

Declining trend for U.S. launch capabilities

For the second consecutive year, the number of space launches attempted worldwide totaled 55. In 2005, 55 rockets launched a total of 71 payloads to Earth orbit, compared to 55 rockets and 73 payloads in 2004.

In the early years of this decade, the launch services industry was stuck in the 60s, posting totals of 60, 63, and 62 attempted launches worldwide in 2000, 2001, and 2002, respectively. Things looked gloomy. The industry had become accustomed to launching more than 75 missions a year consistently during the second half of the 1990s. But we found comfort in at least hoping that the market had bottomed out, and that surely a recovery was close at hand.

Just when the industry was starting to get used to the idea of launching 60 missions a year, it was hit with a mere 55 in 2004. The last time the number had fallen below 55 was in 1961, when the U.S. and the Soviet Union had attempted a total of 53 missions. Back in those days, the U.S. was launching astronauts named Shepard

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and Grissom (and a chimp named Enos) into space.

One striking difference between 2005 and 1961, though, is that in 1961 more than 80% of the rockets launched were of U.S. make—with designations such as Atlas A and D, Delta DM-19, Juno, Redstone, Scout, and Thor. In 2005, only 20% of the total were built primarily in the U.S.—Atlas IIIB, Atlas V, Delta II, Minotaur, Pegasus XL, the space shuttle, and Titan 4B.

Early days

It is not all that surprising that U.S. rockets account for a smaller percentage of space launches now than half a century ago, when the only ones going up were of either U.S. or Soviet origin. After all, you would expect other countries introducing their own vehicles into the market to begin eroding U.S. dominance.

China began fielding its rockets in 1970 with the launch of the first Long March. On April 24, 1970, a Long March CZ-1 successfully launched the 173-kg Dongfanghong-1 communications satellite to LEO.

The Chinese were followed by Japan five years later, when the first of the N-series rockets flew. On September 9, 1975, an N-1 launched the 85-kg Kiku 1 engineering test satellite to LEO. Note that the N vehicles were essentially versions of McDonnell Douglas's Delta rocket, probably a Delta E or Delta M. Mitsubishi Heavy Industries was licensed to build the N series in Japan.

The Europeans followed Japan at the end of the 1970s, when the Arianespace consortium put up its first Ariane rocket. On December 24, 1979, an Ariane 1 launched the 1,602-kg CAT 1 technological capsule to LEO.

A few months before the Ariane 1 launch, India had failed in its attempted launch of the first SLV (Satellite Launch Vehicle), an SLV-3. There was a problem



The Europeans joined the launch business at the end of the 1970s, when the Arianespace consortium put up its first Ariane rocket.

with the thrust vectoring of the vehicle's second stage. However, the Indians recovered quickly, with a successful launch in 1980. On July 18 of that year, an SLV-3 launched the 35-kg Rohini 1 technology development satellite to LEO.

Brazil came close to being the fifth nation (or group of nations) with an indigenously produced space launch vehicle. On November 2, 1997, the country attempted the maiden launch of its VLS (Veiculo Lançador de Satélites). But ground controllers were forced to destroy the rocket shortly after liftoff, when one of the four strap-on boosters failed to ignite, sending the vehicle off course. A second attempted launch also failed, on December 11, 1999, as the vehicle's second stage failed to ignite and ground controllers had to send a destruct signal 3 min after liftoff.

The nation that succeeded India was instead North Korea, which launched its own Taepo Dong 1 rocket on August 31, 1998. The vehicle allegedly carried the 170-kg Kwangmyongsong 1 technology development satellite to LEO. It should

be said that, technically, the mission was likely a failure, since the satellite was never detected, despite official reports from North Korea claiming it had completed 100 orbits of the Earth. DOD believes that either the Taepo Dong's third stage failed altogether and did not release its payload, or that the stage malfunctioned and placed the satellite in too low an orbit, one that would have decayed quickly.

End of a monopoly

With the gradual growth in the number of countries capable of building and launching orbital rockets, the monopoly that U.S. and former Soviet rockets had in the launch market is history. Rockets produced by countries other than the U.S. and the former Soviet states account for about a quarter of the world's launch missions annually. Rockets built in Russia and the Ukraine launch more than half of all missions each year. Whereas U.S.-made once accounted for 80% of the missions launched, the figure has now dropped to one-fifth.

The decline in the number of missions conducted by U.S. rockets has been fairly consistent for the past decade. Since 1997 the numbers have fallen every year except for one, 2003; in the last two years they have dropped drastically. Meanwhile, we have seen an upswing over the past three years in the annual launch numbers for Russian/Ukrainian rockets. Launch numbers for rockets from other parts of the world, such as China, Europe, India, and Japan, have consistently remained in the teens.

The bottom line is that the U.S. appears to be losing its capability to provide access to space using its own hardware. The number of U.S. rockets being launched has decreased, partly because the demand for launch services, particularly to geostationary orbit, has declined noticeably in recent years. Far fewer commercial communications satellites have been ordered, built, and launched in the last five years than in the previous five years. And many of the U.S. government satellites—notably military spacecraft—scheduled to be ready for launch during



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the first half of this decade have been delayed because of technical problems and serious cost overruns.

The rest of the story

But the second part of the story is that a number of U.S.-made rocket programs have been terminated, or have simply not been competitive enough to continue launching with significant frequency.

