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Military Space Programs: Issues Concerning DOD's SBIRS and STSS Programs

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

Summary

The Department of Defense's (DOD's) programs to develop new satellites to alert U.S. military commanders to foreign missile launches, and to support missile defense objectives, are controversial because of cost growth and schedule slippage. SBIRS-High, managed by the Air Force, would replace existing Defense Support Program "early warning" satellites. The Space Tracking and Surveillance System (STSS, formerly SBIRS-Low), managed by the Missile Defense Agency, would perform missile tracking and target discrimination for missile defense objectives. The SBIRS-High program has breached Nunn-McCurdy cost growth thresholds three times since 2002, most recently in March 2005. 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 satellite was launched in November 1970; 22 have been launched to date, most recently in February 2004. The final DSP was delivered to the Air Force in May 2005 for launch later in the year. Each DSP can operate for up to 10 years.[1] Four satellites reportedly are needed for a full operational capability. Six satellites reportedly were operating in January 2001.[2]

DSP satellites (built by Northrop Grumman Space Technology, which was formerly TRW Space and Electronics) 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. A February 2001 General Accounting

[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.

Office (GAO, now the Government Accountability Office) report[3] recounted DOD's attempts to build a replacement for DSP over 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 "due to immature technology, high cost, and affordability issues," according to GAO. 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. Later it was 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] In 2001, SBIRS-Low was shifted back to the Ballistic Missile Defense Organization (BMDO), which was SDIO's successor and is now the Missile Defense Agency. That action was taken to stress that SBIRS-Low's main purpose is to support ballistic missile defense. The satellite program has since been renamed again, and is now the Space Tracking and Surveillance System (STSS).

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[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 500 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.

SBIRS-High

Purpose, Design, and Cost Estimate. SBIRS-High is intended to perform four missions: missile warning, missile defense, technical intelligence, and battlespace characterization (observing and reporting on military activities on a 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 using the existing DSP satellites.

In 1996, *Aviation Week & Space Technology* described the technical capabilities of SBIRS-High (November 18, 1996, p. 23) that were expected at that time. Reportedly it would have high speed scanning sensors and staring sensors. After the scanning sensor detected a launch, it would cue the staring sensor to observe the event and provide more detailed data. DSP satellites, by contrast, reportedly have only scanning sensors. DSP takes 40-50 seconds to detect a missile launch and determine its course, while SBIRS-High was being designed to make those determinations and relay warnings to ground forces in 10-20 seconds. The extent to which these technical design characteristics are still planned is unclear.

A Lockheed Martin-Northrop Grumman team won a $2.16 billion contract to build SBIRS-High in 1996. In September 2002, DOD increased the contract to $4.18 billion, which does not include the cost of three of the five GEO satellites. In the FY2006 budget request, the estimate for SBIRS-High engineering and manufacturing development is $7.7 billion, $1.9 billion (33%) more than the $5.8 billion estimate in the FY2003 budget (The estimates exclude three of the GEO satellites and certain other costs). In October 2004, conferees on the FY2005 DOD authorization bill noted that the cost had grown to $10 billion, from a 1996 estimate of $3.6 billion (H.Rept. 108-767, p. 559). According to Reuters (March 22, 2005), then-Acting Air Force Secretary Peter Teets estimated the cost at $12 billion.

Issues. The SBIRS-High program is controversial because of cost growth and schedule slippage caused by technical challenges that have been encountered in developing the sensors and satellites. In the FY2002 DOD appropriations act, Congress denied all procurement funding ($94 million had been requested) because it felt more research and development (R&D) was required. It added $40 million to the $395 million requested for R&D. 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 was 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% program acquisition unit cost (PAUC) growth limit, which requires certification that the program meets certain criteria to continue. DOD issued the certification on May 2, 2002, and the Air Force restructured the program. DOD decided to pay for the first two GEO satellites (scheduled for launch in FY2006 and FY2007) using research, development, test, and evaluation (RDT&E) funds. The plan was to purchase the remaining three satellites with procurement funds, with a two-year gap between the first two and the last three. Some questioned whether that decision could increase total program costs because the contractor would have to rebuild its team for the later satellites. DOD argued that the two-year break will provide time to learn from the earlier satellites and make improvements.

A May 2003 report of the Defense Science Board and Air Force Scientific Advisory Board [http://www.acq.osd.mil/dsb/reports/space.pdf] criticized early program management of SBIRS-High, and took a cautious attitude concerning whether the restructured program would succeed. An October 2003 GAO report (GAO-04-48) concluded the program remained at "substantial risk of cost and schedule increases." In 2004, the program experienced further setbacks. Delivery of the first SBIRS-High sensor, for launch on one of the HEO satellites, slipped from summer 2003 to August 2004 because of electromagnetic interference between the sensor and other spacecraft equipment. Launch of the first GEO satellite slipped by two years; first launch is now expected in 2008. DOD reportedly is examining whether to proceed with all of the last three GEO satellites.[5] In June 2004, DOD notified Congress that the program had breached a different Nunn-McCurdy threshold, a 15% PAUC cost increase, which requires notification to Congress, but not a certification. In March 2005, Mr. Teets informed Congress that the program breached the Nunn-McCurdy thresholds for a third time, and ordered an independent assessment of program costs.

FY2006 Budget Request. DOD is requesting $756 million. The House-passed FY2006 DOD authorization bill (H.R. 1815), its companion in the Senate, which has been reported from the Senate Armed Services Committee (S. 1042), and the House-passed FY2006 DOD appropriations bill (H.R. 2683), provide full funding, although the House Appropriations report calls the program "extremely troubled" (H.Rept. 109-119, p. 181).

