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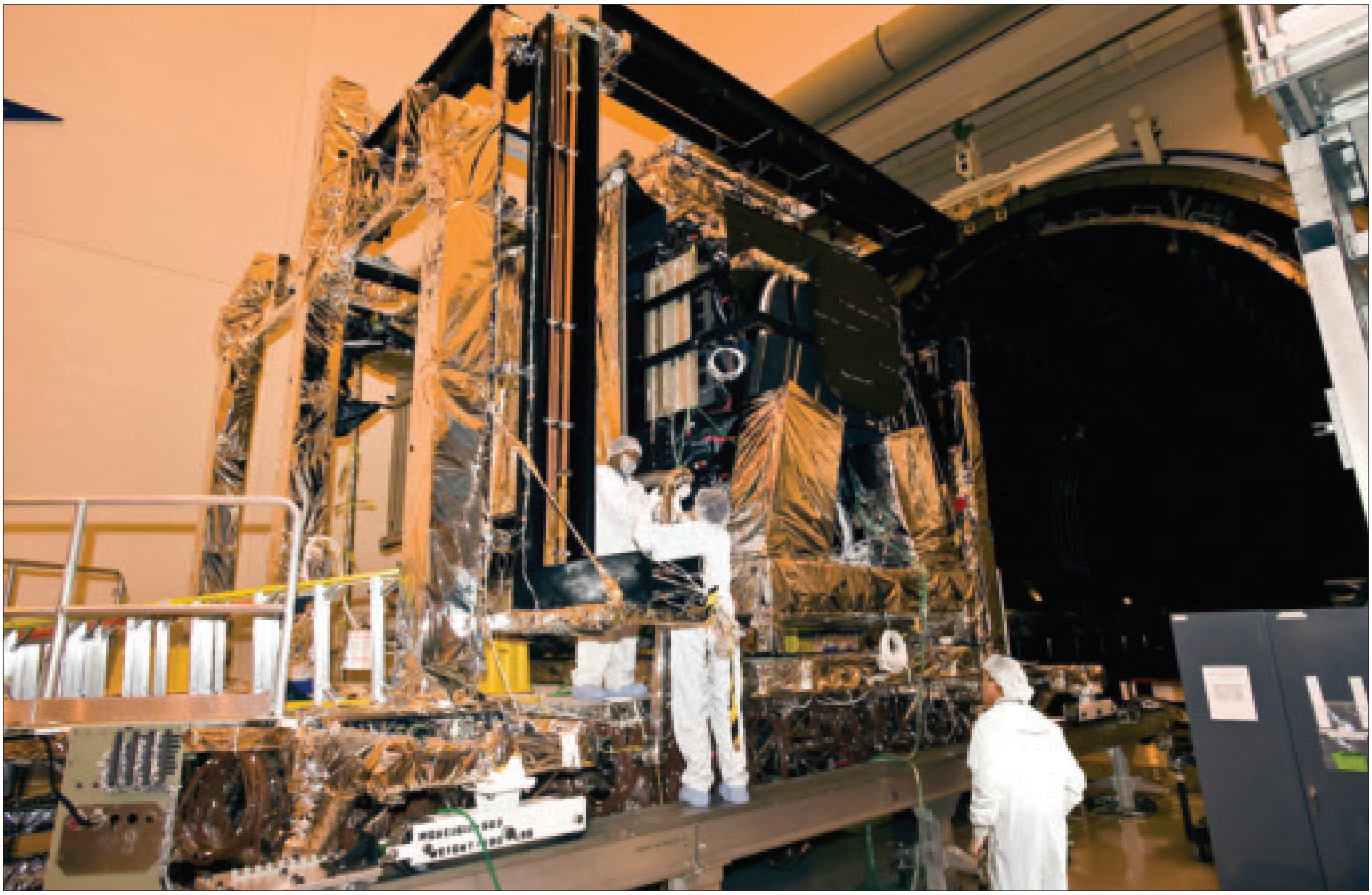
LOWS and HIGHS for

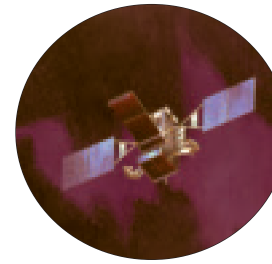
The first decade of this century brought mounting anxiety to defense officials responsible for alerting the U.S. and its allies to impending missile attacks. Early warning satellites in geosynchronous orbit were old and wearing out. The Air Force program for developing new and better satellites to augment and replace them was foundering amid cost and technical problems. A dangerous gap in missile warning coverage lay ahead.