In some instances where the programs were canceled, it was because the launch vehicles were technically unreliable, as in the case of Boeing's Delta III, or because they had little or no market, as with Lockheed Martin's Athena. In other cases where programs were ended, it was because a new generation of vehicles had been developed to replace older ones. The

Atlas V, for example, eliminated the need for the Atlas II and Atlas III families, while Atlas V and Boeing's Delta IV made Lockheed Martin's Titan 4 redundant.

Orbital Sciences' Pegasus XL and Taurus fall into the category of "good vehicles that are uncompetitive," mostly from a pricing standpoint. There are plenty of nano, micro, and small satellites out there waiting to be launched, but the cost of using rockets such as Pegasus and Taurus is prohibitive for the owners of most of these payloads. Similarly sized but much less expensive vehicles such as the Ukrainian-built Dnepr and Russian-built Rockot appear to be in a better competitive position. Thus Pegasus and Taurus may continue sitting idle for extended periods.

The third part of the story is also related to Russian and Ukrainian rockets. Take, for instance, two of today's more active launch vehicle programs—Proton and Zenit 3SL. Both programs are doing



Two of today's more active launch vehicles, Russia's Proton (below) and the Russian/Ukrainian Zenit 3SL, are marketed by U.S.-led joint ventures.





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well, and have probably been taking away launch contracts that might have been won by programs offering U.S.-built rockets.

Ironically, Proton and Zenit 3SL are marketed commercially by U.S.-led joint ventures involving the Russians and the Ukrainians. Through its International Launch Services (ILS) venture, Lockheed Martin has turned Russia's Proton into the most active heavy-lift rocket program in the world. And after years of unfulfilled expectations for the Ukrainian/Russian-built Zenit 3SL, Boeing and its Sea Launch venture started to launch regularly during 2003-2005, with an average of about one launch every 3-4 months.

From a purely business perspective, the U.S. launch industry is not doing as poorly overall as the low number of U.S. rocket launches would suggest. If you were to add the commercial launches completed by ILS and Sea Launch, the number of U.S. rocket launches in 2005 would

nearly double, increasing to 19 or 21, depending on how you categorize a couple of missions for the Russian Satellite Communications Company.

The problem is that while ILS and Sea Launch are U.S.-led ventures, Proton and Zenit 3SL are definitely not U.S. rockets. There is a space access capability contained within both of these programs, but it is not an independent one. And you have to wonder sometimes about what is being sacrificed for the sake of good business.

The fourth part of the story involves aging vehicles such as the space shuttle, which was grounded after the loss of the Columbia orbiter in 2003 and some technical issues experienced during the return-to-flight mission of Discovery in July 2005.

The resulting flight delays have added a sense of urgency to the International Space Station program, given that a fair amount of hardware remains to be launched before assembly of the station can be completed. This includes major segments such as Europe's Columbus Orbiting Facility and the Japanese Experiment Module. Space shuttle missions are also needed to help transport crews and supplies.

Reality and reliance

The inability to count on regular shuttle flights has forced NASA to rely for the past three years on Russian rockets to maintain a minimum level of station assembly work and operations. This dependency was highlighted in December 2005 when NASA agreed to pay the Russian Space Agency \$21.8 million per passenger for rides aboard the Soyuz rocket to and from the station. The deal takes effect this year and runs for a period of six months. Russia, however, has agreed to honor that price through 2011, so it would not be unreasonable to speculate that this relationship could go on for several years.

The U.S. still has a sizable fleet of homemade launch vehicles in operation, including the Atlas V, Delta IV, and Delta

LAUNCHES IN 2004

Rocket	No. of Launches
Long March	8
Proton	8
Soyuz	8
Delta II	7
Atlas IIAS	4
Ariane 5G	3
Zenit 3SL	3
Cosmos	2
Tsyklon	2
Atlas IIIA	1
Atlas V	1
Delta IV	1
Dnepr	1
GSLV	1
Molniya	1
Shavit	1
Taurus	1
Titan 4B	1
Zenit 2	1
Total	55

LAUNCHES IN 2005

Rocket	No. of Launches
Soyuz	11
Proton	7
Long March	5
Zenit 3SL	4
Ariane 5ECA	3
Cosmos	3
Delta II	3
Ariane 5G	2
Atlas V	2
Minotaur	2
Rocket	2
Titan 4B	2
Atlas IIIB	1
Dnepr	1
H-2A	1
M-5	1
Molniya	1
Pegasus XL	1
PSLV	1
Space shuttle	1
Volna	1
Total	55

II families, along with Minotaur, Pegasus XL, space shuttle, and Taurus. But the reduced flight rates for these programs should be of concern to the U.S. government and launch industry, in terms of both lost business opportunities and the effects such inactivity can have on crews and systems that work best when they get into a regular rhythm.

Theoretically, the U.S. has an independent access to space capability. But in reality things look a little different.

Marco Cáceres

Teal Group
mcaceres@tealgroup.com

ROCKETS LAUNCHED IN 1996-2005

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
U.S. rockets	33	38	35	30	28	23	17	22	16	11
Former Soviet rockets	27	33	25	30	39	24	24	22	26	30
Other rockets	18	15	21	17	18	13	22	18	13	14
Total	78	86	81	77	85	60	63	62	55	55