Space Tracking and Surveillance System (formerly SBIRS-Low)

Purpose, Design, and Cost Estimates. The Space Tracking and Surveillance System (STSS, previously SBIRS-Low) is designed 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*. Funding for STSS appears under BMD Sensors in the MDA section of the Defense-Wide portion of DOD's budget.

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). The goal of an operational STSS is to track missiles through all three phases; discriminate between warheads and decoys; transmit data to other systems that will be

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[5] For example, see (1) U.S. Air Force Studies Alternatives to Last 3 SBIRS Satellites. Space News, April 5, 2004, p. 9 and (2) April 20 SBIRS Review to Focus on Three Satellites. Aerospace Daily, April 1, 2004, p. 1-2.

used to cue radars and provide intercept handovers; and provide data for intercept hit/kill assessments. 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, making it necessary to track a cold object against the cold background of space. Similarly, tracking warheads after they have been deployed, and discriminating between warheads and decoys, is a technically challenging task.

Cost estimates are problematic because there is no final system architecture and the schedule is in flux. In its February 2001 report, GAO reported that DOD had estimated the life-cycle cost for STSS (then 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 March 2005, GAO reported (GAO-05-243) that DOD's estimate for the program between 2002 and 2011 is approximately $4.5 billion; a life cycle cost was not provided.

Two industry teams were chosen in 1999 for program definition and risk reduction (PDRR): Spectrum Astro/ Northrop Grumman, and TRW/ Raytheon. DOD was expected to select one of the teams for the next phase in mid-2002 and the satellites were to have been launched between 2006 and 2010.[6] In the April 2002 restructuring (see below), DOD merged the teams. Northrop Grumman Space Technology (formerly TRW Space & Electronics) is the prime contractor, and Spectrum Astro (later acquired by General Dynamics) is a major subcontractor, for building the satellites.

Issues. This program has gone through several name changes, making it difficult to track. Congress began expressing concern about it in 1996, when it was known as the Space and Missile Tracking System, particularly in terms of program management.[7] Indications of technical and funding problems publicly emerged in 1999 when DOD cancelled contracts with TRW and Boeing to build and launch three prototype demonstration satellites because of significant cost growth.[8] In the early 2000s, when its name was SBIRS-Low, questions arose as to whether it was vital to a missile defense system. Views 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, or 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 might have to 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 or sea-based radars can substitute for a space-based system, especially now that the United States is no longer bound by numerical and geographic limitations imposed on

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[6] 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.

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

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

radars that are part of an anti-ballistic missile (ABM) system by the 1972 ABM treaty. In its November 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. (A "BMDS Radars Project" is now part of the BMD Sensors program; a discussion of that program is outside the scope of this report).

Technical challenges continued. In its February 2001 report (cited earlier), GAO found that five of six critical satellite technologies were too immature to ensure they would be ready when needed. The House Appropriations Committee, in its November 2001 report (cited above), expressed concern that the program's life cycle cost had grown from $10 billion to over $23 billion. Consequently, the committee zeroed funding ($385 million was requested) and instead created a Satellite Sensor Technology program ($250 million) and a Ground Sensor Technology program ($75 million) as an alternative. Conferees approved the $250 million for Satellite Sensor Technology, but allowed the Secretary of Defense to spend it either on SBIRS-Low or new technology. It was spent on SBIRS-Low.

A restructuring plan was submitted to Congress on April 15, 2002. A system consisting of 20-30 satellites had been envisioned, with the first launch in 2006. The restructuring plan called for completing two "legacy" demonstration satellites that had been partially built as part of the 1999 plan, and launching them in 2006 and 2007. New technologies would be introduced in future satellites, and two new demonstration satellites would be launched beginning in 2010. In August 2002, DOD awarded Northrop Grumman Space Technologies an $869 million contract to complete the two legacy satellites, develop a ground system, and conduct preliminary engineering analysis of the new demonstration satellites, with options for building eight operational satellites. The program's name was changed to Space Tracking and Surveillance System (STSS). MDA modified the plan in late 2002 after it reduced STSS funding; GAO criticized many of those changes in a May 2003 report (GAO-03-597).

STSS is proceeding in a series of biennial "blocks." According to MDA's FY2006 budget documents, STSS' Block 2006 is the launch of the two legacy satellites; Block 2008 is an improvement of the ground system; and, in Block 2012, operational satellites will be integrated into the program. Block 2010, which appeared in FY2005 budget documents (without descriptive detail), is shown at zero in MDA's FY2006 documents. A March 2005 GAO report (GAO-05-243) states that the program content of Block 2010 and beyond is classified (and, thus, funding for Block 2010 could be in the classified version of the budget). GAO reported that its review of STSS activities in 2004 did not find any indication that the two legacy satellites would not be able to launch on schedule.

FY2006 Request. According to DOD's FY2006 budget documentation, $232 million is requested for STSS in the unclassified budget. No changes are specified in the House-passed or Senate-committee reported DOD authorization bills. The House-passed appropriations bill (H.R. 2863) cuts $4 million, but cites the request as $235.5 million. The House Appropriations Committee restructured MDA's budget, and the accompanying report (H.Rept. 109-119, p. 289, 294) refers to this as the Space Surveillance and Tracking System (SSTS), not STSS, but it apparently is the same program. Under that structure, it has its own line item, rather than being part of BMD sensors.