At the heart of the problem was the Space-Based Infrared System (SBIRS) program, undertaken by the Air Force in 1996 to develop the next generation of heat-sensing sentinels in space. SBIRS had fallen far behind schedule and was verging on failure. Ballistic missiles were coming into play in more and more countries, most menacingly in North Korea and Iran.

Now things are looking up: The SBIRS program, with Lockheed Martin as prime

SBIRS GEO-1 undergoes work at Lockheed Martin Space Systems in Sunnyvale, California.





SBIRS early warning

Just as more nations began building ballistic missiles and acquiring nuclear weapons, U.S. early warning satellites were starting to wear out. Plans to replace them, however, proved overly ambitious, and defense officials redoubled efforts to overcome mounting problems. The resulting Space-Based Infrared System now appears to be exceeding expectations.

by James W. Canan
Contributing writer

contractor and Northrop Grumman as payload integrator, finally seems to have hit its stride. The first dedicated SBIRS satellite, GEO-1, is scheduled for launch from Cape Canaveral into geosynchronous orbit atop an Atlas 5 rocket this month.

Many missions, more coverage

Three additional GEO satellites are scheduled to follow in the near future to form a SBIRS constellation that will support multiple missions: missile warning, missile defense, technical intelligence, and battlespace awareness.

SBIRS will consist of more than just its dedicated GEO satellites, which are highly sophisticated, stabilized platforms featuring telescopes, supersensitive infrared sensors, and pointing/aiming mirrors. The system will also include four infrared sensor payloads on classified, multipurpose host satellites in highly elliptical orbit (HEO). SBIRS spacecraft transmit data to fixed and mobile ground stations and, by relay, to the mission control station at Buckley AFB, Colorado, which currently operates the Defense Support Program (DSP) satellites.

"SBIRS offers improved sensor flexibility and sensitivity compared to DSP," an Air Force paper claims. SBIRS sensors "cover short-wave infrared, expanded midwave infrared, and see-to-the-ground bands, allowing them to perform a broader set of missions," it says.

In recent months, GEO-1 and its sensors and associated systems have passed all prelaunch tests with flying colors. In late January, a major flight operations test of the performance characteristics and ground station linkage demonstrated that GEO-1 is ready to go, marking "one of the most significant milestones to date on the path to launch," Lockheed Martin announced.

Two SBIRS sensor payloads currently aboard a classified HEO satellite are said to be performing spectacularly. Subsequent SBIRS sensor payloads slated for launch on another HEO satellite have met the requirements of the National System for Geospatial Intelligence, which has officially accepted them for the technical intelligence mission.

Reasons for success

"We have confidence in the GEO sensors, in part due to their similarity in design to the HEO sensors," says Jeff Smith, Lockheed Martin's SBIRS vice president and program manager. "We fully expect SBIRS GEO-1 to meet or exceed our customer's expectation, and we are confident in delivering this first-of-its-kind spacecraft to meet our scheduled spring 2011 launch date."

Smith attributes the latter-day success of SBIRS development to "sound program fundamentals and rigorous, disciplined testing," and to the "accountability, trust, teamwork, and commitment" of the Air Force and its contractors. He says that

DSP 23, the last satellite in that constellation, reportedly lost contact with ground control shortly after launch.

steps taken in development and testing over the past year "have reduced program risk significantly, giving us great confidence in achieving mission success."

