



Space Launch RENAISSANCE

By Marc V. Schanz, Senior Editor

Fifteen years ago, the space launch business was attempting to right itself in the wake of costly failures and setbacks. Times have changed.

In April, Air Force Space Command airmen launched a National Reconnaissance Office intelligence satellite from Cape Canaveral AFS, Fla. The event was treated as routine, but it quietly marked a significant milestone in USAF launch history. It was the Air Force's 100th consecutive successful national security space launch, a string that dates back to 1999.

The April 10 United Launch Alliance Atlas V launch, dubbed NROL-67, was the 81st for ULA since the Lockheed Martin and Boeing consortium was established in December 2006. It also was the second successful military space launch that month, as a Defense Meteorological Satellite Program satellite (DMSP-19) made orbit from Vandenberg AFB, Calif., a week earlier.

"I am proud of the persistence and focus of the launch team, the wing, NRO, ULA, and other mission partners to make this launch happen," said Brig. Gen. Nina M. Armagno, the 45th Space Wing commander, in a statement following the April 10 launch.

"Successfully launching two missions from two different coasts in just seven days is a testament to the team's one-launch-at-a-time focus and ULA's commitment to mission success and schedule reliability," said James V. Spornick, ULA vice president of Atlas and Delta programs.

USAF senior leadership, on the other hand, allowed the occasion to pass largely unnoticed. Nearly two weeks after the launch, on April 23, Chief of Staff Gen. Mark A. Welsh

A United Launch Alliance Atlas V rocket stands ready to loft a National Reconnaissance Office satellite into orbit at Space Launch Complex-41 Cape Canaveral AFS, Fla.



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III gave brief mention to the service's launch success in reply to a question about the status of developing new engines for the space heavy launch enterprise.

"We just hit 100 straight national security space launches," Welsh said at an event at the National Press Club in Washington, D.C., calling it "a spectacular success story."

The NSS launch count had been a mark of pride in the space community for years. USAF hit its 50th consecutive launch in March 2007, when another Atlas V sent six experimental satellites from multiple agencies into space.

Seven years later, space launching has picked up its pace. In 2013 alone, USAF successfully put the fifth and sixth Wideband Global SATCOM (WGS) birds, the third Advanced

Extremely High Frequency (AEHF) communications satellite, a fourth GPS IIF satellite, and the Space Based Infrared System (SBIRS) GEO-2 on orbit.

Undersecretary of the Air Force Eric Fanning told reporters March 5 that in Fiscal 2015 USAF plans 10 more launches and will pursue "potential new entrants" to the Evolved Expendable Launch Vehicle program. The 2015 and the future years spending plans solidify the Air Force's commitment to the launch program, Fanning noted, and the service has saved some \$1.2 billion from the program in 2015 alone.

Despite the price tag, USAF's leadership frequently points to military space launch as an unequivocal success. The US military is heavily dependent on the capabilities USAF puts



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An Atlas V rocket at Vandenberg AFB, Calif., hurls a Defense Meteorological Satellite Program payload into orbit on April 3.

into orbit. During his March 5 meeting with reporters, Fanning said USAF has invested “well over \$100 billion in cutting-edge space capabilities” over the past 16 years, and these tools have been inextricably linked with US military and economic power, from GPS satellites to secure communications.

REINVIGORATED LAUNCH

The EELV program began in 1995 as a way to ensure US military access to space, increase reliability, and lower costs in the long run. Operationally, EELV has been an unqualified success and represents 81 percent of USAF’s launches during the 15-year run of national security space launches. The

program uses Delta IV and Atlas V booster rockets and it is a perfect 81-for-81 in national security space launches.

Meanwhile, the cost of operating EELV has crept up. Estimates for the program hover around \$70 billion in total, based on the need for 151 launches through 2030. According to a March report by the Government Accountability Office, this estimate is approximately \$35.7 billion more than the previous estimate USAF provided in March 2012.

