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STSS/PTSS

Outlook

- PTSS terminated in FY14 budget proposal; unlikely to be resurrected in Congress, which is looking to balance the budget
- Precision Tracking Space System (PTSS) was to incorporate lessons from the STSS and SBIRS Low programs
- Block 2006 satellites underwent extensive testing in 2010 and 2011
- Barring any further developments, this report will be archived in 2014

Orientation

Description. The U.S. Department of Defense has a goal to develop satellites to provide space-based persistent global coverage of possible ballistic missile launches.

Sponsor. The U.S. Department of Defense's Missile Defense Agency is responsible for the STSS programs. The contracting authority is the Missile Defense Agency, through the U.S. Air Force Space and Missile Systems Center, El Segundo, California.

Status. The U.S. Department of Defense is currently funding the STSS to develop technologies and techniques necessary for a missile warning satellite system. PTSS has been terminated due to budget constraints.

Two STSS demonstration satellites were launched in September 2009, and continue to operate in orbit.

Total Produced. Two Block 2006 demonstrator satellites were produced in the late 1990s. One Block 2010 (STSS ATRR) satellite has also been produced.

Application. PTSS satellites were planned to operate in low-Earth orbit and use passive sensors to detect and track objects (primarily hostile nuclear warheads), discriminate hostile re-entry vehicles from decoys, and provide targeting information to ground-based interceptors.

Price Range. STSS satellites were estimated to cost between $350 million and $500 million each. The entire STSS program was expected to cost about $20 billion. The PTSS program was expected to cost a similar amount.

Contractors

Prime

Northrop Grumman Aerospace Systems, Space Systems	http://www.as.northropgrumman.com, 1 Space Park, Redondo Beach, CA 90278 United States, Tel: + 1 (310) 812-4321, Fax: + 1 (310) 813-7548, Prime
Aerospace Corp	http://www.aero.org, 2350 E El Segundo Blvd, El Segundo, CA 90245-4691 United States, Tel: + 1 (310) 336-5000, Fax: + 1 (310) 336-8249, RDT+E

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	(Systems Engineering and Integration)
General Dynamics C4 Systems	http://www.gdc4s.com, 8201 E McDowell Rd, Scottsdale, AZ 85252-3812 United States, Tel: + 1 (480) 441-3033, Email: info@gdc4s.com, RDT+E (Risk Reduction and Definition Studies)

Subcontractor

Raytheon Network Centric Systems, Command and Control Systems (C2S)	http://www.raytheon.com/businesses/ncs/c2s/, 6620 Chase Oaks Blvd, M/S 8529, Building 4, Plano, TX 75023 United States, Tel: + 1 (972) 575-2647 (Block 2006 Sensor Payloads)

Comprehensive information on Contractors can be found in Forecast International's "International Contractors" series. For a detailed description, go to www.forecastinternational.com (see Products & Services/Governments & Industries) or call + 1 (203) 426-0800.

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

Design Features. Like the now-defunct SBIRS Low satellites, STSS spacecraft were designed to use passive surveillance techniques to spot and track missile exhaust plumes. Two infrared sensors were to be installed on each spacecraft. One, called the acquisition sensor, was intended to provide wide-field-of-view infrared scanning.

Once the acquisition sensor had spotted a missile plume, the information would pass to a track sensor featuring a narrow field of view. The track sensor was to be mounted on a two-axis gimbal, and was capable of locking on to a target and tracking it into its re-entry phase. Onboard processing would provide data on the target's impact point and then pass this information to ground-based interceptors.

STSS satellites were designed to have inter-satellite crosslinks, with each satellite able to communicate with all other satellites in the constellation (plans had called for at least eight spacecraft). Since STSS satellites were intended to operate in low-Earth orbits (constantly moving over various regions of the Earth's surface), this ability to hand over targeting information from one satellite to another would allow a target to be tracked even if it left the field of view of any one satellite.

PTSS. The overall goal of the PTSS program was to develop space-based assets that can complement other detection and fire control capabilities within the overall Ballistic Missile Defense (BMD) architecture, including AEGIS Ballistic Missile Defense and ground-based interceptor weapon systems.

The program worked to improve certain aspects of the STSS. Under the program, the Pentagon worked to simplify the design, incorporate components with high degrees of readiness, and involve industry and military services more actively than in the past.