The Air Force and its contractor team adopted a more rigorous approach to the program in recent years in an attempt to reduce risk in technology development and control costs. There was concern in some defense circles that this would severely compromise the capabilities of the system as it was originally planned. By all accounts, this has not happened.

Over the past two years, the Air Force and its contractors have eliminated "almost all of the developmental risk associated with the first-time integration of a new satellite design," and "made major strides in restoring confidence in the program team's ability to execute [the activity] on plan and produce quality products," says Brig. Gen.-selectee Roger Teague, SBIRS program director and wing commander with Air Force Space and Missile Systems Center (SMSC).

In the process of developing SBIRS, the center is also focused on sustaining the DSP constellation. "Our goal," Teague says, is the seamless replacement of DSP with SBIRS, and "we are working closely with Air Force Space Command to ensure that the SBIRS satellites are available for launch to support their operational mission."

Last legs for DSP

The SBIRS program seems to have made a comeback in the nick of time—DSP satellites are almost out of gas. Defense officials do not openly discuss the operations or status of DSP spacecraft, but acknowledge that some of those still in operation are in danger of going dark.

Loren Thompson, a longtime national security observer and analyst with the Lexington Institute, recently observed, "there is evidence that some satellites in the [DSP] constellation are on their last legs. In fact, a few are already functioning well beyond their nominal design lives."

The Air Force launched its first DSP satellite in 1970. Since then, 22 more have been launched. The early versions reportedly weighed about 2,000 lb and had a very brief design life. Those launched in the past two decades are said to have weighed more than 5,000 lb and were designed to keep operating much longer. The last one to be launched—DSP 23, about two years ago—reportedly lost contact with ground control not long after launch into GEO ("It just disappeared," said one official).

"When a satellite no longer has the redundancy left to cope with a parts or circuit failure, it is said to have become a 'single-string' bird. It appears that some birds in the present [DSP] constellation have become just that as the government has waited for SBIRS to mature," Thompson observes.

DSP satellites were the first line of strategic defense for the U.S. through much of its Cold War nuclear standoff with the Soviet Union. The satellites were built by the erstwhile TRW and then by Northrop Grumman to detect the intense infrared signatures of ICBM launches and nuclear bursts, and not necessarily to sense the less discernible signatures of shorter range theater, or tactical, ballistic missiles on the rise.

During Operation Desert Storm in 1991, a DSP satellite perched in GEO surprisingly picked up the heat from launches of Iraq's Scud tactical ballistic missiles. This drew praise from Gen. Thomas Moorman (then head of Air Force Space Command), who called it "enormously important" to the successful outcome of that conflict.

Long road to replacement

By the time of Desert Storm, the Air Force had shelved its plan for the Advanced Warning System, a constellation of satellites to replace the DSP system. Instead the Pentagon devised a more ambitious plan for a Follow-on Early Warning System (FEWS) to detect the launches of both theater ballistic missiles and ICBMs. FEWS was designed to improve on the DSP satellites but to have less capability and lower cost than the highly elaborate warning-and-targeting satellites envisioned in the Strategic Defense Initiative (SDI) program of the 1980s.

FEWS became too expensive and fell by the wayside. In 1994, after yet another study of missile threat and advance warning prospects, the Air Force incorporated an SDI early warning concept called Brilliant Eyes in plans for a newly conceived Space-Based Infrared System, or SBIRS, featuring sentinel satellites in various orbits.

Brilliant Eyes was renamed the Space and Missile Tracking System and then SBIRS Low. The DSP replacement element of the program was named SBIRS High.

Ten years ago, SBIRS Low was transferred from the Air Force to the national Ballistic Missile Defense Organization, now the Missile Defense Agency. This was done to emphasize the program's dedication to ballistic missile defense and to distance it from SBIRS High, which even then was running into troublesome cost and technical problems. SBIRS Low was renamed the Space Tracking and Surveillance System, and SBIRS High became simply SBIRS.

