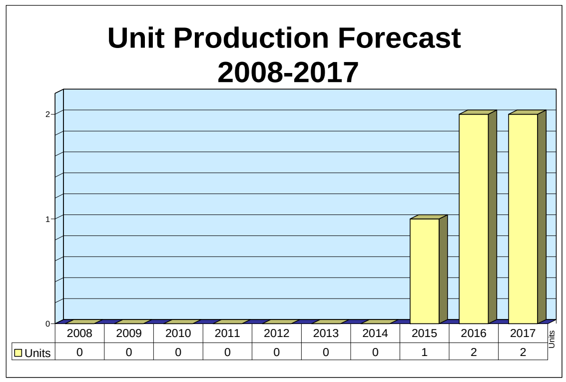
Transformational Satellites (TSATs) - Archived 11/2009

Outlook

- TSAT funding cut in FY09 budget plan by about $4 billion through 2013
- TSAT Initial Operating Capability likely slipping to 2018
- TSAT will replace the Advanced Extremely High Frequency (AEHF) Satellite Communications System
- The U.S. Air Force is managing the program at the MILSATCOM Joint Program Office



Orientation

Description. The Transformational Communications Satellite (TSAT) system is a planned constellation of five advanced military communication satellites that will form the spaceborne element of the Global Information Grid (GIG) of the U.S. Department of Defense (DoD), as defined by the new Transformational Communications Architecture (TCA).

Sponsor. The U.S. Air Force is managing the program at the MILSATCOM Joint Program Office, located at the Space and Missile Systems Center, Los Angeles Air Force Base, California.

Status. Currently in risk reduction and technology studies. The DoD is expected to select a prime contractor before the end of 2008.

Total Produced. None

Application. TSAT will replace the Advanced Extremely High Frequency Satellite Communications System, whose first satellite is expected to launch in 2008. TSAT will provide a vastly updated worldwide communications network for NASA, the DoD, and intelligence communities.

Price Range. The cost of the TSAT program is expected to total between $14 billion and $18 billion.

Contractors

Prime

Boeing Satellite Development Center	http://www.boeing.com/defense-space/space/bss/, 2260 E Imperial Hwy, El Segundo, CA 90245 United States, Tel: + 1 (951) 340-2492, RDT+E (Architecture Studies; Risk Reduction/System Definition)
Booz Allen & Hamilton Inc	Los Angeles, CA United States, RDT+E (System Engineering & Integration)

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Lockheed Martin Space Systems - Sunnyvale	http://www.lockheedmartin.com/ssc, 1111 Lockheed Martin Way, Sunnyvale, CA 94088-3504 United States, Tel: + 1 (408) 742-4321, RDT+E (Architecture Studies; Risk Reduction/System Definition)

Subcontractor

Lockheed Martin Information Systems & Global Services, Division HQ	http://www.lockheedmartin.com/aboutus/organization/isgs/, 700 N Frederick Ave, Bldg 181, Gaithersburg, MD 20879 United States, Tel: + 1 (301) 897-6000 (TMOS)

Technical Data

Design Features. Exact technical specifications are not available, as a development contract is not planned to be announced until FY08. The program goals and critical technologies will be discussed.

Initial TSATs are expected to be at least five times as capable as the Advanced EHF satellites that are currently in production, and will provide wideband high-data-rate communications that are improved, secure, survivable, and jam-resistant. The finished satellite constellation will serve NASA, the DoD, and intelligence communities. TSAT will provide beyond-line-of-sight connectivity for thousands of mobile and stationary users well beyond anything in operation today.

The key to TSAT's ability is its use of the Internet Protocol (IP) environment of packet-routed communications, as opposed to conventional circuit-switched systems. In the new system, incoming analog radio signals are converted into an Internet-like digital data packet. The header of the data packet is interpreted and sent to its destination by means of an Internet-like address. All information is transferred through dynamic bandwidth and resource allocation (DBRA), meaning different frequency waveforms will be used depending on what speed the data need to be sent. Allocation depends on factors such as environmental conditions and priority.

The primary device behind this communications scheme is the Next Generation Processor/Router (NGPR), essentially the brain of TSAT. The NGPR makes use of XDR+ (extended data rate plus) waveform, a secure, protected, anti-jamming waveform developed for ground-to-satellite communications. XDR+ is an advancement over XDR used in the Advanced EHF system. NGPR will also be able to make use of Ka bands to transfer information.

