Order Code RS21148
Updated December 4, 2002

CRS Report for Congress

Military Space Programs: Issues Concerning DOD's Space-Based InfraRed System (SBIRS)

Marcia S. Smith
Specialist in Aerospace and Telecommunications Policy
Resources, Science, and Industry Division

Summary

The Department of Defense (DOD) is developing the Space-Based InfraRed System (SBIRS) to replace existing "early warning" satellites that alert U.S. military commanders to foreign missile launches, and to support missile defense objectives. SBIRS consists of two separate but related programs. SBIRS-High, managed by the Air Force, would replace existing Defense Support Program satellites. SBIRS-Low, managed by the Missile Defense Agency, would perform missile tracking, target discrimination, and other missile defense tasks. Both systems are encountering technical challenges, affecting cost and schedule. DOD requested $815 million for SBIRS-High, and $294 million for SBIRS-Low, in FY2003. The FY2003 DOD appropriations act (P.L. 107-248, H.R. 5010) cuts SBIRS-High by $30 million, and fully funds SBIRS-Low. The FY2003 DOD authorization act (P.L. 107-314, H.R. 4546) cuts $40 million from SBIRS-High, and fully funds SBIRS-Low. This report will be updated.

Satellite Early Warning Systems

The United States began developing early warning satellite systems in the 1950s to alert the National Command Authority to foreign missile launches. The current series is called the Defense Support Program (DSP). The first DSP was launched in November 1970; 21 have been launched to date. Two more have been built and are awaiting launch; each can operate for up to 10 years.[1] Four satellites reportedly are needed for a full operational capability; six satellites reportedly were operating as of January 2001.[2]

DSP satellites (built by TRW) use infrared sensors to detect the heat of fuel exhausts associated with missile launches. Sensors on the satellites also can detect nuclear bursts associated with the detonation of nuclear weapons. As recounted in a 2001 General

[1] Space News (January 7, 2002, p. 14)

[2] Space & Missile Defense Report, Jan. 18, 2001, p. 8. More recent data could not be obtained in the open literature.

Accounting Office (GAO) report,[3] DOD has wanted to build a replacement for DSP for more than two decades. None of the proposed replacement programs—the Advanced Warning System in the early 1980s, the Boost Surveillance and Tracking System in the late 1980s, the Follow-On Early Warning System in the early 1990s, and the Alert, Locate and Report Missiles System in the mid-1990s—reached fruition, according to GAO, "due to immature technology, high cost, and affordability issues." Instead, enhancements were made to the DSP series. For example, DSP was designed to detect launches of strategic long range missiles (such as Intercontinental Ballistic Missiles). However, the need to detect short range tactical missiles, such as Scud, was highlighted during the 1990-1991 Persian Gulf War. In 1995, DOD added the ALERT (Attack and Launch Early Reporting to Theater) system to DSP satellites to augment their theater missile warning capabilities.

DSP-type satellites are intrinsically part of any effort to develop a missile defense system because they provide the first warning that a foreign missile has been launched (during the missile's "boost" phase), but DSP also serves other objectives. Since the 1980s, there has been interest in developing a system explicitly to support missile defense —one that can track missiles as they progress along their flight path (the "mid-course" phase), detect and track warheads once they are deployed from the missile, and cue weapon systems to attack the missiles or warheads. A concept for a constellation of many satellites in low Earth orbit, called Brilliant Eyes, was developed during the 1980s under the auspices of the Strategic Defense Initiative Office (SDIO). Following a 1994 DOD study on how best to meet the nation's early warning needs, Brilliant Eyes was transferred to the Air Force, which was given responsibility to build an integrated Space-Based InfraRed System (SBIRS) with satellites in several orbits. Brilliant Eyes was renamed the Space and Missile Tracking System and became the low Earth orbit component of SBIRS (it was later renamed SBIRS-Low). The system to replace DSP was named SBIRS-High, consisting of satellites in geostationary orbit (GEO, where DSP satellites are placed) and sensors on other DOD satellites in highly elliptical orbits (HEO).[4]

SBIRS-High

Purpose, Design, and Cost Estimates. According to the Air Force [http://www.losangeles.af.mil/SMC/MT/BROCHURE/brochure.htm], SBIRS-High will perform four missions: missile warning, missile defense, technical intelligence, and battlespace characterization (observing and reporting on military activities on a

---

[3] U.S. General Accounting Office. Defense Acquisitions: Space-Based Infrared System-low at Risk of Missing Initial Deployment Date. GAO-01-6. Washington, U.S. GAO, Feb. 2001. For more detail on the history of U.S. early warning satellite systems, see: Richelson, Jeffrey. America's Space Sentinels. Lawrence, Kansas, University Press of Kansas, 1999.

