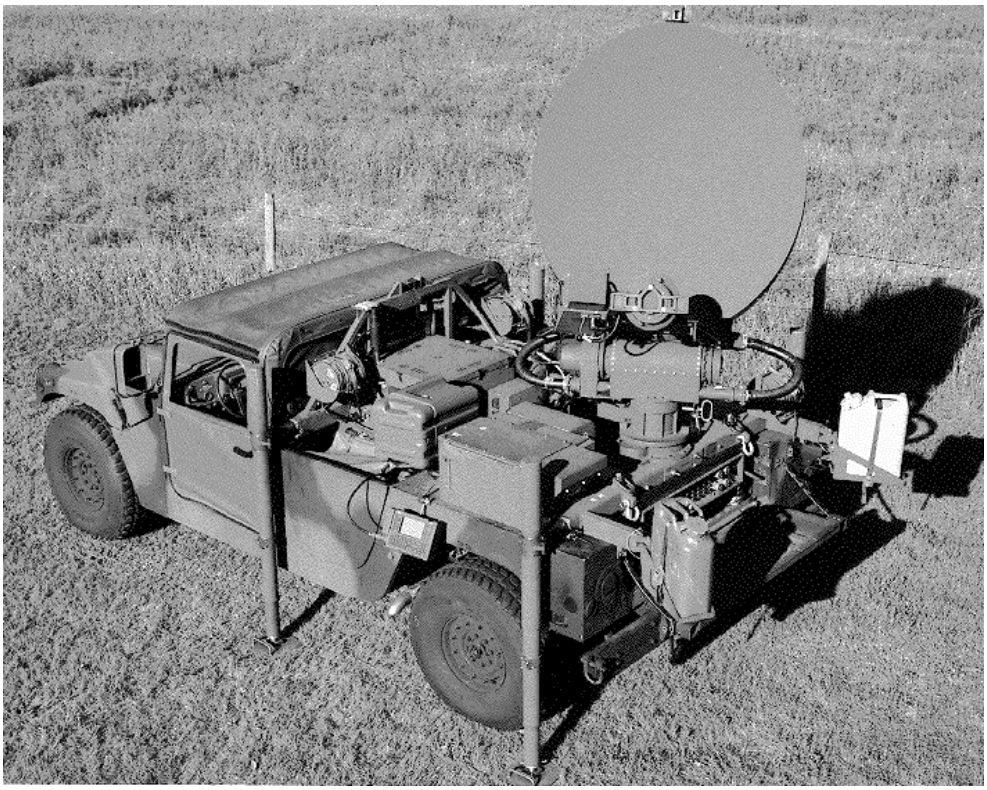
SECURE, MOBILE, ANTIJAM, RELIABLE, TACTICAL TERMINAL (SMART-T)



Army ACAT IC Program:		**Prime Contractor**
Total Number of Systems:	318	Raytheon
Total Program Cost (TY$):	$1.28B	
Average Unit Cost (TY$):	$2.4M	
Full-rate production:	1QFY99	

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2010

The Secure, Mobile, Anti-jam, Reliable, Tactical Terminal (SMART-T), a Military Strategic and Tactical Relay (MILSTAR) satellite communications transmit and receive terminal, is a core element of the Joint Service ground terminal segment of the MILSTAR satellite system. Operating at both the MILSTAR low (75-2400 bits/second) and medium (up to 1.544 mega-bits/second) data rates, it is designed to provide Army warfighters at corps, division and lower levels with secure, jam resistant, extended range, two-way, point-to-point and network voice, data, and video communications. These characteristics should enable our forces to maintain ***information superiority*** throughout all levels of conflict, support the ***full-dimensional protection*** operational concept, and ensure that warfighters retain freedom of action through continuous, secure communication.

The primary SMART-T mission is multi-channel, near global extended range connectivity for the Army's Mobile Subscriber Equipment, which is the primary tactical communications equipment for corps

and division operations. SMART-T is intended to provide tactical commanders with the communications capacity and flexibility to electronically link networks of dispersed forces in situations beyond line-of-sight. This is accomplished by routing calls and messages from terminal-to-terminal via satellites orbiting 22,000 miles above the earth. The terminal is designed to be rapidly moved and set up, communicate for short or extended periods of time, and torn down and moved again in response to changing tactical situations.