Artist's Conception of STSS Block 2006 Satellites

Source: Northrop Grumman Space Technology

Program Review

Background. STSS (formerly SBIRS Low, Brilliant Eyes, and Space and Missile Tracking System) was part of a comprehensive program aimed at replacing existing Defense Support Program (DSP) satellites with an advanced system capable of providing initial warning of a ballistic missile attack on the United States, its deployed forces, or its allies. The complete STSS architecture was planned to consist of approximately eight satellites in a low-Earth orbit, which were to be used in combination with four satellites in geosynchronous orbits (SBIRS High), two satellites in highly elliptical orbits (HEO), and related ground receiving stations.

SSTS. The DoD's current efforts to develop a low-Earth-orbiting missile detection satellite constellation can trace its roots to the Strategic Defense Initiative's Space-Based Sensors Program, which has undergone a number of changes since the SDI program officially began in 1984. In the mid-1980s, the Strategic Defense Initiative Organization (now called the Missile Defense Agency) worked to develop the Space Surveillance and Tracking System (SSTS), a constellation of large, complex, and very expensive spacecraft to provide mid-course tracking of ballistic missiles.

GPALS. In late 1990, the Pentagon reconsidered the SSTS scheme as part of an overall shift toward the Global Protection Against Limited Strikes (GPALS) concept. Under the GPALS concept, the U.S. would purchase nearly 100 smaller, less capable satellites known as Brilliant Eyes instead of about 18 very capable, yet expensive, SSTS spacecraft. In 1991, Rockwell International (now part of Boeing) and TRW Inc (now part of Northrop Grumman) were awarded demonstration/validation (dem/val) contracts worth $265 million and $233.5 million, respectively.

SBIRS. By 1994, the Pentagon again had decided to change course when it announced a new program dubbed Space Based Infrared System (SBIRS). SBIRS was planned to consist of 30 satellites in a low-Earth orbit.

The USAF awarded two contracts to build competing prototypes under the SBIRS program. In 1995, TRW was selected to build the SBIRS Low Flight Demonstration System (FDS), and in 1996, a Lockheed Martin/Rockwell (now part of Boeing Co) team was selected to build the Low Altitude Demonstration System (LADS). The Air Force planned to award a single contract in 1999 to build the SBIRS Low system.

In 1999, the Air Force shifted funding for these efforts to an expanded Program Definition and Risk Reduction (PDRR) effort. This time, there were two teams. The first consisted of Spectrum Astro and Northrop Grumman, and the second consisted of TRW (now part of Northrop Grumman) and Raytheon.

SBIRS Low Shifted to MDA. Overall responsibility for SBIRS Low was transferred from the Air Force to the Ballistic Missile Defense Organization (now the Missile Defense Agency) in October 2001. The move was in keeping with the agency's broad-based approach to missile-defense architecture.

SBIRS Low Program Gets a Makeover

STSS. By early 2002, both the Bush administration and congressional members concurred that the SBIRS Low program had run into cost, scheduling, and performance problems. SBIRS Low's lifetime cost estimates had increased from $10 billion to $23 billion. In August 2002, the SBIRS Low program was canceled in favor of yet another plan to achieve the same goal: the Space Tracking and Surveillance System (STSS).

That month, the USAF Space and Missile Systems Center and MDA awarded Northrop Grumman Space Technology (which had recently purchased TRW Inc) an $868.7 million contract. The contract called for Northrop Grumman to develop and deliver two STSS demonstrator satellites and a ground segment, and provide core systems engineering support through September 2008. Major subcontractors included Raytheon Corp, Spectrum Astro, and Northrop Grumman Electronic Systems.

The MDA decided to save costs by having the contractors complete the construction of two SBIRS Low Flight Demonstrator spacecraft that the former TRW had begun building in the late 1990s.

A Government Accountability Office (GAO) report, released in June 2003, criticized the MDA's plan, citing the following problems:

- The MDA chose to complete the development of existing legacy satellites knowing that it wanted to pursue different designs and technologies for its target STSS, and that the legacy systems would not support a producible design. The decision may ultimately only serve to delay work on new satellites that could offer a better demonstration basis from which MDA could build an operational capability.

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- MDA established a 2007 launch date without assessing whether or not the required building blocks were in working condition, and therefore did not really know the cost or extent of the work that might be required before the spacecraft could be launched.
- The MDA's elimination of competitive procurement funds reserved to procure an alternative satellite sensor from a competing contractor in favor of funding only related design efforts could raise the costs of STSS considerably if the MDA was ultimately locked into a single contractor for both design and production of the constellation.