TSAT combines the use of Ka band and XDR+ with new laser communication (lasercom) technology to achieve its extremely high data rates. Laser terminals communicate through modulated beams of light, and are smaller and more cost-effective for high-data-rate communication than standard radio frequency devices. A single-access lasercom unit will make use of a single telescope, optical module, high-power optical power amplifier, and modem to transfer its data. The goal for TSAT is to support RF data rates up to 45 Mbps and lasercom data rates in the 10-100 Gbps range. Total bandwidth capacity will approach 2 Gbps of RF per satellite, compared with only 250 Mbps per Advanced EHF.

TSAT will work in conjunction with the Transformational Satellite Communications Mission Operations System (TMOS), whose $2.02 billion contract was awarded to Lockheed Martin Integrated Systems and Solutions, San Jose, California (now Lockheed Martin Information Systems & Global Services), in January 2006. TMOS will provide network and operations management from the ground, and will enable TSAT connectivity to the GIG, thereby making full use of TSAT's global networking capability.

TSAT continues to focus on maturing its key subsystem technologies to a technology readiness level (TRL) 6. Systems tested at this level are considered to be sufficiently mature and have been tested in a relevant environment. According to the program office, in FY07, the three technologies not already at TRL-6 (see table below) remain on track to achieve TRL-6, prior to the preliminary design phase.

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Critical Technologies	**Technology Readiness Level**	**Purpose**
Communication-on-the move antenna (COTM)	6	Enables high capacity data communications to small terminals.
Packet Processing Payload	6	Converts incoming radio signals into digital data for delivery to the correct Internet-like address.
Information Assurance – Transmission Security	6	Protects transmissions from jamming and interception.
Information Assurance - Space High Assurance Internet Protocol Encryptor(HAIPE)	6	Facilitates security between network nodes.
Bandwidth Efficient Modulation (XDR+)	5	Allows higher capacity protected communications.
Dynamic Bandwidth Resource Allocation (DBRA)	5	Adjusts on-orbit resource allocations more efficiently, which will allow more users to be serviced simultaneously.
Single-access Laser Communications	5	Provides a high bandwidth medium to transmit huge amounts of data between satellites.

Source: GAO

Program Review

Background. As early as 2001, the issue of bandwidth availability was brought up to the Defense Science Board, the Department of Defense (DoD), and non-DoD federal agencies to find a solution. An idea to implement the newly termed "Transformational Communications," a proposed interoperable communications network for the military, NASA, and intelligence agencies, was advanced early on. In 2002, the Transformational Communications Office (TCO) was established to study the implementation of such a communications system. A study by the TCO led to the creation of the Transformational Communications Architecture (TCA) in October 2003. The TCA outlined long-term goals in communications development, focusing on high-data-rate network connectivity and the use of Internet Protocol (IP) technology for improved communications.

TSAT was the spaceborne segment of the new communications architecture, and would essentially act as a router within the Global Information Grid (GIG). The TSAT program entered Phase B, Risk Reduction and Design Development, in January 2004. Phase B contracts (cost plus fixed fee) for the space segment were awarded to Lockheed Martin Space Systems and Boeing Satellite Systems. The DoD is slated to select a single development contractor by year-end 2008.

Budget Cuts and a Change of Plans

TSAT's proposed FY06 budget was cut nearly in half, from $836 million to $429.244 million, forcing the DoD to reevaluate the direction of the mission. A decision was reached in the Quadrennial Defense Review, released February 3, 2006. The review endorsed pursuing TSAT, leading to a decision to implement an incremental build consisting of two blocks of capabilities. The first block of satellites (currently the first two satellites) would be reduced in complexity and capability, thereby lowering the development and integration risk. Initial capabilities would not be ideal when compared to the original plan, though the new mission structure would increase the chances of the DoD staying on schedule. Certain technologies would also have more time in development, allowing for better implementation in the more capable second block of satellites. As a result of the FY06 cuts, the initial planned launch date of 2013 was pushed back a year to 2014 (as of mid-2008, this launch is expected in 2016).

TMOS Contract Awarded. In January 2006, the contract for TMOS, the ground-based mission operations system for TSAT, was awarded to Lockheed Martin Integrated Systems and Solutions, San Jose, California. Awarding the contract decreases TSAT program risk, as it provides an integral piece of the communications network essential for TSAT's success. Lockheed can also begin working on definite network specifications, which will aid in parts of the TSAT design and implementation.

