Responsive Space

Making space launch faster, easier, and cheaper sounds simple. It’s not.

As a US combatant commander prepares for battle, he might need a close, up-to-date look at what is happening on the ground. He may need to put more “eyes” on a particular area. If so, a call may go out to Air Force Space Command, with the question: What have you got?

Today, Space Command could use only those systems that are already overhead. Developing, launching, and certifying a new one would take years.

By 2010, however, Space Command may well have another option—to swiftly prepare and launch a small satellite that will survive only long enough to meet the intelligence-surveillance-reconnaissance (ISR) needs of the immediate mission. For that, 14th Air Force at Vandenberg AFB, Calif., would maintain a fleet of tiny spacecraft ready to fly within days of a “go” order.

Shortly after reaching orbit, Air Force operators would turn the satellite on, and it would provide ISR data—almost immediately—to air, ground, or sea forces.

This is the Air Force’s vision for what it calls “Responsive Space,” as laid out by Gen. Lance W. Lord, commander of Air Force Space Command. Achieving that goal, however, will not be simple.
If they are to be swiftly “launcherable,” responsive satellites need to be much smaller than the standard spacecraft that the Air Force uses today. Launches must be faster and less expensive. The satellites themselves must go into service almost immediately, without the lengthy “check out” period common for today’s systems.

USAF officials envision satellites weighing between 100 to 850 pounds, much smaller than satellites such as today’s Milstar communications spacecraft. Each of those weighs about 10,000 pounds, Lord said.

With satellites of such small size, critical design and engineering work would be far less complex than is the case with today’s huge systems. Current birds can take a decade to develop, years to build, and cost billions of dollars.

**Staying Simple**

The Air Force also will keep the cost down by not pushing the technological envelope. USAF wants immediately achievable results, not major technological breakthroughs, according to Lt. Col. Gus Hernandez, chief of space vehicle requirements for the operationally responsive spacleslift effort at Air Force Space Command in Colorado Springs, Colo.

Using such satellites for short operational periods would allow the Air Force to further reduce the cost of the spacecraft, which soars whenever the system is expected to last for decades.

Such a change of philosophy would help the US circumvent a traditional and debilitating practice. Gen. John P. Jumper, in an interview shortly before he retired last fall, described it this way: “It costs so much to launch a satellite that, when you launch it, you have to pile everything you can on the satellite.”

Jumper went on, “If that’s the reason we build $2 billion-to-$3 billion satellites, then why don’t we make space launch easier, so that it’s not such an episodic event, and we don’t mind if they stay operational for only months? I think we need to recognize that it’s very hard to make big, expensive satellites that can look at any time anywhere on the Earth.”

Some missions, such as missile warning, require highly capable and durable satellites staring continuously at the ground. Those are the missions unlikely to be handled by small responsive spacecraft, Lord said.

Large satellites will always play a leading role for missions such as communications and intelligence, but responsive satellites can fill in the gaps for tactical forces. They can provide added persistence over areas of interest, so that the larger satellites do not need to be diverted from their primary mission, Jumper said.

There is certainly a niche to be filled for providing as-needed ISR or
communications capability to support unexpected contingencies.

The Air Force has primarily used small satellites to experiment with technology that is later to be used aboard much larger operational systems.

While the Air Force Research Laboratory and other military organizations are continuing their work with experimental research payloads, they have begun work on a series of small satellites called TacSats that are expected to pave the way for deployed commanders to call up space capabilities on short notice.

$15 Million Goal

The Pentagon began pursuing the TacSat concept in 2003 with the goal of launching satellites for about $15 million, including construction of the satellite and purchase of its launch vehicle. The concept took hold thanks to the advocacy of the Pentagon’s Office of Force Transformation, which also funded the first TacSat experiment.

The satellites are intended to be accessed directly through secret Internet protocol router network links by commanders in the field. These end users have traditionally languished behind higher-level officials in the priority queue for space capabilities.

The Air Force is hoping the TacSat experiments will lead directly to the purchase of similar satellites for operational use, Hernandez said. The TacSats may prove to have some operational utility during the time that the military experiments with them, but that would simply be a bonus. Funding for responsive space satellites dedicated to operational missions will likely be requested for the first time in 2010, he said.

Some officials compare the payloads for the TacSat satellites to those of unmanned aerial systems. In fact, the first spacecraft in the TacSat series features a payload initially built by the Naval Research Laboratory for an unmanned aircraft.

After several delays, the Air Force is planning to launch TacSat-1 by the middle of this year. That satellite, weighing about 240 pounds, features a payload that includes an infrared camera and a low-resolution imaging camera.

US Pacific Command is among the groups planning to take advantage of the capabilities offered by the TacSat-1 spacecraft over the next year.