MDA Open to Alternatives – Again

The Missile Defense Agency said it would consider pursuing alternate approaches, including launching the legacy satellites and stopping work on the old systems to develop new demonstrators instead.

However, the GAO recommended that the MDA focus its spending on assessing what needed to be done to complete its current work, pulling together a reasonable basis for its cost and scheduling estimates. It further suggested that the MDA consider strategic alternatives that may offer higher potential for risk reduction and increased knowledge.

The DoD partly concurred with two of the GAO's recommendations and fully agreed with two others, including the imprudence of delaying the 2007 launch of the demonstrator satellites. The need to make overall STSS ballistic missile defense sensor assessments by the end of 2007 was deemed crucial.

Block 2006 Payload Delivered

Raytheon delivered the first Block 2006 sensor payload for the missile-detection STSS to Northrop Grumman in March 2006. The Block 2006 payload developed by Raytheon consists of an infrared acquisition-and-track sensor suite that was integrated into STSS satellites. This early-warning missile detection technology enables target acquisition and tracking above and below the horizon. The payload further enables missile events to be tracked from liftoff through mid-course in real time.

Raytheon Delivers STSS Sensors

In February 2007, Raytheon delivered the second of two advanced infrared sensor payloads to Northrop Grumman Space Technology for the STSS Block 2006 program. Block 2006 R&D satellites were designed to demonstrate the key functions of a space-based sensor within the Ballistic Missile Defense System, passing missile tracking data to missile defense interceptors with the accuracy and timeliness necessary to enable them to successfully intercept missile targets.

Northrop Grumman Reaches Milestones

In 2007, Northrop Grumman carried out the last ground segment acceptance test for STSS. The test was held at the STSS ground operations center at the Missile Defense Space Experimentation Center (MDSEC) at Schriever AFB in Colorado Springs, Colorado.

Northrop Grumman said it had also successfully carried out a final STSS operational readiness demonstration at the MDSEC that demonstrated ground system hardware and software.

The MDA launched the STSS Advanced Technology Risk Reduction (ATRR) satellite from Vandenberg Air Force Base, California, on board a Delta II launch vehicle in May 2009. STSS ATRR is a small experimental satellite that serves as a pathfinder for next-generation sensor technology for future MDA space missions. The program takes multiple approaches to reduce overall risk to the layered Ballistic Missile Defense System (BMDS) through sensor testing, launch and space vehicle integration, resource protection and security planning, and launch site processing.

The first STSS demonstrator (Block 2006) satellite was delivered to Cape Canaveral for launch in June 2009, with the second satellite delivered a month later. The two satellites were launched aboard a Delta II from Cape Canaveral on September 25, 2009.

The satellites experienced some in-orbit issues, such as problems with the attitude control software. Those problems have since been fixed. Because of a lack of funding, no live tests were conducted in 2009.

In 2010, the STSS demonstrator satellites in orbit underwent a number of tests. In June, the satellites detected the launch of two ground-based interceptors and a Minuteman III. In September, the satellites detected and tracked an NOAA weather satellite. By November 2010, on-orbit calibration of the acquisition and tracking sensors of the two satellites had been completed. In addition, the satellites had demonstrated the ability to hand off data from the acquisition sensor to the tracking sensor.

The tests continued in 2011. In January, the RF communications link between the two satellites was demonstrated. Tests demonstrated continually more difficult situations. In March, the satellites tracked a ballistic missile from launch to the end of its flight. Later in the month, the tracking sensor was cued faster than it had been previously. In April, both satellites acquired and tracked a target while only one was in communication with the ground. In July, trajectory

information of a test missile was sent to the STSS demonstration satellites. They were able to use that data to detect the missiles, and track their movement. Later that month, STSS satellites detected an air-launched target. And in November, the satellites tracked multiple targets and transmitted the data to ground stations.

In August 2012, STSS satellites collected data from a mock medium-range ballistic missile during tests and transferred that information to an AEGIS-equipped warship. The warship successfully intercepted the missile.

The MDA will use the results of these tests to refine future requirements for a satellite network, and integrate the satellites into the overall BMDS.