Transformational Satellites (TSATs)

Critical Technology Milestones Achieved

In November and December 2005, OSVS-1, the first test of the lasercom terminal hardware, built by the Northrop Grumman Space Technology sector, was conducted against the Optical Systems Validation Suite (OSVS) testbed at the Massachusetts Institute of Technology's Lincoln Laboratory. The second testing phase, OSVS-2, is planned to be completed by February 2007. OSVS-1 measured the quality of communications between the lasercom terminal and the testbed, as well as the terminal's ability to track and maintain contact with another terminal in the presence of spacecraft vibrations. The test demonstrated the hardware's ability to handle data rates of 10 and 40 Gbps, meeting the goals of OSVS-1.

In early 2006, a team led by Lockheed Martin became the first to demonstrate compatibility of the Next Generation Processor/Router (NGPR) with XDR+, a new high-data-rate protected waveform. The test, NGPR-1, also measured increased bandwidth efficiency, and showed that the NGPR could operate at data rates established for TSAT. In June 2006, Boeing announced that it had successfully completed similar compatibility tests. Boeing says it has more comprehensive tests planned for later in the year.

GAO Reviews TSAT Program

In May 2006, the United States Government Accountability Office (GAO) released a Report to Congressional Committees in which it reviewed the current state of the TSAT program. The GAO felt that the DoD had not fully assessed the value of the TSAT program after recent budget and program changes. A number of executive actions were recommended as a result. First, the DoD should reassess the value and progress of TSAT in context with all other DoD investments before committing to building the full constellation of satellites. The DoD should also coordinate with the TSAT user community to ensure that all project requirements are updated appropriately. Finally, the DoD should prove the operability of key technologies, and establish new cost, schedule, and performance goals for TSAT after a complete review of the program.

The report noted that three critical technologies were expected to mature sometime in 2007: Bandwidth Efficient Modulation (XDR+), Dynamic Bandwidth Resource Allocation (DBRA), and Single-Access lasercom. The two main tests that will impact project success are NGPR-2 and OSVS-2, the second series of integration tests for the NGPR and lasercom.

Competing Teams

In 2007, the Boeing team included Ball Aerospace, BBN Technologies, Cisco Systems, EMS Technologies, General Dynamics, Harris Corp, Hughes Network Systems, IBM, L-3 Communications, LGS Innovations, Raytheon, and SAIC.

The Lockheed Martin TSAT team includes Northrop Grumman, Juniper Networks, ViaSat, Rockwell Collins, General Dynamics Advanced Information Systems, L-3 Communications, Stratogis, and Caspian Networks.

Latest Program Milestones

In March 2007, Boeing and its partners became the first team to successfully demonstrate the ability of its TSAT system to deliver operational data rates at high power operations during U.S. Air Force tests.

In May 2007, the Lockheed Martin/Northrop Grumman team completed a three-day Space Segment Design Review (SSDR) at Lockheed Martin Space Systems facilities in Sunnyvale, California, signaling the team's readiness to proceed with the next development phase of the program.

In June 2007, a test conducted by the Lockheed Martin/Northrop Grumman team validated that its laser communications technology developed for the Risk Reduction and System Definition phase had achieved Technology Readiness Level 6 (TRL-6), a key milestone on the path to flight for the TSAT program.

In June 2007, Ball Aerospace & Technologies Corp, a teammate on the Boeing-led TSAT Space Segment program, announced a successful completion of the program's Space Segment Design Review (SSDR).

Related News

Current Schedule Estimate – A TSAT Integrated Baseline Review is scheduled for the second quarter of FY09, followed by a Program Synch Review in the fourth quarter of FY09. A Preliminary Design Review is expected in mid-FY11, with a Critical Design Review following in late FY13. The first TSAT launch is planned for 2016. (FI, 8/08)

Funding

Transformational Satellite funding is found in the RDT&E portion of the USAF budget, PE#0603845F. The program is currently in Budget Activity 04, Advanced Component Development and Prototypes. FY08-11 funds for qualification/productization of radiation-hardened (RADHARD) components for USAF/DoD space programs have been transferred to PE#063430F, Advanced EHF MILSATCOM (Space); and PE#0603845F, Transformational SATCOM. Additionally, PE#063845F will fund FY12/13 RADHARD efforts. The following data are derived from USAF FY09 budget documentation:

U.S. FUNDING

	FY06 AMT	FY07 AMT	FY08 AMT	FY09 AMT	FY10 AMT	FY11 AMT	FY12 AMT	FY13 AMT
Transformational SATCOM	416.8	700.4	804.7	842.9	985.1	1,237.8	1,514.4	1,791.5

All $ are in millions.