Commanders who use the TacSat satellites will receive their new “space products” on the same ground equipment that today connects to existing assets such as unmanned aerial systems, Hernandez said. This will help avoid overburdening troops with additional infrastructure, he said.

TacSat-1 is expected to be followed next year by the second spacecraft in the series. TacSat-2 features a color imaging camera capable of taking pictures sharp enough to distinguish images three feet in diameter, Hernandez said. The TacSat-2 payload, also known as Roadrunner, is being built as a joint project led by the Air Force Research Laboratory.

As the Pentagon works to pack as
Responsive Space Experiments

The Air Force within a year is scheduled to launch two experimental satellites to test responsive space capabilities. After TacSat-1 this spring, TacSat-2 will follow in May 2007, with improved imaging capabilities. TacSat-2 is still considered a small satellite, though, at about 660 pounds, it is almost three times larger than TacSat-1, Air Force Space Command’s Lt. Col. Gus Hernandez said. The Air Force hopes to follow in July 2007 with TacSat-3, featuring a hyperspectral imaging sensor built by Raytheon. The hyperspectral imager can help see through camouflage, enabling US forces to better spot concealed targets, Hernandez said.

The imager also can help US forces learn more about the terrain on and around the battlefield, helping to determine whether the ground is capable of supporting a landing aircraft or the ingress and egress of troops and ground vehicles, Hernandez said. This capability also can be used to plan evacuation routes for refugees.

The planning process for TacSat-3 featured increased collaboration amongst the Air Force Research Laboratory, the Army, and the Navy.

Collaboration expanded further for the next satellite; the National Reconnaissance Office provided input for TacSat-4. Hernandez said. The fourth TacSat spacecraft, also known as Com-X, is expected to fly in 2008.

Com-X should feature a communications payload that helps connect troops with other forces located beyond their line of sight. The satellite also is expected to relay data from blue force tracking devices used by troops linked to the Global Positioning System, to help monitor the locations of friendly forces and avoid friendly fire accidents.

A third mission for the satellite is to relay data collected by buoys bobbing in the ocean, Hernandez said.

Com-X will be the first TacSat spacecraft placed in a highly elliptical orbit, unlike the rest of the series which are going into low Earth orbit.

A lower altitude improves the resolution of the sensors on the imaging satellites, but launching TacSat-4 into a highly elliptical orbit will keep the satellite in view of areas of interest for longer periods. That will maximize the utility of its communications payload, Hernandez said. The HEO orientation will likely keep TacSat-4 over target areas for hours at a time, rather than just a few minutes each day.

TacSat-4 also is expected to be near the upper limit of the definition of a small satellite, weighing in at more than 800 pounds.

The Air Force will likely seek to meet increasingly complex mission needs as it begins the planning process for TacSat-5 later this year.

Best Thing Going for Us

Rep. Terry Everett (R-Ala.), chairman of the House Armed Services strategic forces subcommittee, called the TacSat “the best thing we have going for us” in space acquisition.

“My only regret is that we have so few of them,” Everett said in a July interview.

Everett indicated that he is interested in the capability that the TacSats could give to US troops seeking to flush out insurgents in Iraq or to locate American forces taken prisoner during battle.

The Air Force plans by 2008 to establish a program office to handle the purchase of small, responsive satellites such as the TacSats. The program office will be at the Space and Missile Systems Center’s Det. 12 at Kirtland Air Force Base in New Mexico. The office will be known as the Joint Warfighting Space program office.

In the interim, the service established a “virtual” program office at Kirtland that includes participation from AFRL’s space vehicles directorate, the Space and Missile Systems Center’s transformation office, and AFSPC’s space battlelab.

The Joint Warfighting Space program office also will handle the purchase of so-called near-space vehicles operating between 12 and 62 miles above the Earth’s surface. (See “Near-Space” July 2005, p. 36.)

Near-space vehicles are envisioned as loitering over areas of interest much longer than even satellites in highly elliptical orbits and are conceived as being able to respond quickly to combat needs. Near-space vehicles raise overflight issues not present for satellites, however, leaving a door open for responsive spacecraft.

Before the Air Force can take advantage of responsive space capabilities such as those on the TacSats, it needs rockets capable of launching on just a few days’ notice. The Air Force today typically plans the majority of its space launches two years in advance—a duration service officials would likely to cut to a matter of days for responsive satellites.

The late Vice Adm. Arthur K. Cebrowski, who headed DOD’s Office of Force Transformation until his retirement in January 2005, said in 2003 that he hoped the TacSat work would stimulate the market for low-cost launch options.

One option available today is the Falcon-I rocket built by Space Exploration Technologies (SpaceX) of El Segundo, Calif. The Falcon-I rocket was scheduled to make its maiden voyage in February, carrying an experimental payload built by students at the Air Force Academy.