The SMART-T mounts to a High Mobility Multi-Purpose Wheeled Vehicle (HMMWV). This gives it the required high mobility in the tactical environment. The SMART-T consists of a HMMWV, pallet, generator, antenna, radio frequency equipment, associated electronics, remote operating unit, low data rate interface device and cable, AC to DC converter, chemical protection devices, and support equipment. The terminal can be operated either mounted on the HMMWV or as a standalone unit. In addition to overcoming the limitations of terrain masking and distance, the SMART-T is designed to operate and survive in severe electronic warfare and nuclear, biological, and chemical environments.

The SMART-T operator will be trained to accomplish unit-level and direct support (DS) level maintenance, which includes troubleshooting and repair. Repair tasks beyond the DS support level ability will be evacuated to the appropriate specialized activity or depot.

BACKGROUND INFORMATION

The SMART-T entered the EMD phase of the acquisition process in May 1992, and the low-rate initial production phase in February 1996. The SMART-T acquisition strategy is designed to deliver terminals in advance of the first medium data rate (MDR) MILSTAR satellite being placed in orbit. This would allow users immediate access to the first MDR capable satellite, which was scheduled for launch in early 1999. The acquisition strategy does not require the terminals to demonstrate all operational effectiveness and suitability requirements during IOT&E and prior to the Milestone III full-rate production decision. Rather, the production decisions are based on whether the SMART-T shows adequate progress towards meeting those requirements. The SMART-T is required to meet operational effectiveness and suitability requirements during operational testing prior to a fielding decision.

IOT&E to support the full-rate production decision was conducted June 1-12, 1998. Since an on-orbit MDR satellite was not available, IOT&E was supported by both the Lincoln Laboratory MDR over-the-air satellite simulator and an on-orbit low data rate (LDR) satellite. The Program Office executed the first of three planned SMART-T production options in January 1999, based on IOT&E results. Further production options beyond the current 91 terminals were to be supported by additional operational tests in 4QFY99 using an in-orbit MDR satellite. However, the April 30, 1999 launch of the MILSTAR satellite failed. Consequently, the planned test has been delayed until after the next MILSTAR launch in 2000.

TEST & EVALUATION ACTIVITY

SMART-T IOT&E was conducted June 1-12, 1998, at Ft. Gordon, GA, using eight production representative terminals. The test used an in-orbit MILSTAR satellite for LDR communication and the Massachusetts Institute of Technology (MIT)/Lincoln Laboratory MDR/LDR satellite simulator for MDR communications. SMART-Ts were deployed to support range extension in a mobile subscriber network, replicating a typical division and corps Area Common User System. Both LDR and MDR voice and data point-to-point and network capabilities were extensively tested to evaluate operational

effectiveness. The terminals were moved at 12- and 48-hour intervals to simulate a division and corps mobile subscriber equipment tactical deployment in support of combat operations on a mobile battlefield. Movements took place over improved and unimproved roads. The test consisted of two 96-hour scenarios with varying conditions, such as day/night operations, mounted and dismounted operations, and under specialized mission-oriented protective postures designed to stress the system and soldier/machine operations and demonstrate operational suitability of SMART-T.

There were two major limitations to SMART-T IOT&E.

- As there was no MDR-capable MILSTAR satellite on orbit, the MIT/Lincoln Laboratory satellite simulator was used for MDR communications. The simulator allowed SMART-Ts to form MDR networks through a ground-based antenna system on a tower. Although the simulator adequately represents an in-orbit satellite in many ways, the satellite simulator does not replicate all the physical acquisition and tracking characteristics of an orbiting satellite, nor does it replicate the delay times or footprint associated with an orbiting satellite. In-orbit MDR capabilities will be fully evaluated during upcoming combined Service operational tests.

