

The United States has become complacent about military space, depending heavily on a few small satellite constellations that are increasingly vulnerable to attack or accidental loss but for which there are no backups. The nation must build some resiliency into its space systems, even as it searches for innovative and affordable ways to lower costs while expanding its overall space capabilities.

These observations and warnings came from Air Force and industry leaders gathered in Los Angeles for the Air Force Association's Global Warfare Symposium, held in November. The US is irrevocably dependent on its space infrastructure, making its satellites a prime target for its enemies. At the same time, the technology for disabling or interfering with satellites is proliferating and getting cheaper. The situation demands a shift to a more resilient, loss-tolerant space infrastructure, they said.

"There isn't a single operation out there, from humanitarian relief operations to irregular warfare to full-scale conflict, that doesn't depend on space capabilities," Air Force Space Command chief Gen. William L. Shelton said in his address at the symposium.

"The ability to operate with impunity in space" for several decades "allowed us to develop very fragile satellites," he said, "with lots of capability on a single spacecraft." But because those spacecraft cost so much and take so long to build, "we've evolved into a 'just in time and just enough' mentality, with no margin for launch failure or premature spacecraft failure," he observed.

Though United Launch Alliance has racked up an impressive string of successful launches, Shelton said the Defense Department is kidding itself if it assumes there will never be a loss.

"We know failures are inevitable," he said, but "we simply don't invest to account for failures." The loss of a crucial satellite when there are no backups, given the near-total dependence of the US military on navigation, communication, timing, weather, and the collection of data from space would be devastating and hard to work around, Shelton maintained. The situation is "unacceptable" from a military perspective.

"We'll need to honestly assess the future, as opposed to attempting to find fault" with studies that argue for a new approach, he insisted.

Jamie M. Morin, acting undersecretary of the Air Force, pointed out that space dominance—or even unencumbered use

Breaking the Space Status Quo

By John A. Tirpak, Executive Editor

The US must shake off complacency about the space arena. Challengers abound.

USAF photo by TSgt. Peter Dean



USAF photo by Dennis Rogers

Left: A United Launch Alliance Delta IV rocket lofts the GPS IIF-3 satellite in early October. Air Force Space Command is working on ways to increase GPS coverage in challenging terrain and urban areas. Above: Gen. William Shelton at Schriever AFB, Colo. Shelton said that every military operation now performed depends, in some part, on space capabilities.

of space—“is not a birthright, ... not a guarantee” for the US, and the nation must continue to invest to ensure the continuing flow of space-based information to terrestrial forces.

Efficient Procurement

There are now nine nations that can reach space on their own, he said. Air Force leaders, when they talk about space, have come to discuss it as “congested, contested, and competitive,” and national strategy recognizes this. With more crowding and unfriendly neighbors on orbit, the US must strive for space mission assurance along “multiple avenues,” including resiliency with “affordable mission goals in mind,” Morin said.

It’s a critical time for Air Force space, he said. USAF invests 20 percent of its procurement funds in space programs, because a variety of constellations—all of them having outlived their expected service lives—must all be replaced at about the same time. These include missile warning systems such as the Defense Support Program, along with communications birds such as Milstar and the Defense Satellite Communications System. A new generation of more powerful satellites is being deployed, but “with significant cost issues.”

USAF is pursuing “efficient space procurement,” a blanket term to describe a host of measures aimed at reducing costs, Morin said. These include stabilizing research and development funding, buying satellites in production blocks, “greater use

of fixed-price and incentive-fee contracts,” and “should cost” reviews to determine where cost growth is happening and what drives it.

Morin said these measures have collectively saved \$778 million on the Advanced Extremely High Frequency (AEHF) communications satellite program and could save a further \$521 million on the oft-restructured Space Based Infrared System satellite program, or SBIRS, if Congress goes along with USAF proposals. That \$1.3 billion in savings is “real money,” he asserted, adding that he expects Congress will approve USAF’s changing methods. “We’ve gotten good support” from Capitol Hill, so far, he said.