That launch is to be paid for by the Air Force and the Defense Advanced Research Projects Agency through a program also known as Falcon, Force Application and Launch from the Continental United States.

The Air Force and DARPA have used their Falcon program to fund the development of small launch concepts. SpaceX was further along with its rocket when the Pentagon began the Falcon program in 2003, with the goal of launching costing no more than $5 million.

SpaceX, which advertises its Falcon-1 launches for $6.7 million, is under contract to launch TacSat-1. SpaceX founder Elon Musk developed the Falcon-1 rocket with his own funds.

The Air Force is looking at additional launch options for the following TacSat launches, due to the inherent risk of relying on a single provider, Hernandez said.

The Air Force and DARPA had initially funded development of nine small launcher concepts under their Falcon effort and awarded a $17.8 million contract in November to a company called AirLaunch. This is for continued work that could lead to a flight demonstration later this decade.

AirLaunch was the sole contestant in a Falcon competition for boosters that do not take off vertically from the ground—as most launch vehicles have since the dawn of the space age.

AirLaunch’s QuickReach booster is designed to be carried by an unmodified C-17 or other large cargo aircraft.

From flight, QuickReach is released and heads to orbit.

The use of a standard aircraft is an appealing attribute, according to DARPA Director Anthony J. Tether, because that factor saves money.

DARPA had sponsored another aircraft-based small satellite launcher called RASCAL, Responsive Access, Small Cargo and Affordable Launch, but canceled the project in 2005. The
program was axed when it became clear that RASCAL would require a custom aircraft, which would have busted DARPA’s budget for the work.

Other companies that hope to build quick-reaction launchers include Microcosm, which has been refining its concept for a family of rockets called Scorpius for years. (Microcosm was one of the nine companies that received initial Falcon contracts from the Air Force and DARPA.) The company is continuing to evolve its Scorpius concept with the hopes of winning future work.

Express Checkout

Working with responsive satellites and launchers also will require changes in the way the Air Force approaches space operations. One of the most important issues that must be addressed is the speed with which Air Force satellite operators can “turn on” the spacecraft following launch.

Satellites typically take months to “check out.” That is anything but responsive, observed Gary E. Payton, deputy undersecretary of the Air Force for space programs.

If commanders have to wait for the satellites to be checked out over the course of two months, it practically negates the benefit of having an inventory of satellites and rockets in storage to be launched on two days’ notice, Payton said during a speech in December sponsored by the Space Transportation Association.

Satellite launch dates need to be more durable as well. Launches are typically scrubbed for weather conditions such as fog or heavy winds, but those traditional constraints cannot be allowed to interfere with responsive launches, Payton said.

“It would be rather embarrassing for a range commander or a launch squadron commander to cancel a launch because of weather,” Payton said.

To call up CENTCOM “and say, ‘gee whiz, General, I’m sorry we couldn’t launch today because there was fog at Vandenberg,’” would be unacceptable, he said. Under today’s rules, responsive launch could quickly devolve into a nonresponsive situation of “there’s going to be fog tomorrow morning, and the morning after that, so we can get around to launching your [crucial] satellite ... in a week or so,” Payton explained. That simply will not do.

Other issues that must be addressed before responsive satellites can become a regular part of Air Force operations include the approach to launch failures, Payton said. A launch failure today can ground a rocket fleet for months, while the cause of the problem is studied and corrected.

“Right now, we have a mentality in our space launch business that if one fails, you ground the fleet,” scrutinize telemetry for weeks, call review teams, and write action items, he said. This takes “anywhere from six months to nine months to three years. ... That sort of system is not responsive to the combatant commander.”

Operationally responsive space requires a different mind-set—one similar to that for aircraft, where a problem is usually dealt with in a matter of hours or days, he said.

In addition to launching small satellites at the beginning of a military operation, commanders may find themselves turning to small spacecraft to fill in the gap if an existing satellite is suddenly unavailable. This could be for any reason, from part failure to enemy attack.

Most of the details of the recent Schriever space wargames conducted by Air Force Space Command are classified, but a key theme was the use of small satellites to replenish spacecraft.

In fact, some officials believe that the capability to launch small replenishment satellites, even if they may not be as capable as standard spacecraft, may deter enemies from attacking the Air Force’s space-based assets.

Despite their comparatively low cost and envisioned fast availability, responsive satellites are unlikely to replace their larger, pricier brethren. The Air Force still will need large satellites for the bulk of the communications flow to deployed forces and to watch out for enemy missile launches all over the globe, and durability certainly has value.

But smaller, cheaper spacecraft may become a prominent part of the Air Force’s arsenal to fill in the gaps in capabilities leading up to or during conflicts. That is the Air Force’s goal for responsive space.

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