- Secondly, the Automated Communications Management System (ACMS) was not available during the test. ACMS is the objective communications management tool that will be used to perform MILSTAR network planning, management control, terminal adaptation data generation and distribution. An interim planning tool was specially developed and used to do the network planning for IOT&E. However, without ACMS or a tool of equivalent capabilities, the ability of SMART-T communications planners to manage, monitor, and reconfigure networks in real-time, as required by the Army concept of operations, could not be evaluated. Furthermore, not having ACMS available limited efforts to determine the manpower and training requirements for corps and division staffs to support reengineering of SMART-T networks. ACMS is still under development but is expected to be available to support MILSTAR Flight 4 strategic (LDR) operations in 2000. As ACMS will not be capable of supporting tactical (MDR) requirements until November 2001, the interim-planning tool used during IOT&E has been improved to support on-the-move tactical operations. The operational effectiveness and suitability of these two systems working together will be evaluated in follow-on operational tests with the in-orbit MDR satellite.

The Program Manager conducted a RAM confidence demonstration in April 1999, to substantiate the improvements made to SMART-T since IOT&E. The five-day test replicated many of the same events as the IOT&E, including soldiers as operators performing multiple terminal relocations over rough terrain. The event was successful in demonstrating areas of significant progress, as well as areas where additional work still needs to be done.

Operational testing of SMART-T and the in-orbit MDR satellite was scheduled to occur in 4QFY99. However, problems with the Titan IVB Centaur upper stage resulted in the MILSTAR Flight 3 satellite being declared a total loss. Therefore, testing of the in-orbit satellite will be delayed until after MILSTAR Flight 4 is launched in early to mid-2000. After initial in-orbit satellite checkout is completed, SMART-T will participate in combined Service testing to demonstrate the compatibility and interoperability of the SMART-T with the in-orbit MILSTAR Flight 4 satellite. The Army Test and Evaluation Command is planning a three-week SMART-T test to include LDR/MDR satellite acquisition, network operations, interoperable LDR network and point-to-point calls with Army, Navy, and Air Force

terminals, and antenna/network control functions. This test will be conducted under operationally realistic conditions to replicate range extension operations similar to those during IOT&E.

TEST & EVALUATION ASSESSMENT

DOT&E reported the results of the June 1-12, 1998 IOT&E in our B-LRIP report to Congress in January 1999. Although SMART-T has made significant progress in most areas since IOT&E, sufficient progress in system reliability has not been demonstrated in developmental testing and verified through operational testing to warrant changing the basic assessment of SMART-T operational effectiveness and operational suitability. We note, however, that the Program Office is making significant progress in addressing shortcomings. The major issues from the B-LRIP are summarized below.

Even though SMART-T is capable of performing the communications functions for which the terminal was designed, operational effectiveness could not be fully demonstrated because ACMS was not available for IOT&E and there was no MDR MILSTAR satellite in orbit. Additionally, SMART-T lacked an orderwire during IOT&E. An orderwire is the rudimentary communications link normally used by the Army when first establishing communications links among dispersed terminals. Although not listed as a terminal requirement, tests confirmed that orderwire communications are required to quickly and efficiently establish communications networks. The Program Office has added an orderwire to the SMART-T system. Operational effectiveness will remain an open issue pending operational testing of the communications planning and management system and the orderwire with an in-orbit MDR MILSTAR satellite.

SMART-T is not operationally suitable. The most serious shortfall occurred in achieving the expected operational reliability. Although the developer's reliability growth curve indicated SMART-T Mean Time Between Failure (MTBF) exceeded the 400-hour entrance requirement for IOT&E, field test results for MTBF were only 50 hours (point estimate). Also, the observed Mean Time Between Operational Mission Failure (MTBOMF) was 43 hours (point estimate) in IOT&E. This is substantially below the 700-hour requirement the system must demonstrate prior to a fielding decision. Failures were attributed to a wide range of software, hardware, training, procedural issues, and operator errors.

SMART-T is operationally survivable. The performance was evaluated using contractor and independent laboratory tests and analyses, models, and open-air tests.