Several causes are behind the rise in cost, the GAO noted, such as the extension of the program’s life span, the purchase of some 60 additional launch vehicles, the “inherently unstable nature” of military

space launch, and instability in the space industrial base. The large block buy for the EELV, committing the government to purchasing 60 more vehicles and extending the program to 2030, was a way to regulate these costs long term and ensure stability in the launch enterprise.

The cost of a failure would, of course, be much higher both financially and in terms of mission impact, USAF leaders say.

“We have used competition, long-term contracts, ... and good understanding of costs to get better deals for the government,” Air Force Secretary Deborah Lee James and Welsh said of the EELV program in a statement to lawmakers April 2. “We must maintain our commitment to mission assurance that has resulted in unprecedented success,” they wrote.

At the time, there had been 98 national security space launches. DMSP-19 was slated to launch the next day, from Vandenberg, but James and Welsh

Success,

Despite the success of the USAF launch enterprise, its steadily rising costs have attracted criticism. From the start of the Evolved Expendable Launch Vehicle effort in 1995, Boeing and Lockheed Martin dominated the launch business as they retained most of the industrial and human capital base involved in it.

Even before the formation of the United Launch Alliance in 2006, critics charged the merger would remove incentives to cut costs. A December 2005 letter from the National Taxpayers Union to Congress claimed the companies had underestimated the costs of the EELV program and Congress had responded to requests for more funds by providing “assured access payments.” The arrangement ensures the companies “cannot lose money,” Paul Gessing, the NTU’s director of government affairs wrote. USAF approved the merger.

Since then, EELV has achieved 100 percent mission success, but costs have gone up. A March 2014 Government Accountability Office report said the program’s total acquisition cost grew some \$28 billion between 2012 and 2013, a 78 percent increase over its prior year numbers. During an

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added that they knew “the only launch that matters is the next one.”

THE BAD OLD DAYS

As bad as launch reliability had become at the end of the 1990s, it is almost shocking how quickly USAF turned things around. The string of successes began suddenly and ended a frustrating and expensive period marked by several extremely high profile space launch failures.

On April 30, 1999, a Titan IV rocket carrying a Milstar II satellite from Cape Canaveral successfully launched but left the satellite on a useless orbit and represented the third straight Titan IV failure. The Milstar II was, at the time, USAF’s most advanced communications satellite, and the event was the Cape’s single most expensive unmanned rocket launch failure in its 48 years of operations. The cost of the satellite and launch totaled \$1.23 billion.

That final loss came less than a month after an April 9, 1999, segment separation failure on another Titan. That mishap left a missile warning satellite on a useless orbit. The previ-

ous summer, on Aug. 12, 1998, a Titan IV rocket launching from the Cape exploded 40 seconds into flight. The launch vehicle and an \$800 million classified intelligence satellite were destroyed. A subsequent USAF investigation concluded the rocket’s electrical system was damaged before launch.

The failures were jarring for USAF’s space community. In May 1999, then-Air Force Secretary F. Whitten Peters asked for a sweeping review of the military space launch business, along with the NRO’s and USAF’s civilian contractors. Gen. William L. Shelton, AFSPC commander, in an April 2014 interview with *Air Force Magazine*, said the turnaround for USAF could be traced to a 1999 Broad Area Review of the launch enterprise. Former USAF Chief of Staff Gen. Larry D. Welch headed the study.

The BAR, Shelton said, showed the Air Force “had drifted away from tried and true mission assurance practices of the past.” In short, USAF, contractors, and the organizations involved in assembling both the satellites and integrating them into the launches were falling short of the tasks that examined all aspects, scenarios,

risks, and segments of a given space launch—performed over the course of the life cycle of a space vehicle development program all the way to its launch. This is known in AFSPC as mission assurance.

Since the BAR, leaders have stressed that the improvement of these processes is vital to the continued health of launches. Putting satellites in orbit is a very different business from fixing aircraft on a flight line.