[4] Geostationary orbit (GEO) exists 35,800 kilometers above the equator. A satellite in GEO maintains a fixed position relative to a point on Earth. Three or four properly spaced GEO satellites can view the entire globe, except for the polar regions. HEO orbits can provide coverage of the polar regions. A classic HEO orbit (called a Molniya orbit after the Soviet communications satellite system that first utilized it), has an apogee (the highest point of the orbit) of approximately 40,000 kilometers, and a perigee (the lowest point) of about 5,000 kilometers, giving the orbit an elliptical shape. With an inclination of about 63 degrees (the angle at which it intersects the equator), such an orbit allows a satellite to linger or "dwell" over the northern hemisphere for several hours per orbit, viewing parts of the globe not observable from GEO. DOD reportedly uses this type of orbit for classified satellites.

battlefield). It will consist of four operational GEO satellites (plus a ground spare), sensors on two classified DOD satellites in HEO, a ground-based Mission Control Station (MCS), and ground-based relay stations. MCS achieved initial operational capability in January 2002, and will be used for SBIRS-High and SBIRS-Low.

Aviation Week & Space Technology (November 18, 1996, p. 23) described the technical capabilities of SBIRS-High. It will have both high speed scanning sensors and staring sensors. After the scanning sensor detects a launch, it will cue the staring sensor to observe the event and provide more detailed data. DSP satellites, by contrast, have only the scanning sensors. DSP takes 40-50 seconds to detect a missile launch and determine its course, while SBIRS-High is being designed to make those determinations and relay warnings to ground forces in 10-20 seconds. A Lockheed Martin-Northrop Grumman team won a $2.16 billion contract to build SBIRS-High in 1996.

Issues. Cost growth and schedule slippage led Congress to deny all procurement funding for SBIRS-High in the FY2002 DOD appropriations act, while adding funds for research, development, test, and evaluation (RDT&E)—see below. Northrop Grumman officials assert that SBIRS-High met 19 key parameters for operational requirements in its critical design review, and the sensors are meeting or exceeding requirements.[5] But the House Appropriations Committee's report on the FY2002 DOD appropriations act (H.Rept. 107-298, p. 140) cited findings by GAO that the program is facing serious hardware and software design problems including sensor jitter, inadequate infrared sensitivity, and stray sunlight. (The GAO report is classified). *Space News* reported on January 7, 2002 (p. 14) that the program's cost estimate had grown from $1.9 billion to $4.5 billion, and the first launch slipped from 2002 to 2006. *Space News* attributed the cost increase to technical problems, including software development; faulty cost estimates; budget erosion; and schedule slippage.

In December 2001, SBIRS-High breached the "Nunn-McCurdy" 25% cost growth limit, which requires recertification of the program by the Undersecretary of Defense for Acquisition, Technology, and Logistics (USD/ATL) that the program meets certain criteria to continue USD/ATL Aldridge issued the recertification on May 2, 2002. DOD reportedly now estimates that SBIRS-High will cost $8.4 billion through 2010. DOD increased the Lockheed Martin contract by $2.15 billion in September 2002, bringing its value to $4.18 billion, which does not include the cost of three of the five GEO satellites.

FY2002 Budget Action and FY2003 Request. For FY2002, the Air Force requested $405 million for RDT&E, plus $94 million for procurement. The final FY2002 DOD authorization act (P.L. 107-107) approved all the RDT&E funding, but cut procurement funding to $48 million. In the FY2002 DOD appropriations act (P.L. 107-117), conferees denied all the procurement funding and added $40 million for RDT&E, for a total of $445 million.

The FY2003 request for SBIRS-High was $815 million for RDT&E; no procurement funds were requested. The FY2003 DOD appropriations act (P.L. 107-248) provides $785 million, a cut of $30 million. The FY2003 DOD authorization act (P.L. 107-314), cut $40 million

---

[5] Defense News, Jan. 8, 2002, p. 4-5.