Contracts/Orders & Options

Contractor	Award ($ millions)	Date/Description
Lockheed Martin Space Systems	278.2	November 2006 – Risk reduction and program system definition
Boeing Satellite Development Center	278.2	November 2006 – Risk reduction and program system definition
Booz Allen Hamilton	92.7	November 2006 – System Engineering & Integration
Lockheed Martin Integrated Systems	2,023	January 2006 – Cost-plus TMOS (ground segment) contract
Lockheed Martin Space Systems	41.7	April 2005 – Cost-plus-fixed-fee contract modification.
Boeing Satellite Development Center	41.9	January 2005 - Cost-plus-fixed-fee contract modification.
Lockheed Martin Space Systems	472	January 2004 – Risk reduction and system definition study.
Boeing Satellite Development Center	472	January 2004 – Risk reduction and system definition study.

Timetable

Month	Year	Major Development
Jan	2004	Risk reduction and design development contracts awarded
Jan	2006	TMOS contract awarded
2 Qtr	FY09	Integrated Baseline Review
4 Qtr	FY09	Program Synch Review
Mid-	FY11	Preliminary Design Review
4 Qtr	FY13	Critical Design Review
1 Qtr	FY16	Planned launch of first TSAT satellite on Delta IV and Atlas V EELV

Forecast Rationale

Lockheed Martin and Boeing both submitted proposals on July 30, 2007, to build the Transformational Satellite Communication System (TSAT). Before the end of 2008, the Air Force is expected to pick a winner for the five-satellite, $4.5 billion contract. That firm will also get a shot at as much as $18 billion (estimated total) over the life of the program, which is expected to continue through 2020.

The final price tag includes the satellites, ground operations system, satellite operations center, and the cost of operations and maintenance.

Transformational Satellites (TSATs)

After surviving evaluations from both the GAO and the Department of Defense, it appears that the TSAT communications system will proceed as planned.

The Pentagon plans to award a prime contract worth about $15 billion to Lockheed Martin or Boeing by the end of 2008. A $4 billion budget cut to the program, released in the FY09 Air Force budget request put the program in jeopardy and slipped the TSAT Initial Operating Capability to around 2018.

The Pentagon's acquisition chief, John Young, tasked his people with a study of possible TSAT alternatives, including buying more AEHF spacecraft and deploying smaller, less-capable TSAT-like spacecraft. After that review was completed in mid-2008 the USAF was ordered to proceed as planned with TSAT. Funding, however, may still be a problem.

To build the system as planned and deploy it beginning in 2016, the Congress needs to appropriate more money to the program than was originally requested for FY09. According to the FY08 budget, the USAF expected over $1 billion in funds for TSAT RDT&E in FY09. However, when the FY09 budget came out, TSAT was short by almost $400 million for that year alone.

The House Armed Services Committee recommended funding the program at the requested $843 million for FY09, while the Senate Armed Services Committee recommended adding $350 million to the president's request. Markups by the House and Senate Appropriations defense subcommittees are not known at this time.

Delays and funding hurdles aside, the program is a huge jump in capability. For example, a TSAT could disseminate a radar image from a Global Hawk UAV in less than a second, whereas transmitting this same image via Advanced Extremely High Frequency (AEHF) satellites would take 2 minutes and an even lengthier 12 minutes transmitted via a Milstar satellite.

The potential value of such a system to U.S. and allied forces is obvious, and the DoD has committed to the restructured TSAT program (block delivery approach) as the best way to field the system. The strategy reduces risk by implementing a more incremental fielding approach during the development phase – especially for the two driving technologies on the TSATS – the lasercom and the NGPR.

The TSAT program is a technical and fiscal challenge, but should the program falter, market forces would see an opportunity and respond to fill the bandwidth void. This goes against the arguments of some purveyors of doom that a lack of bandwidth threatens to cripple today's military. These ideas may also help calm fears over the impact and threat of increasing use of commercial satellite links by the military. One glimmer on the horizon is the planned development of "pseudo-satellite" systems, such as transponders carried by loitering unmanned air vehicles (UAVs) or manned aircraft to add capacity directly on the battlefield.

As it stands, Forecast International expects full TSAT production, albeit later than initially planned. The spacecraft are the next logical progression in MILSATCOM architecture, with the AEHF spacecraft ready for initial replacement around the time the first TSAT is ready for launch.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program		**High Confidence**					**Good Confidence**			**Speculative**		
	Thru 2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**
MFR Not Selected												
T-SAT												
	0	0	0	0	0	0	0	0	1	2	2	5
Total	0	0	0	0	0	0	0	0	1	2	2	5