The Air Force is also open to new ideas, such as “disaggregations” of satellite systems—reducing behemoth spacecraft in size and complexity by dividing their tasks among smaller, presumably less costly and less complicated satellites. Other ideas include using partnerships with allies and hosted payloads, so a defense mission package would ride along on a commercial satellite.

Australia paid for Wideband Global SATCOM satellite No. 6, Morin pointed out, in exchange for access to a portion of the bandwidth from the whole constellation. A similar deal was reached on WGS 9, he noted, paid for by Canada, Denmark, Luxembourg, Netherlands, New Zealand, and the US. This is a huge opportunity to leverage allied dollars, Morin said.

Overall, USAF seeks a balance between resilience, functionality, and affordability, Morin said.

Shelton, however, emphasized that space is changing faster than policy.

“We certainly haven’t adjusted to the new realities of the neighborhood we operate in,” he said, warning that key orbits are becoming increasingly crowded, with rising incidents of collisions with space junk or other spacecraft. This “formerly pristine” environment is now “occupied by friend and foe alike,” and adversaries have “begun posting signs to warn us they will take action against us in time of conflict.”

He’s well pleased, in general, with the progress of the new generation of satellites, such as SBIRS and AEHF. They were built for “when the hour is darkest,” but little consideration has been given to “survival of the actual platform,” he said.

If these missions must, indeed, be no-fail, since they warn of nuclear war and allow the President to control global US forces in wartime, “doesn’t it follow,” Shelton asked, “that we need to build in some resiliency?”

In an interview, Shelton said there are many ways enemies can—and do—interfere with US satellites.

“You can buy a GPS jammer on the Internet,” he said. Jamming communications satellites is not difficult, either, “if you’ve got a satellite TV truck . . . and you can match the frequency and . . . power to the signal you’re trying to jam.” Voice of America broadcasts have been blocked by such methods, he said.

“Technically, it’s not difficult at all,” he said. In fact, “it’s prevalent.”

More worrisome to him is directed energy. There are already ground-based lasers that can “dazzle” satellites by impairing their optics, but not too far off are “higher-power lasers that would be more destructive,” he said.

Moreover, “with the right laser, you can hit a satellite, destroy it, go to the next satellite, destroy it; just keep reloading in very quick fashion, and you can take out our low Earth orbiting satellites of interest in pretty short order.”

It would take Space Command “a while to infer . . . what’s happened,” if a satellite were attacked, Shelton observed. A laser has no trajectory that can be tracked back to a point of origin as a rocket does. One dead satellite could be “an anomaly”; only with a second one going off the air in about the same region would a pattern be established and a point of origin of the attack approximated. Even then, the laser anti-satellite system could be mobile, “so this is going to be a real challenge for

An artist’s conception of a series of “space mines” destroying a satellite with a laser.



us.” He emphasized the need to keep up with USAF’s space-based surveillance systems program so the nation can know as quickly as possible if its constellations are under attack.

A Road Paved in Gold

China’s 2007 test of a kinetic anti-satellite system—which left a terrible mess of space junk in its wake that has been a hazard to space navigation ever since—is just one more example that there are “any number of threats out there in the counterspace world, and we have to adapt; we have to adjust,” Shelton asserted. “There is no question in my mind . . . that the status quo is not adequate, in terms of the way we’ve filled out our constellations.”

Shelton told the symposium attendees the US should consider making “battlefield attrition purchases” of critical spacecraft, much as it does with fighters

or bombers. For some reason, decision-makers accept that there will be combat losses of aircraft and plan for them, but don’t do so with satellites, he said. This change in mindset is especially crucial now that national strategy focuses on overcoming anti-access, area-denial environments, he said.

“The same rigorous examination of A2/AD in the terrestrial domains must incorporate the challenges to enabling space and cyber services we take for granted in our permissive environments in Afghanistan today,” Shelton said.

He acknowledged that space programs such as SBIRS were extremely costly to mature—“a road paved in gold.” Some argue that “we’ve reached the production mode on our constellations, so we shouldn’t change a darn thing,” and that any changes should be “minor evolutionary [modifications], and life will



Artist's conception by Erik Simonsen

Getting to Orbit and New Players in the Launch Business

“We love the operational record” of United Launch Alliance, which has racked up 57 consecutive successful satellite launches, said Air Force Space Command chief Gen. William L. Shelton at the Air Force Association’s Global Warfare Symposium in Los Angeles in November. But while he’s buoyed by the prospect that new competitors in the launch business could drive down launch costs—he has previously said savings could amount to 50 percent over current contracts—Shelton isn’t sure there’s a business case for a lot of new companies in the industry.