SBIRS-Low

Purpose, Design, and Cost Estimates. SBIRS-Low is designed specifically to support missile defense. Management of the program was transferred from the Air Force back to the Ballistic Missile Defense Organization (BMDO, the successor to SDIO—see earlier discussion of Brilliant Eyes), to emphasize that missile defense is its primary objective. BMDO is now the Missile Defense Agency (MDA). For more on missile defense, see CRS Report RL31111, *Missile Defense: The Current Debate.*

The missile defense system is envisioned as a "layered" defense that can attack missiles or warheads in three different phases of flight: boost (launch), mid-course (enroute to a target, when warheads are deployed from the missile), and terminal (after reentry). SBIRS-Low is being designed to track missiles through all three phases; discriminate between warheads and decoys once they are deployed; transmit data to other missile defense systems that will be used to cue radars and provide intercept handovers; and provide data for intercept hit/kill assessments.[6] Tracking missiles during the mid-course phase is more difficult than during boost, because the missile is no longer firing its engines and hence does not have a strong infrared (heat) signature. Similarly, tracking warheads after they have been deployed, and discriminating between warheads and decoys, is a technically challenging task. SBIRS-Low will be equipped with optical, mid- and long-wave infrared sensors to accomplish its mission. The satellites also will have communications cross links so they can communicate with each other directly.

Cost estimates are problematic because the program was recently restructured (see below), and there is no final system architecture. In its February 2001 report, GAO reported that DOD had estimated the life-cycle cost for SBIRS-Low through FY2022 at $11.8 billion. The House Appropriations Committee reported in late 2001 (H.Rept. 107-298, p. 250) that the program's life cycle cost had grown from $10 billion to over $23 billion. In January 2002, the Congressional Budget Office estimated the cost through 2015 at $14-17 billion (of which $1 billion was appropriated prior to FY2002).

Two industry teams were chosen in 1999 for program definition and risk reduction (PDRR), one led by Spectrum Astro and Northrop Grumman, and the other led by TRW and Raytheon. DOD was expected to select one of the teams for the next phase (Engineering and Manufacturing Development) in mid-2002 and the satellites were to have been launched between 2006 and 2010.[7] In the April 2002 restructuring (see below), however, DOD decided to merge the teams. TRW will be the prime contractor, and Spectrum Astro a major subcontractor, for building the satellites. Competition will continue for the sensor, however, with Raytheon and Northrop Grumman pursuing parallel sensor development to demonstrate on-orbit performance with the R&D satellites.

---

[6] BMDO FY2002 RDT&E budget justification (R2-A Exhibit, Project 5020, PE0603774C): [http://www.dtic.mil/comptroller/fy2002budget/budget_justification/index.html].

[7] The first launch was scheduled for 2006, but Congress directed DOD to accelerate the schedule to 2002. The Defense Science Board concluded that 2002 was technically feasible, but 2004 would represent a more efficient approach. (Aerospace Daily, Oct. 3, 1996, p. 18; Space News, Sept. 16-22, 1996, p. 10.) The date then slipped back to 2006 primarily due to funding issues.

Issues. Congress began expressing concern about SBIRS-Low (then known as the Space and Missile Tracking System) as early as 1996, particularly in terms of program management.[8] Indications of technical and funding problems emerged in 1999 when DOD cancelled contracts with TRW and Boeing to build and launch three prototype demonstration satellites because of significant cost growth.[9] Questions began to arise as to whether SBIRS-Low was truly vital to a missile defense system.

Views on the need for SBIRS-Low vary. Some assert that missile defense cannot be achieved without such a system, while others argue that there are alternatives, such as ground based radars. To some extent, the answer may depend on the nature of the threat the missile defense system is expected to defeat (e.g., number of incoming warheads, sophistication of countermeasures). Radars have been used for early warning of missile launches for decades, and already are envisioned as part of the missile defense system. To provide effective coverage, the radars must be based not only in the United States, but in other countries—radars in England and Greenland are part of the early warning system on which the United States relies today. The question is whether ground based radars can substitute for SBIRS-Low. They may be less costly to build and maintain than a multi-satellite constellation such as SBIRS-Low, but the need to locate them in other countries could be a disadvantage if the countries with suitable geographic locations were to decline to accommodate them. Without an extensive network, there also might be gaps in coverage such that missiles could not be tracked throughout their flights. Thus, trade-offs must be made between the cost and availability of space based versus ground based systems, and the capabilities each offers. In its November 19, 2001, report on the FY2002 DOD appropriations bill (H.R. 3338, H.Rept. 107-298, p. 250), the House Appropriations Committee cited an internal DOD study that indicated ground based radars are a viable, lower cost, and lower risk, alternative to SBIRS-Low.