“There are no unconstrained post-launch orbital corrections, and there are no de-orbits of spacecraft to fix faulty wiring,” wrote then-Brig. Gen. Ellen M. Pawlikowski in a 2008 white paper on mission assurance, when she was the deputy director of the National Reconnaissance Office. “There is no second chance for success. We must ensure that every launch places a satellite in the correct orbit and that once there, the satellite performs flawlessly.” Because of this, Pawlikowski said, the lessons of the Welch review should be continuously integrated into the EELV program.

Launch mission assurance, at its most basic, consists of three main parts: system design assurance, operational mission

At a Cost

April 2 Senate hearing, Sen. Lindsey Graham (R-S.C.) asked why USAF was reducing future competitive EELV launches in its five-year spending plan even though the Office of the Secretary of Defense has directed the service to open up more competition. It’s due to the longer life-span of some of those assets, Air Force Secretary Deborah Lee James replied.

GAO stated the vast majority of the 2013 cost increase came from buying 60 additional boosters, while \$6 billion in cost growth came from extending the program’s life cycle by a decade—pushing many launches to later years to save funds in the short run.

The March GAO report noted EELV had incurred a Nunn-McCurdy Act cost growth breach in 2012, prompting a program restructuring. This drove the Air Force to examine additional launch service providers—such as California-based SpaceX, which still awaits USAF certification for competition with its Falcon 9 launch vehicle. The long certification process and the scaling back of competition opportunities in the EELV effort have attracted the ire of SpaceX’s CEO Elon Musk.

During a March 5 Senate appearance, Musk said SpaceX has com-

pleted its three certification launches required to boost USAF payloads and was still awaiting final technical certification for heavy lift with its Falcon 9 rocket.

“The Air Force and other agencies are simply paying too high a price for a launch,” Musk said, claiming taxpayers could have saved \$11.6 billion on the last EELV block purchase had bidding opened up.

At the same hearing, however, ULA President Michael C. Gass touted ULA’s record of success and reliability. “I am ... pleased to report that ULA and the government team have consistently delivered 100 percent mission success,” he said, adding that ULA’s Atlas V and Delta IV are the “most powerful and most reliable rockets in the world.”

Musk and others claim there is a strategic vulnerability created by reliance on the RD-180 rocket engine for all Atlas V ULA launches. It is a Russian-made engine, Musk said in his testimony, and while the supply chain has spares, there is some risk in relying on a foreign supplier to guarantee space access, particularly one that the US is increasingly at odds with. Speaking to Senate appropriators in April, James said USAF has a two-year supply of

engines and USAF could always use Delta IV as a fallback.

The matter concerns USAF enough that a study of potential vulnerability in the supply chain for the engine was underway as of April, Air Force Space Command boss Gen. William L. Shelton told Congress on April 3. An indigenous engine program has advantages, Shelton said, two being the US would not be reliant on a foreign supplier and the US rocket engine industrial base would be shored up. “Both of those would make a great contribution to the overall launch program,” Shelton said.

There is some evidence that USAF leadership’s cost gambit on EELV may be working. In April, DOD released its annual Selected Acquisition Reports, detailing cost, schedule, and performance changes on major programs (the most recent running through 2013). The EELV program’s costs, the SAR stated, decreased \$3 billion, from \$70.6 billion to \$67.6 billion, due to “savings realized in the negotiation and award of the new 2013-2017 Phase 1 contract” and net decreases from a change in launch vehicle configuration requirements.

In late April, Musk announced that SpaceX is suing the Air Force over the EELV contract with ULA.



USAF photo by Scott M. Ash



USAF photo by SSGT. Carlin Leslie



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Clockwise: Gen. William Shelton, head of Air Force Space Command, speaks with Douglas Loverro, deputy assistant secretary of defense for space policy, in March. Shelton said the Air Force now looks at every launch as a first. Gen. Mark Welsh III, USAF Chief of Staff, speaks at the National Press Club in April. He called the streak a "spectacular success story." A Delta IV rocket lifts off at Vandenberg carrying a National Reconnaissance Office payload. A Delta IV lifts off carrying a GPS IIF satellite.



