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

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## 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. For FY2004, DOD is requesting $617 million for SBIRS-High RDT&E, $95 million for SBIRS-High procurement (of a backup control station), and $300 million for STSS RDT&E. The House approved the requested funding in the FY2004 DOD authorization bill, while the Senate cut STSS by $15.5 million (H.R. 1588/S. 1050). In the FY2004 DOD appropriations act (P.L. 108-87), SBIRS-High is fully funded, and STSS is cut by $15.5 million. 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]

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[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.

DSP satellites (built by TRW Space and Electronics, which is now Northrop Grumman Space Technology) 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 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. 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

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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 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.

program has since been renamed again, and is now the Space Tracking and Surveillance System (STSS).

## 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.

*Aviation Week & Space Technology* (November 18, 1996, p. 23) described the expected technical capabilities of SBIRS-High. Reportedly 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, reportedly have only 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. 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. In the FY2004 budget request, the total SBIRS-High cost for engineering and manufacturing development (EMD) is shown as $6.3 billion, a 9% increase over DOD's prior estimate (in the FY2003 budget documentation) of $5.8 billion. That figure does not include certain other costs that reportedly bring total projected program costs to $8-8.5 billion.[5]

**Issues.** The SBIRS-High program has become 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% 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

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[5] Delayed SBIRS-High Payload to be Delivered in May. Aerospace Daily, April 8, 2003, p. 3.

criteria to continue. Then-USD/ATL Pete Aldridge issued the recertification on May 2, 2002, and the Air Force restructured the program. *Space News* reported on February 17, 2003 (page 8) that the first SBIRS-High sensor, intended to be launched on one of the HEO satellites, had encountered technical difficulties and its delivery was delayed. 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 remaining three will be bought with procurement funds, and there will be a 2-year gap between the first two and the last three. Some question whether that decision could increase total program costs because the contractor will have to rebuild its team for the later satellites. DOD argues that the 2-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/space.pdf] on acquisition of national security space programs sharply 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 remains at "substantial risk of cost and schedule increases" despite the restructuring.

**FY2004 Request and Congressional Action.** The FY2004 request was $617 million for RDT&E, and $95 million for procurement of a backup mission control station. Congress approved full funding in the FY2004 DOD appropriations actl (P.L. 108-87). In the FY2004 DOD authorization bill (H.R. 1588/S. 1050), the House added $15 million for RDT&E, while the Senate approved full funding. The report from the Senate Armed Services Committee (S.Rept. 108-46) called the 2-year gap in acquiring the satellites "unwise" (page 244).

## Space Tracking and Surveillance System (formerly SBIRS-Low)

**Purpose, Design, and Cost Estimates.** The Space Tracking and Surveillance System (STSS, previously named 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). 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 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 January 2002, the Congressional Budget Office estimated the cost through 2015 at $14-17 billion.

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.[6] In the April 2002 restructuring (see below), DOD decided to merge the teams. Northrop Grumman Space Technology (formerly TRW Space & Electronics) is the prime contractor, and Spectrum Astro a major subcontractor, for building the satellites. Competition between Raytheon and Northrop Grumman to build the sensors was to continue, but a May 2003 GAO report (see below) reports that MDA now plans to fund tentatively the design, but not the production, of a competitive sensor.

**Issues.** This program has gone through several name changes, making it difficult to track. Congress began expressing concern about it as early as 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 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 began to arise as to whether it was truly vital to a missile defense system. Views on the need for this type of capability 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 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 a space-based system, especially now that the United States is no longer bound by numerical and geographic limitations imposed on radars that are part of an anti-ballistic missile (ABM) system by the 1972 ABM treaty. Ground-based radars may be less costly to build and maintain than a multi-satellite constellation, but the need to locate them in other countries could be a disadvantage if the countries with suitable geographic

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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.

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. Sea-based radars may be another alternative. 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. In the FY2004 budget request, DOD requested $101 million under the sensor line item to study radars further.

Technical challenges have continued. In its February 2001 report (cited earlier), GAO raised a number of questions about whether the program (then SBIRS-Low) could meet its technical milestones. For example, it 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 too, including that the program's life cycle cost that 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 a possible alternative. Conferees approved the $250 million for Satellite Sensor Technology, but allowed the Secretary of Defense to choose to spend it either on SBIRS-Low or new technology. (It was spent on SBIRS-Low.) The ground sensor technology program was not approved in conference.

A restructuring plan was submitted to Congress on April 15, 2002. Previously, a system consisting of 20-30 satellites was 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 (formerly TRW) 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). In May 2003, GAO reviewed (GAO-03-597) changes made to the restructuring plan by MDA in late 2002 because MDA decided to reduce STSS funding. Under this plan, both legacy demonstration satellites will be launched in 2007. Work on one (rather than two) new demonstration satellite will begin in 2003, with launch delayed from 2010 to 2011. GAO criticized MDA's decisions because it asserts that MDA does not understand the status of the legacy hardware and therefore the schedule risks associated with the 2007 launch date. It also criticized the decision to delay development and launch of new demonstrators because, GAO says, MDA already knows that it wants to pursue different designs and different technologies than in the legacy satellites. Further, GAO reports that MDA decided to forego production of sensors from a competing contractors, thereby losing the potential benefits of competition.

**FY2004 Request and Congressional Action.** The FY2004 request for STSS was $300 million for RDT&E. Congress cut STSS by $15.5 million in the FY2004 DOD appropriations act (P.L. 108-87). In the FY2004 DOD authorization bill (H.R. 1588/S. 1050), the Senate cut STSS by $15.5 million, while the House approved the requested amount.