PTSS. In its FY11 budget request, the MDA requested funding for a new program, dubbed the Precision Tracking Space System (PTSS). The new program planned to use knowledge gained from the STSS demonstrator satellites currently in orbit to develop a missile warning and tracking satellite system. The goal of the program was to demonstrate a prototype satellite by FY14. Funds were to be used to cover trade studies, alternative analysis and concept review; define and document the internal and external interfaces; conduct software-in-the-loop testing; and complete systems requirement reviews, system design reviews, and preliminary design reviews.

The House of Representatives proposed terminating funding for the program. However, in conference, $80.8 million was restored to the program for FY12.

Despite the last-minute save in FY12, the Missile Defense Agency proposed to terminate the program in FY14, citing budget constraints.

Funding

The Missile Defense Agency provides funding for the STSS program under PE#0603893C. The MDA provided funding for PTSS in PE#0604883C. PTSS has been terminated. The following is excerpted from the MDA FY14 budget request.

U.S. MDA FUNDING

	FY10 AMT	FY11 AMT	FY12 AMT	FY13 AMT	FY14 AMT	FY15 AMT	FY16 AMT	FY17 AMT	FY18 AMT
PE#0603893C									
WX12: STSS Capability Development	148.51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MD12: STSS	0.0	101.74	85.22	48.71	42.59	30.45	32.05	32.61	33.04
Program-Wide Support (MD40)	0.0	3.84	1.05	2.61	2.36	1.56	1.73	1.95	1.94
PE#0604883C									
MD10: PTSS	0.0	35.63	73.59	282.28	0.0	0.0	0.0	0.0	0.0
Program-Wide Support (MD40)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

All $ are in millions.

Timetable

Month	Year	Major Development
Jan	1984	SDIO formed
	1984	SSTS plan formulated
	1987	Brilliant Pebbles plan formulated
	1990	Brilliant Eyes idea formulated
Jun	1992	Rockwell and TRW complete Brilliant Eyes concept designs
	1994	Brilliant Eyes canceled in favor of SBIRS Low
May	1995	TRW selected to develop two Flight Demonstration SBIRS Low spacecraft
Sep	1996	Boeing selected to develop competing LADS SBIRS Low prototype
Feb	1999	USAF cancels LADS and FDS efforts
Aug	1999	TRW and Spectrum Astro teams selected for SBIRS Low PDRR
Oct	2001	SBIRS Low program transferred to the Missile Defense Agency
Apr	2002	SBIRS Low program restructured; TRW selected as prime contractor
Aug	2002	SBIRS Low canceled in favor of STSS
Aug	2002	Northrop Grumman awarded STSS contract to supply two satellites and a ground station

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Month	Year	Major Development
May	2009	STSS ATRR (Block 2010) satellite launched on Delta II launch vehicle
Sep	2009	Launch of two Block 2006 (STSS demonstrator) satellites on a Delta II launch vehicle
Nov	2010	On-orbit calibration of acquisition and tracking sensors completed
Apr	2013	PTSS terminated

Forecast Rationale

Despite the importance that the U.S. Missile Defense Agency (MDA) has placed on developing a constellation of low-Earth-orbiting (LEO) infrared satellites, the Precision Tracking Space System (PTSS) program has been terminated. The agency is dealing with budget constraints that are preventing the agency from spending the money required to develop and deploy the satellites.

Under the predecessor to the PTSS, known as the Space Tracking and Surveillance System (STSS) program, Northrop Grumman was to build five missile tracking satellites. However, that program was terminated after it was criticized for not taking into account lessons learned from the STSS Block 2006 (also known as the STSS demonstrator) satellites, which had launched in 2009 and are used to test missile defense concepts.

PTSS was designed to take into account lessons learned from STSS demonstrator satellites. However, the program was ultimately done in by budget constraints in Washington. Ironically, with the STSS demonstrator satellites still operating in orbit, the STSS has outlived the PTSS program. Funding is expected to continue for the next few years to support testing of the in-orbit satellites.

At this time, the future of the MDA's LEO missile defense satellite plans is unclear. The agency has talked about the importance of the system to the defense of the United States. Issues with countries like North Korea have served to highlight the importance of the ability to detect missile launches. However, budget issues in Washington mean all agencies will need to make sacrifices. With Congress also focused on balancing budgets, it is unlikely that it will force the MDA to continue to fund PTSS. If the MDA does pursue LEO satellites, it will likely be under a smaller and less ambitious program than PTSS or STSS. Therefore, Forecast International does not expect any satellites to be produced under either the PTSS or the STSS program during the forecast period.

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