	CCAFS		HESSI	NASA	Scientific	$12-15M
3/XX/01		Zenit 2	Baikonur		Meteor 3M-1	Russia	Meteorological	$35-50M
					Badr 2	SUPARCO	Remote Sensing	
					Maroc-Tubsat	TUB	Development	
					Reflector	USAF	Scientific	
3/XX/01		Proton M	Baikonur	*	Ekran M16	Russia/CIS PTT	Communications	$85-100M
1st Quarter	√	Ariane 4 TBA	Kourou		Skynet 4F	British Defense Ministry	Communications	N/A
					Sicral 1	Italian MoD	Communications	
1st Quarter	√	Ariane 5	Kourou	*	GE 9	GE Americom	Communications	$150-180M
1st Quarter	√ +	Atlas 2AS	CCAFS	*	DirecTV 5	DirecTV, Inc.	Communications	$90-105M
1st Quarter	√ +	Delta 3	CCAFS	*	Loral TBD A	TBA	Communications	$75-90M
1st Quarter		Long March 4B	Taiyuan		New Gen. FSW	China	Meterological	$25-35M
1st Quarter	√	Proton (SL-12)	Baikonur	*	PAS 10	Pan American Satellite Corp.	Communications	$75-95M
1st Quarter		PSLV	Sriharikota Range (SHAR)		IRS P5	ISRO	Remote Sensing	$15-25M
					BIRD	DLR	Test	

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Second Quarter 2001 Projected Orbital Launch Events

Date		Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price
4/6/01	√	Ariane 5	Kourou	*	AmeriStar 1	WorldSpace	Communications	$150-180M
4/7/01		Delta 2 7925	CCAFS		2001 Mars Odyssey	NASA	Scientific	$50-60M
4/19/01		Shuttle Endeavour	KSC		STS 100	NASA	Crewed	$300M
					ISS 6A	NASA	ISS	
4/21/01		Delta 2 7920	VAFB		Jason 1	NASA/CNES	Remote Sensing	$50-60M
					TIMED	NASA	Scientific	
4/30/01		Soyuz	Baikonur		ISS 2S	RKA	ISS	$35-40M
4/XX/01		Soyuz	Baikonur		Progress M-ISS-04	RKK Energia	ISS	$35-40M
5/17/01		Shuttle Atlantis	KSC		STS 104	NASA	Crewed	$300M
					ISS 7A	NASA	ISS	
5/23/01	√	+ Taurus 1	VAFB	*	OrbView 4	Orbimage	Remote Sensing	$18-20M
					QuikTOMS	OSC	Scientific	
5/XX/01		Long March 4B	Taiyuan		FY 1D	China	Meterological	$25-35M
					Haiyang 1	China	Remote Sensing	
6/6/01		Delta 2 7326	CCAFS		Genesis	NASA/ JPL	Scientific	$45-55M
6/11/01		Delta 2 7925	CCAFS		Navstar GPS 2R- 9	DoD	Navigation	$50-60M
					ProSEDS 2001	NASA	Development	
6/13/01		Titan 2	VAFB		NOAA M	NOAA	Meteorological	$30-40M
6/21/01		Shuttle Discovery	KSC		STS 105	NASA	Crewed	$300M
					ISS 7A.1	NASA	ISS	
6/23/01		Rockot	Plesetsk		GRACE 1	NASA/GFZ	Scientific	$12-15M
					GRACE 2	NASA/DLR	Scientific	
6/30/01		Delta 2 7425	CCAFS		MAP	NASA	Scientific	$45-55M
6/XX/01		Ariane 5	Kourou		Envisat 1	European Space Agency (ESA)	Remote Sensing	$150-180M
6/XX/01		Soyuz	Baikonur		Progress M-ISS-05	RKK Energia	ISS	$35-40M
2nd Quarter	√	Ariane TBA	Kourou	*	Intelsat 9 F1	Intelsat	Communications	N/A
2nd Quarter	√	+ Delta 3	CCAFS	*	Loral TBD B	TBA	Communications	$75-90M
2nd Quarter	√	Long March 3A	Xichang	*	Atlantic Bird 1	Eutelsat	Communications	$45-55M
2nd Quarter	√	+ Zenit 3SL	Sea Launch Platform	*	XM Rock	XM Satellite Radio, Inc.	Communications	$75-95M

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