Though the US is absolutely dependent on a space launch industrial base, Shelton also isn’t sure the time has come yet to create an industrial policy that would pick winners and losers.

The ULA joint venture of Boeing and Lockheed Martin—builders of Atlas and Delta rockets under the Evolved Expendable Launch Vehicle program—came about because an expected boom in demand for launch services never materialized. It still hasn’t, Shelton said.

It’s not clear there will be “adequate business for multiple launch providers,” Shelton said in his speech, despite the aggressive growth of new-start entrants such as SpaceX, which has already lofted payloads for NASA. Even counting the international market, it remains to be seen whether any company can capture enough business to make a go of it.

In an interview, Shelton said the emergence of SpaceX was possible only because of the “deep pockets” of founder Elon Musk, who raised outside capital to get the company started and win NASA contracts.

“He’s not ready to carry national security payloads” of high value, Shelton said. “We have a certification process that we will go through to get him certified, but until we can get to the place where we have adequate mission assurance with SpaceX, we won’t contract with them. And he knows that.” There’s a lot of “due diligence” to be done “on both sides,” Shelton noted.

Other companies looking to break into the rocket industry may have a long way to go to build their business through international contracts or space tourism, and “we’ll see if that takes off.” Space tourism has a “very select” potential customer base, but “nevertheless, they’ve got customers lined up,” Shelton admitted.

However, there just aren’t “a plethora of payloads out there waiting [for] rides,” Shelton said. “We could get to a place where there is an overabundance, ... and the market just doesn’t support that many providers. It’s going to be interesting to watch this develop over the next few years and see who gets to stay in the business and who doesn’t.”

The Air Force is “struggling” with the issue of whether it must subsidize certain elements of the industrial base to assure a steady supply of critical elements, Shelton said.

The decision to maintain both Atlas and Delta ensured that a problem with a single type of rocket would not ground the military space effort.

The service is looking at whether it can “decide that we need just Atlas or just Delta and walk away” from maintaining two rocket types.

In a sense, USAF is already down to one supplier for its upper stage, with the Pratt & Whitney RL-10 rocket motor, currently under a cloud due to an anomaly in launching the GPS IIF-3 satellite. That bird reached orbit, but if it had been heavier, might not have, Shelton said.

These considerations are “really a Rubik’s Cube” of questions with interrelated answers, Shelton said.

Though the Air Force is “concerned” about the health of space contractors, it is not yet worried enough that “we would make targeted investments, necessarily, to make sure that we’ve got a valid industrial base.”

be good.” But that, Shelton said, would be like deciding never to invest in fifth generation fighters, “even though modern integrated air defenses will clearly defeat our older platforms.”

Lt. Gen. Ellen M. Pawlikowski, head of the Space and Missile Systems Center, said there are many opportunities for disaggregating satellites. On SBIRS, for example, “the strategic and tactical functions could be divided” among two satellites rather than being carried aboard a single large and heavy one, she said. It’s a strategy Shelton agrees with: More satellites mean “we at least complicate the attack options for the adversary.”

Likewise, he said, the scanning and staring functions on SBIRS could be flown on different platforms, “or if the staring sensors develop as well as we expect, we could go to a larger number of staring sensors on smaller platforms.”

Pawlikowski also observed that the US relies heavily on buying satellite communications capability and even imagery from private satellite companies, and Shelton noted that “80 percent of the [communications] traffic coming back from Afghanistan is over commercial SATCOM.” The US can go a step further with “hosted” payloads.

Walter S. Scott, executive VP of DigitalGlobe, suggested half-jokingly that one

way to discourage China or Russia from targeting a US orbital system is to host it aboard a Russian or Chinese television broadcast satellite capability. Shelton concurred.