In its February 2001 report (cited earlier), GAO raised a number of questions about whether SBIRS-Low could meet its technical milestones. It found that five of six critical satellite technologies were too immature to ensure they would be ready when needed: the scanning infrared sensor, tracking infrared sensor, fore optics cryocooler, tracking infrared sensor cryocooler, and satellite communications crosslinks. GAO also cited concurrency as a concern in that satellite development and production were scheduled to occur at the same time; the results of an on-orbit test would not be available until 5 years after the satellites entered production; and software would be developed concurrent with the deployment of the satellites and not be completed until more than 3 years after the first SBIRS-Low satellites were launched. Others cite the ability to discriminate between targets and decoys, and the ability to share information between satellites, as significant technical hurdles (*Wall Street Journal*, June 15, 2001, pp. A1, 6).

In its November 2001 report, the House Appropriations Committee expressed concern about "markedly negative trends in cost, schedule, and performance estimates" (pp. 249-250). The committee noted sharp growth in the number of lines of software code needed; spacecraft weight growth; and a total program life cycle cost that had grown from $10 billion to over $23 billion. Consequently, the committee zeroed funding for the program and instead created a Satellite Sensor Technology program funded at $250

---

[8] Authorizers Blast DOD for SMTS Management. Aerospace Daily, Aug. 8, 1996, p. 207.

[9] Ferster, Warren. SBIRS Demonstration Projects Terminated. Space News, Feb. 15, 1999, p. 1.

million, and a Ground Sensor Technology program funded at $75 million, as a possible alternative to SBIRS-Low. Conferees on the bill adopted the $250 million for Satellite Sensor Technology, but allowed the Secretary of Defense to choose to spend it on SBIRS-Low or new technology. The $75 million for ground sensor technology was not approved. Support for SBIRS-Low in the Bush Administration appeared mixed. The White House opposed termination of SBIRS-Low in its November 28, 2001 Statement of Administration Policy on H.R. 3338, but DOD's Comptroller and the USD/ATL reportedly urged conferees not to rescue the program (Defense Daily, Dec. 19, 2001, p 1).

A restructuring plan was submitted to Congress on April 15, 2002. Last year, a system consisting of 20-30 satellites was envisioned, with the first launch in 2006. Original FY2003 DOD budget materials indicated that the launch would slip to 2008, but under the April 15 restructuring plan, two demonstration satellites will be launched beginning in FY2006 or FY2007. MDA will use its "spiral development" strategy for SBIRS-Low and these demonstration satellites will have less capability than what was expected. Thus, DOD is returning to the 1999 plan to launch demonstration satellites. Sensors and flight structures built for those demonstrations satellites will be used for the new ones. New technologies will be introduced in future satellites as they mature, with incremental improvements in satellite lifetimes, focal plane arrays, and cryocoolers, for example. The restructuring plan did not include a new system cost estimate, but said out-year funding estimates would be developed as part of the FY2004-2009 Future Years Defense Plan. In August 2002, DOD awarded TRW an $869 million contract to build the two demonstration satellites plus eight operational satellites for an initial constellation.

FY2002 Budget Action and FY2003 Request. DOD requested $385 million for SBIRS-Low for FY2002. Congress approved the full request in DOD authorization act (P.L. 107-107), but did not fund it directly in the appropriations act (P.L. 107-117). Instead, it provided $250 million for a new program, Satellite Sensor Technology, for risk reduction and maturation of new sensor technologies. Congress permitted the Secretary of Defense to spend that funding for SBIRS-Low, however, and the FY2003 budget shows $246 million being spent on SBIRS-Low in FY2002. DOD's FY2002 omnibus reprogramming request would reprogram another $13.4 million into SBIRS-Low.

For FY2003, DOD requested $294 million. The FY2003 DOD appropriations act (P.L. 107-248) and authorization act (P.L. 107-314) funds the program at the requested level.