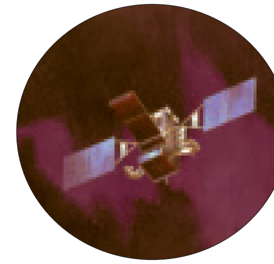
Air Force Space Command in Colorado controls the SBIRS and DSP satellites. The SMSC's Infrared Space Systems Directorate is in charge of SBIRS development. Lockheed Martin's original SBIRS High contract with the Air Force called for two HEO payloads, two GEO satellites, and the ground-based assets to receive and process the infrared data from space.

Early last year the SBIRS contract was modified to cover two additional HEO sensor payloads—HEO 3 and HEO 4—and follow-on production of two more GEO satellites. This increased the estimated program cost from $11.5 billion to $15.1 billion. HEO 3 is scheduled for delivery next year, Teague says.

An indication that the additional cost of the SBIRS contract will be well justified came in March 2010: An Air Force/Lockheed Martin preliminary design review of the third and fourth GEO satellites was pronounced highly successful.

"This represents an important step" in the SBIRS program, said Col. John Mueller, vice commander of SMSC's SBIRS wing. "Now we are ready to dig into the details on the design of the third and fourth spacecraft in preparation for production."

The Air Force had apparently overreached in devising the SBIRS High program, setting out to do much more than merely replace DSP satellites with SBIRS High spacecraft in the early warning mode. It had planned to adorn the SBIRS sensors with cutting-edge sensor technologies that would enable the satellites to perform multiple missions: warn of ballistic missile launches, anchor an advanced, digitally integrated system of ballistic missile defense, and provide technical intelligence and battlefield awareness data to combat commanders. This was asking too much of the sensors too soon, as it turned out.



SBIRS High quickly got into difficulty because the program was improperly structured, initial testing of parts and components was inadequate, and the investment in building and integrating hardware was premature and excessive, according to Air Force acquisition officials. In 2005 the service, under pressure from the Dept. of Defense, began work on a possible SBIRS backup program called the Alternative Infrared Satellite System (AIRSS).

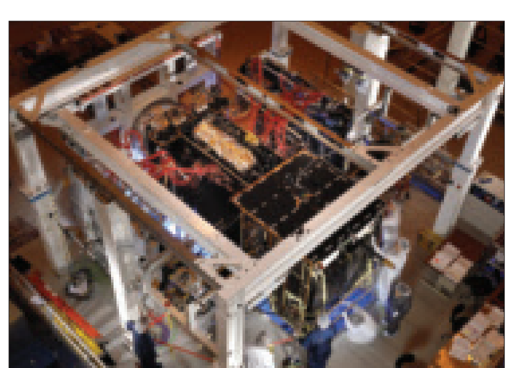
At the time, Air Force officials seemed hopeful that corrective measures were beginning to give the SBIRS program 'some traction,' as one put it. But they acknowledged that SBIRS had a long way to go, and would remain suspect.

Back to basics

In mid-2006, Gary Payton, then the chief of Air Force space acquisition, told *Aerospace America*: "In the beginning of the SBIRS High program, everybody said 'we're going to take a grand and glorious big leap forward to replace the old DSP missile warning satellites that are old and not good enough any more.' The problem was that we didn't have the technology that would be needed...but we went ahead anyway." The Air Force and its SBIRS High contractors "began doing the design work without having the technology in hand for the sensor that was supposed to go on the spacecraft," he explained.

"We've gone back to basics, simplified things," Payton said. "We're letting the technology catch up." He expressed hope that launches of SBIRS High GEO-1 and GEO-2 would take place in October 2008 and October 2009, respectively, and that the cost estimate for the program had peaked and stabilized at roughly $10 billion.

A year later, in 2007, SBIRS was in trouble again—the Air Force announced an additional cost overrun of around $1 billion. The cause was a problem with the GEO



Work on the GEO-2 is well under way.

The second HEO payload, a critical element of SBIRS, undergoes final inspection prior to delivery.

The final integrated system test of GEO-1, a major program milestone that verifies the spacecraft's performance and functionality in preparation for delivery to the launch site, was completed on December 13.

satellite's 'safe-hold' system, which takes control of basic functions such as positioning when the satellite runs into operational anomalies, and puts it on hold, in effect, until ground controllers can assess and rectify the situation.

