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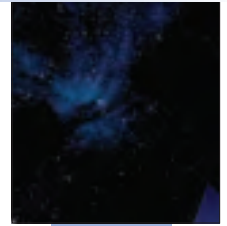
Human space exploration

A GLOBAL QUEST

**Snaring a piece of the sky
Hypersonic transport...30 years and holding**

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Soyuz and Long March set the pace



THE LAUNCH SERVICES INDUSTRY CONTINUED to grow last year, posting 79 attempted orbital launch missions. That total surpassed the 75 missions in each of the previous two years and represents more launches than at any time since 2000, when 87 were attempted. But although the number of launches increased, there was far less diversity in terms of the rockets used. In 2009 and again in 2010, 21 different launch vehicle models were employed, compared to only 18 in 2011.

[Note that for the sake of simplicity, we count all the Long March models as one and break out the Zenits into either land-launched or sea-launched models.]

In other words, last year's launch activities were slightly more concentrated, with 92% of all launches undertaken by the 12 most active rockets—Russia's Soyuz, China's Long March,

Russia's Proton, Europe's Ariane 5, the U.S. Atlas V, the Ukraine's Zenit, the U.S. Delta IV and Delta II, Japan's H-2, the U.S. Minotaur and space shuttle, and India's PSLV. By contrast, the 12 most active vehicles accounted for 88% of all attempted launches in each of 2009 and 2010.

The rising trend in launch activity concentration is apparent for the three most active rockets, which accounted for 40% of all launches in 2009, 52% in 2010, and 53% in 2011. But it is particularly noticeable for the two most active vehicles, which accounted for 29% of launches in 2009, 36% in 2010, and 44% in 2011.

It is clear that the top two rockets are increasingly driving the launch services market. In 2009, it was Soyuz and Proton. In 2010 and again last year it was Long March and Soyuz.

In short, Soyuz and Long March

have emerged as the most prolific space launch programs in the world, by far. Together they account for 34% of all the launches attempted during the past three years; we project that this dominance will continue—and probably expand—for the foreseeable future.

Commercial expansion for Soyuz

While Soyuz has consistently ranked among the leading rockets for decades, most of its business traditionally has focused on launching civil satellites and capsules for the Rosaviakosmos, the Russian space agency, or military satellites for Russia's ministry of defense. This started to change dramatically in 1999, when the Soyuz began to be used for launching Globalstar mobile communications satellites to LEO. That year, seven Soyuz vehicles successfully launched Globalstar satellites, in batches of five.

Over the past decade, Soyuz has been used most often to launch Soyuz manned crew transport capsules to the ISS and Progress unmanned resupply capsules—increasingly so, given the drawdown of the space shuttle program. During this time, however, Arianespace has invested in helping to develop the Soyuz 2.1a and 2.1b and in marketing them commercially. In 2010, Soyuz was again being used to launch Globalstars. On October 19 of that year, a Soyuz 2.1a successfully launched six Globalstars from Tyuratam, Kazakhstan.

On July 16, 2011, a 2.1a launched six Globalstars, this time from Arianespace's main launch facilities at Kourou, French Guiana. The first Soyuz 2.1b from Kourou followed on October 21. That mission carried two Galileo navigation satellites for ESA. On December 17, another 2.1a lifted off from Kourou, carrying small French and Chilean imaging satellites, followed by a 2.1a with six Globalstars from Tyuratam.



Soyuz (left) and Long March are increasingly driving the launch services market.



The Soyuz lifts off on its inaugural flight from the spaceport in French Guiana.

Between Arianespace's investment in and commercial marketing of Soyuz and the readiness of the Globalstar program to use the vehicle for launching most of its satellites, Soyuz has grown to become the industry's most commercially successful medium-sized launch vehicle. It thoroughly dominates the medium-lift segment of the market, especially now that Boeing's Delta II is so overpriced (more than \$100 million per mission) that it is essentially uncompetitive.

Soyuz's growing commercial business—along with its already substantial civil and military activity—accounts for the vehicle's 19 launches in 2011. It is

LAUNCH MISSIONS BY MONTH

January	4
February	5
March	3
April	6
May	5
June	7
July	8
August	7
September	7
October	9
November	9
December	9

hard to recall the last time any rocket posted 19 or more launches, but the feat has certainly not been matched this century. You might have to go back to the early 1990s or 1980s to the days of the Soviet Union.

While more than 80% of Soyuz launches were for the Russian government last year, there is a trend toward more commercial customers, such as Globalstar. About 40% of the satellites launched by Soyuz rockets last year were commercial, including the two Galileos. A few Soyuz launchers have already been contracted by ESA to carry Galileo satellites, as well as by O3b Networks for its constellation of eight broadband communications satellites at medium Earth orbit.

We expect Soyuz to maintain its near monopoly of the medium-lift launch market for the foreseeable future. The only U.S. rockets that may eventually provide some competition are Space Exploration Technologies' medium to heavy Falcon 9 and Orbital Sciences' medium Antares (formerly known as Taurus II).

With a diverse customer base, the marketing prowess of Arianespace,

and the advantage of three different launch sites (Plesetsk, Tyuratam, and Kourou), Soyuz's growth potential is considerable. The only launch vehicle program that stands to outpace Soyuz is China Great Wall Industry's Long March, which consists of just under a dozen rocket models that are either active or under development.