“People joke about that but there has been a lot of talk about hosted payloads on consortium satellites,” he said. An attack on such a craft—owned by a number of countries—means “again, you’ve complicated the targeting calculus. So



A look inside the Atlas V payload fairing while the second Advanced Extremely High Frequency satellite is encapsulated. Shelton is pleased by the progress of the new generation of satellites such as AEHF, but feels more attention must be paid to the survival of the actual platform.

this is all part of the departure from the status quo that we need to think about.”

Kay Sears, president of Intelsat General, said in a panel discussion that the US strategic pivot to the Pacific will require greater investment in satellite coverage of the area.

“We need more ground stations in the Pacific,” she said. “We need very different satellites and frequencies” and more jam-proof satellite capabilities. Intelsat provides the lion’s share, by far, of the satellite communications that allow the Global Hawk to fly and gather information. A step up in use of Global Hawk in the Pacific theater will require a commensurate increase in satellite coverage of the area, she said.

But she also confessed to being “pretty worried” about the theater and “our ability to recover and endure in wartime” in any Pacific conflict.

Commercial satellites need more tools to remain capable if jammed or attacked, and she offered a list of technologies—steerable and switchable beams, for instance—that would keep the commercial constellations DOD depends on functional in a conflict. The Department of Defense should bear

a good part of that cost, she argued, but it would be affordable for the insurance it would provide. There could be a number of arrangements explored, such as sharing costs or bartering imagery for security, she said.

Scott said he didn’t think the Civil Reserve Air Fleet—commercial cargo carriers that get preferential contracts in peacetime in exchange for a willingness to be “drafted” in wartime—is the right model for satellite imagery and communications. That’s because there is a premium to be charged for selling “first priority” to other users that could be pre-empted by the US in wartime. Sears said she thinks the “co-investment” model, such as with WGS arrangements with Australia and other countries, makes a better exemplar for hosted payloads and priority service.

Die Is Cast for AEHF, SBIRS

John Celli, president of Space Systems/Loral, said he thinks the hosted payload is the way to fill needed capacity in the Pacific, but he warned that the Pentagon would have to change the way it does business to get industry to partner in this way.

It might take 20 years of a satellite’s life to pay back the cost of designing, launching, and operating it, he said, but the Pentagon only wants to make two-year deals for services, at most.

“I don’t know who would take that deal,” he said.

In design terms, “the die is cast” for AEHF and SBIRS through the sixth satellite in both series, Shelton said. With block buys and other considerations, that means no significant change in the configuration of those satellites through the mid-2020s, he said, assuming no launch failures or premature satellite failures. Given stable designs, “I’ll freely admit the safe bet, from a cost perspective, is to stay the course.” However, from a survivability and resiliency standpoint, he said, work should begin soon to disaggregate, shift to smaller satellites and hosted payloads. GPS is a model, he said, because “with such a large constellation, there is built-in resiliency,” and AFSPC is pursuing anti-jam efforts and “more comprehensive coverage in challenging terrain and urban areas.”

Shelton is seeking to shelve the Operationally Responsive Space office, arguing that the functions it has performed and its “philosophies” are best fulfilled by SMC. The ORS program has explored the idea of hosted payload, and tried it once so far, with CHIRP, or Commercially Hosted Infrared Payload. The ORS program has also looked at the concept of smallsats. So far, Congress has not agreed to stand down the ORS office, “so we will find a compromise to make best use of the funds provided,” Shelton said.

The notion of ORS, though, is fundamentally flawed, he argued. The ORS also looked at how to rapidly launch replacement satellites if one was taken out by an accident or attack. Shelton said, though, that it makes little sense to have satellites on the ground, “sitting around waiting for the day” when they might be needed—and then try to launch them under “crisis conditions.” Better to have them already on orbit, he said, since a larger constellation will improve functionality and present a greater number of targets to an adversary.

While adversaries have demonstrated their ability to attack satellites with electronic warfare, lasers, and kinetic means, the latter is “not anything we favor” as a potential US response, Shelton argued. Kinetic attacks create thousands of pieces of debris which only makes things more difficult for the US in its own space operations.

“That’s not a good strategy,” he said, adding the US will “look at other ways to do counterspace.” ■