The Program Office's April 1999 RAM confidence demonstration indicates substantial SMART-T improvements in these areas since IOT&E, particularly in the area of reliability. Although developmental testing conducted prior to IOT&E was a poor indicator of operational reliability, the Program Office made major changes in the conduct of developmental testing in 1999, adding rigorous field testing with soldiers as operators to complement their standard technical tests. Due to changes in the conduct of the reliability growth tests, DOT&E is confident that the current contractor MTBF of over 450 hours will prove to be a more accurate indicator of SMART-T operational performance than previous developmental tests. However, current developmental test data also indicate that despite the admirable reliability improvements since IOT&E, SMART-T still falls short of its final operational reliability requirements of 800 hours MTBF (contract specification) and 700 hours MTBOMF (operational reliability requirement stated in the Operational Requirements Document).

Y2K compliance testing consisted of three major events. Raytheon conducted functional performance testing at the Lincoln Laboratory, MA, from February 11-14, 1997. Lockheed Martin conducted Y2K testing in Sunnyvale, CA, as part of combined satellite and ground system tests, from

July 1-10, 1997 and again from July 20-24, 1998. The Lockheed Martin tests included Army and Air Force terminals as well as the MILSTAR Flight 3 satellite. No Y2K issues were found. The Army completed Y2K compliance certification on November 25, 1998.

CONCLUSIONS

The Program Office has made significant improvements to SMART-T since IOT&E in June 1998, and DOT&E is confident that the program is on its way to becoming operationally effective and suitable. However, the following conclusions remain valid:

- Operational effectiveness has not been demonstrated. Although the SMART-T terminal is capable of supporting communications for the Army's corps and division extended range operations, SMART-T's effectiveness as a deployed combat system cannot be confirmed until the MILSTAR communication management system is fully developed and operationally tested. This testing should take place in mid-year 2000 after the launch of MILSTAR Flight 4.

- SMART-T is not operationally suitable. Although the program office has made numerous modifications to improve reliability and other shortfalls, none of the fixes have been verified in an operationally realistic test. Additionally, although the MTBF has grown to over 450 hours (80 percent lower confidence level), the required 800-hour level (the entrance criteria for follow-on operational testing) has not been demonstrated.

- Operational survivability is satisfactory.

RECOMMENDATIONS

The following recommendations are based on observations from the June 1-12, 1998 IOT&E and Program Office activities since that time.

- A fielding decision should not be made until operational testing confirms that SMART-T is both operationally effective and operationally suitable. Primary concerns are:

- The MILSTAR communications planning and network management system must be tested with SMART-T under operational conditions.

- The orderwire capability should be fully developed and operationally tested.

- Reliability, availability, and maintainability shortcomings, most notably Mean Time Between Failure and Mean Time Between Operational Mission Failure, must be corrected and fixes should be verified by operational testing.

- In order to meet operational reliability requirements, the Program Office should continue executing an aggressive reliability growth program until SMART-T demonstrates that it meets technical reliability requirements and entrance criteria for follow-on operational testing.

- The failure of the MILSTAR Flight 3 satellite precluded operational testing with an in-orbit satellite in 1999. As a minimum, production decisions beyond the current 91 terminals should take place only after a favorable operational assessment by the Army's Operational Test and Evaluation Command, stating SMART-T has or will in all likelihood meet its operational suitability requirements prior to planned operational testing in 3-4QFY00.

- Additionally, DOT&E recommends that the following items receive special attention during future operational tests and evaluations:

- Setup and teardown times in normal, cold weather, and MOPP IV uniforms must be retested. Additionally, SMART-T should be field tested in tropical and cold weather conditions, with operators performing setup, teardown and all normal communications operations.

- Improvements in training, troubleshooting procedures, and technical manuals must be verified in operational testing.

- The numerous user man/machine interface shortcomings must be corrected. Additionally, the SMART-T terminal should be evaluated for overall quality of construction.

- Integrated logistics issues such as poor computer screen readability in sunlight, inadequate audible alarms, and poor placement of generator switches must be corrected.

- DOT&E recommends that SMART-T be evaluated for vulnerability to non-nuclear, high-power microwaves to determine its ability to withstand this emerging threat.

DOT&E will continue oversight of SMART-T and work with the Program Office, the Army, and the operational test community to further refine test requirements and ensure that SMART-T is operationally effective and suitable prior to fielding.