That glitch was overcome, and the program went ahead but remained dubious. A General Accountability Office report noted that the cost estimate for the program had ballooned to $12.2 billion, that the number of satellites in the planned SBIRS constellation had been reduced from five to four, and that the launch of the first GEO satellite would take place many years later than originally scheduled.

Hedging its bets on SBIRS, the Air Force asked Congress for funds to start work on yet another space-based early warning program, the Third Generation Infrared Surveillance (3GIRS) system, an outgrowth of AIRSS, with Raytheon and SAIC the contractor team for both programs. The AIRSS/3GIRS endeavor was undertaken as a less costly alternative to the faltering SBIRS program. But now, with that effort apparently back on track, it is seen as a possible supplement to SBIRS if needed.

DOD's Operationally Responsive Space office, which considers options for preventing or closing a coverage gap in the U.S. space-based missile warning system, reportedly continues to pursue future possibilities for the use of AIRSS/3GIRS sensors. The first such sensor is said to be scheduled for launch this year on an Orbital Sciences satellite as part of a commercial space payload experiment.

Rising prospects

Steady progress in the development and testing of SBIRS sensors has given the program a big lift. Sensors on the host satellite currently in HEO have performed admirably, officials claim. The second HEO sensor payload and associated ground systems were certified for missile warning operations by Strategic Command last August.

At the time, Teague called the certification "another major operational achievement" in the program. "The HEO system is delivering revolutionary new surveillance capabilities to combatant commanders, and we look forward to continued strong progress," he declared.

The SBIRS infrared staring and scanning sensors are said to be demonstrably superior to those on GPS satellites in the scope, flexibility, and sensitivity of their coverage. The staring sensor "has high agility to rapidly stare at one Earth location and then move to other locations" and "will be used for step-stare or dedicated-stare operations over smaller geographic areas" than the scanning sensor can monitor, the Air Force claims.

Late last year, the Air Force and its contractors completed the final integrated system test of GEO-1, the first geosynchronous SBIRS satellite. The test verified that the spacecraft will perform as advertised, the Air Force announced.

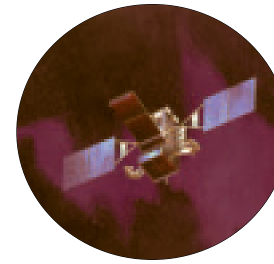
Lockheed Martin's Smith described the test as "disciplined and thorough" and called it "a major program milestone on the path to mission success." Lockheed officials also hailed another milestone: the successful baseline integrated system test of the first GEO satellite's updated flight software subsystem (FSS), in conjunction with satellite hardware.

Bringing the FSS software up to snuff and ensuring its stability required nearly two years of painstaking development, the Air Force says. FSS performs many tasks, such as operating and controlling the satellite's health, operational status, and safety; power management; fault detection and recovery; thermal control; and telemetry.

Development of the SBIRS stations on land also seems to have come along nicely, given last summer's successful system-level test of their interfaces with the satellites. According to the Air Force, that test validated the GEO satellite's command and control capability, demonstrating that the satellite and its ground stations are well able to transmit and receive data while frequency-hopping as planned.

Testing "validated the functionality, performance, and operability of the SBIRS GEO ground system" and demonstrated that "the ground system is on track to support launch of the first…GEO-1 satellite in the constellation," the Air Force claims. The test covered more than 1.5 million source lines of software code and 133 ground segment requirements, the service says.

With the launch of SBIRS GEO-1 nearly at hand, the outlook for the SBIRS program seems more upbeat than ever before. Lexington Institute's Thompson is among those who express that. Calling SBIRS "an absolutely essential space asset," he says that the Air Force and its contractors "succeeded in building SBIRS as originally envisioned," and that the reduction of SBIRS capabilities in the program's corrective retrenchment "did not happen."



The Space Tracking and Surveillance System, formerly named Brilliant Eyes, was an SDI early warning concept.