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assurance, and independent space vehicle assurance. The first two show the launch vehicle and its payload have passed a review, with technical issues resolved and risks mitigated, and confidence in launch mission success is acceptable to the mission launch authority. This normally requires a review and validation of the launch system, assembly of the rocket, launch site, mission design, software, and command and control processes. A third and final step involves additional assessments by a third party to check assumptions of both contractors' and the Air Force's processes.

Mission assurance, as Shelton and others observed, is as much a culture as it is a collection of processes. Some of the lapses in mission assurance, leading to the failures of the late 1990s, were related to acquisition reform efforts, Shelton conceded in his April interview, but in other areas cost was a big driver in changes to tried-and-true practices.

As a result of the Welch BAR, the Air Force implemented launch process changes, such as increased independent reviews in the mission assurance process, improved systems engineering, and better USAF oversight of contractor mission assurance activities. "We have literally gone back to basics on the launch business, ensuring we maintain adequate mission assurance, and conducting hard-nosed reviews leading up to every launch," Shelton said.

EVERY LAUNCH IS A FIRST

The focus on mission assurance is one reason why AFSPC officials downplay the streak. Shelton said that today, every space launch is looked at as "our first in the sequence, not the latest in a long string of successes." USAF's record since 1999 "speaks to the efficacy of this approach," he said.

The NSS launch mission supports a wide spectrum of military and civilian agencies' activities on orbit, a reason it is often difficult to get an agreement between stakeholders on the mission count.

The national security space launch count includes AFSPC launches, Missile Defense Agency missions, US Navy satellite launches, and missions for other agencies with dual-purpose satellite launches, according to AFSPC officials. National Oceanic and Atmospheric Administration (NOAA) satellites are also included. NRO payloads count, as do missions supporting DOD agencies under what are called "national security missions."

The count does not include NASA missions, suborbital launches, commercial satellite launches, research and development, or civilian scientific missions. Following these criteria, and the public statements of senior USAF officials, the April 3 launch of the DMSP-19 mission at Vandenberg was the 99th launch, with the 100th following seven days later. The May 16

GPS IIF launch from Cape Canaveral became the 101st success.

But reliable launch is not the only factor in maintaining military space capabilities, particularly as near-peer rival nations build weapons that could disable or even destroy key US space assets. This potentially creates the need to rapidly replenish on-orbit capabilities. "An agile architecture that provides enhanced resiliency and redundancy is critical to maintaining our advantage in space," Fanning said in March.

Launch is critical to USAF's space capabilities. Shelton said he believes USAF builds "just enough, just in time to keep our constellations healthy." Unlike other USAF capabilities, AFSPC does not build excess capacity to compensate for attrition and does not plan for failure of the launch vehicle or the satellite itself. One of the reasons USAF is slashing the number of planned "competitive" space launches in its five-year plan is due to the longer lifespan of some of those assets, such as the GPS constellation and some AEHF satellites.

"We must become more resilient, not only to failure but also to attack," Shelton said. Several USAF studies underway will decide how to balance on-orbit needs with "affordability and resilience," he said, taking into account ideas such as disaggregating payloads, using different orbits, co-hosting payloads on commercial satellites, or joining with allied nations' satellites. All of these concepts are being considered for an "alternative architecture" for the future.

Service leadership continues to strike a cautious tone on the future. "One of the things we have to be very careful about in any decisions in the space launch arena is first do no harm," Welsh said in his April 23 speech in Washington. "And make sure that as we transition, we transition in a smart, meaningful, dedicated, ... detailed. And I think that clearly it's a good time to look at 'what is the future of heavy space launch and propulsion?'"

In a House Armed Services Committee hearing in March, James emphasized that USAF's launch success should not be traded against mission assurance. Critical national security payloads require stringent controls, and the service won't compromise on them.

In a nod to the lessons of 1990s, James said the Air Force seeks to lower costs in the long term but is not willing to take chances. "Some [launches] have almost catastrophic consequences" if they fail, she said. "There would be huge military significance." ■