Rapid rise of Long March

Although not a major player in the commercial market, Long March has been one of the most successful launch vehicle programs during the past five years. Throughout much of its history, it averaged no more than two to three missions per year.

However, Long March launch rates began growing to four to five missions annually over the past decade, as China's national space program noticeably expanded and built many more spacecraft. These included communications and scientific satellites, exploratory probes, and capsules, together with the first series of demonstration Beidou navigation satellites.

The Chinese government also began making a greater effort to market



The Falcon 9, along with the Antares, may be the only U.S. competition for the Soyuz.

LAUNCH MISSIONS BY VEHICLE

Soyuz	19
Long March	16
Proton	7
Ariane 5	5
Atlas V	5
Zenit	4
Delta IV	3
Delta II	3
H-2	3
Minotaur	3
Space shuttle	3
PSLV	2
Dnepr	1
GSLV	1
Rocket	1
Safir	1
Sea Launch Zenit	1
Taurus	1

Long March commercially to other countries with which it had developed closer political and economic ties—nations such as Venezuela and Nigeria. During 2007-2008, Long March rockets lofted Nigcomsat 1 and Simon Bolivar 1 (Venasat 1) communications satellites for Nigerian Communication Satellite and the Venezuelan Ministry of Science and Technology, respectively.

But by 2008, a much more diverse and ambitious Chinese space program and some initial success at marketing launch services abroad combined to produce a record number of missions for Long March. Seemingly overnight, the rocket posted 11 launches that year, matching Russia's heavy-lift Proton as the most prolific launch program. Suddenly, Long March had joined Soyuz, Proton, Delta II, and Ariane 5 as one of the upper-tier rockets in terms of activity level.

In less than a decade, Long March went from being a low-launch-rate program posting two to three missions a year to a medium-rate one averaging four to five, and finally to a high-rate one with 11. The growth was fueled almost entirely by the Chinese space program.

If you look at the 15 spacecraft launched by Long March rockets in 2008, all but two—the Simon Bolivar 1 for Venezuela and the Chinasat 9 direct TV broadcast satellite for China Satellite Communications—were for the Chinese government.

Tianlian 1-1 was a civil data relay spacecraft and the Tansuo 3 (Shiyan 3) and BX-1 were scientific technology development satellites. Shenzhou 7 was a manned space capsule—the first manned mission for the Shenzhou program and the first to feature a spacewalk by a Chinese taikonaut.

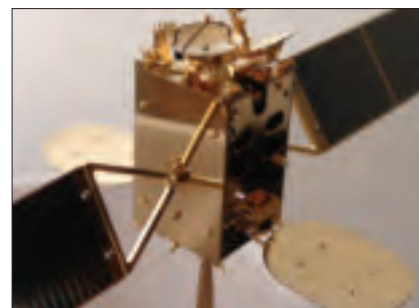
The remaining nine satellites launched by Long Marches that year were for Earth observation. At least four of those—Shijian 6E, Shijian 6F, Yaogan 4, and Yaogan 5—were designed for military imaging missions. Three were disaster monitoring satellites—Chuangxin 1-2, Huan Jing 1, and Huan Jing 2. And two were meteorological—Feng Yun 3A and 2E.

The four Long March launches in 2009 suggested that the previous year's record number of flights might have been an anomaly, but that thought was quickly put to rest in 2010 when the program successfully carried out a total of 15 missions. In fact, the slowdown was due to an extremely unusual failure (the first in 13 years) by a Long March on August 31, 2009.

The problem was attributed to a malfunction of the CZ-3B's third stage, caused by a burnthrough of one of the stage's YF-75 engine gas generators. This resulted in the placement of Indonesia's Palapa D1 commercial communications satellite in a lower than planned orbit.

The 15 launches in 2010 set another record for Long March and made it the most active of all the launch programs in the world. It surpassed both Proton and Soyuz, which had experienced one of their most successful launch years in recent memory, with 12 missions each. And again, nearly all those launches by Long March were for the Chinese government. The only exception to this was the Chinasat 6A for China Satellite Communications.

The most common types of Chinese spacecraft launched that year were civil navigation and military imaging satellites. Long Marches orbited five Beidou satellites for China's proposed Compass navigation system, which will consist of 35 satellites within the next decade. They also



China has begun launching commercial satellites, including the Venasat 1, for foreign customers.

launched five military imaging satellites—three more Yaogans and the Tianhu 1.

In addition, these rockets launched three Shijian scientific satellites, the Chang'e-2 Moon probe, the Feng Yun 3B meteorological satellite, and the Zhongxing 20A military communications satellite.

Had Soyuz not had such an unusually stellar year in 2011, Long March would have led the world in number of launches for the second consecutive year, with a total of 16—although one of those (on August 18) was a failure. The program continued to benefit from a full manifest of Chinese civil and military satellites, including three more Beidous, two Yaogans, a Shenzhou, a Chuangxin, and a Tianlian, but also three commercial satellites for foreign customers.

With the launch of three telecommunications/broadcasting satellites in 2011—Paksat 1R for the Pakistan Telecommunications Authority on August 11, Eutelsat W3C on October 7, and Nigcomsat-1R for Nigerian Communication Satellite on December 19—the Long March program seems finally to have made a breakthrough in the international launch market.

Combined with its captive and increasingly diverse and robust domestic market, its successful penetration of emerging markets in Africa, Central Asia, and South America, and more recently the mature and lucrative European market, the business potential is perhaps more promising for Long March than for any other launch vehicle anywhere.

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