JOINT SURVEILLANCE TARGET ATTACK RADAR SYSTEM (JSTARS)
E-8C AND COMMON GROUND STATION (CGS)

Air Force E-8C ACAT ID Program		**Prime Contractor**
Total Number of Systems:	15	Northrop Grumman
Total Program Cost (TY):	$9.080B	
Average Unit Cost (TY):	$648.6M	
Full-rate production:	1QFY97	

Army CGS ACAT IC Program		**Prime Contractor**
Total Number of Systems:	96	Motorola
Total Program Cost (TY):	$1.2635B	
Average Unit Cost (TY):	$13.2M	
Full-rate production:	4QFY00	

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2020

The Joint Surveillance Target Attack Radar System (JSTARS) supports ***dominant maneuver*** of joint forces through its contribution of a synoptic battlefield view to operational maneuver commanders. The system's required ability to perform battlefield surveillance, battle management for both air and land component forces, and indications and warnings functions provide the capability to contribute to ***information superiority*** of U.S. and combined forces. JSTARS is intended to meet the operational need for locating, classifying, and supporting ***precision engagement*** of time-sensitive moving and stationary targets.

JSTARS consists of an Air Force E-8C aircraft, an Army ground station, and the data link that connects the two elements. The E-8C is a remanufactured Boeing 707. The basic airframe of the 25 to 30 year old aircraft has been extensively refurbished and updated with the JSTARS radar system, communications gear, data link capability, 18 primary mission workstations, and air refueling capability. The Air Force has chosen to retain the existing basic aircraft engines, flight control, fuel, and hydraulic systems. JSTARS brings the technical capability to perform surveillance through interleaved synthetic aperture radar (SAR) and moving target indicator (MTI) radar modes to the battlefield as well as the capability to integrate battlefield and geographic information into a near real-time picture of the ground battle.

The ground station receives, processes, and displays JSTARS radar imagery transmitted down from the E-8C. The evolution of the Army ground station has progressed from two versions (light and medium) of the earlier Ground Station Module (GSM) to the current Common Ground Station (CGS). CGS is mounted on a High Mobility Multi-Purpose Wheeled Vehicle (HMMWV). It consists of computer workstations, communications equipment, and data link capability to integrate with the JSTARS aircraft, intelligence networks, and national level information sources. CGS is expected to provide the Army ground elements with the capability to prosecute air and land engagement of time-sensitive targets and support the intelligence preparation of the battlefield.

The Joint STARS program office planned a series of block upgrades and modifications for the E-8C. The block upgrades are:

- Block 10 consisted primarily of the Tactical Digital Information Link (TADIL-J) upgrade (TJU) and Y2K compatibility. The primary purpose of TJU was to implement messages to enable the E-8C to transmit ground surveillance information to other TADIL-J equipped command and control and weapons platforms.

- Block 20 consists primarily of the Computer Replacement Program (CRP), which replaces the current five computer system with two commercial-off-the-shelf computers. This facilitates upgrading the E-8's computers in parallel with industry. In addition, new software is added and the existing processor in the radar is replaced.

- Block 30 includes the integration of satellite communications (SATCOM), and an upgrade of this SATCOM to conform to Demand Assigned Multiple Access compliance.

- Block 40 will consist of the Radar Technology Insertion Program (RTIP), which will replace the JSTARS radar, adding several significant enhancements to both the SAR and MTI radar modes. The enhancements are intended to provide almost order-of-magnitude improvements in resolution and area coverage rates for all radar modes.

In addition to the block upgrades, the Air Force has identified numerous supportability improvements aimed at modifying high failure items and components that require significant maintenance, such as the air cycle machine and addressing growing diminishing resource items.

The Army also has a series of planned upgrades for the CGS. CGS block numbers are different than those used for the E-8. The Block 10 upgrade will add connectivity between the CGS and several additional sensors, including the ARL, U-2 aircraft, and Predator Unmanned Aerial Vehicle. This upgrade will also include additional software tools for the CGS operator, such as radar shadow mapping, video query, and multi-mode enhanced target tracking. The remote workstation in the CGS will also be upgraded. The Block 20 upgrade implements the ability to exchange data on the local area network of Tactical Operating Centers. Also, the Block 20 program integrates the Joint Tactical Terminal, which replaces the older Commander's Tactical Terminal. Finally, it is anticipated that a considerable amount of the automated data processing equipment in the CGS will have to be modified or replaced in order to interface with the improved capabilities available from the Block 40 upgrade of the E-8 aircraft.

BACKGROUND INFORMATION

A Multi-Service Operational Test and Evaluation (MOT&E) was scheduled to start in November 1995 and proceed through mid-1996. However, because of operational tasking in support of OPERATION JOINT ENDEAVOR, the system was evaluated during the operational deployment supporting the forces in Bosnia. While the opportunity to assess the system in an operational context was valuable, it presented critical limitations to the scope of the evaluation. The system was only able to demonstrate limited capability in support of joint forces target attack and battle management because of the nature of the air tasking. The E-8C did not meet its overall suitability requirements during the deployment. Without significant corrective action, the system was evaluated as unsuitable to support a high operational tempo conflict. Because of these shortfalls and unresolved issues in MOT&E, OSD directed FOT&E for the E-8C under the oversight of DOT&E.

The Air Force conducted FOT&E on the E-8C, the Regression Test, which focused on operational suitability. The operational suitability of the E-8C was improved during the Regression Test, but serious deficiencies remained.

The GSM program was granted approval in August 1993 for LRIP of twelve medium units to be mounted on standard 5-ton trucks. Prior to the decision, a Limited User Test of the Medium GSM (MGSM) was conducted. MGSMs were subsequently fielded with contingency forces and used as training equipment. In May 1995, the Army approved LRIP of ten light GSMs (HMMWV-mounted) following the completion of a Force Developmental Test and Evaluation in September 1994. With approval of the CGS program in October 1995, thirty-eight CGS LRIP systems were approved.

Initial Operational Test and Evaluation for CGS was conducted in April 1998. The IOT&E revealed serious operational shortfalls in effectiveness and suitability in the CGS. The CGS operators were unable to report on targets to intelligence or fire support nodes in a timely, accurate and complete manner. The operators were unable to discern stationary targets from their background in the SAR mode of the radar. The doctrine, training, tactics, techniques, and procedures for CGS operations were not adequate for operational effectiveness. The benefit of including other sensor feeds in the CGS was not shown. When operating with an E-8C, the CGS demonstrated a 4-hour mean time between essential function failure compared to a requirement of 48 hours, and an availability of 0.62 compared to a requirement of 0.75. The High Mobility Trailer is unsafe and not usable. These unfavorable operational effectiveness and operational suitability evaluations caused the post-ponement of the full-rate production decision. In December 1998, twelve LRIP systems were approved to maintain the production line while additional testing was conducted. Again, in September 1999 seven LRIP systems were approved to maintain the production line while additional testing was conducted. In total, seventy-nine systems of a total buy of 96 CGSs have been approved to be built as LRIP systems.

TEST & EVALUATION ACTIVITY

In December 1999, the Air Force completed the operational test phase of the E-8C Block 10 upgrade testing. The Block 10 upgrade was not on oversight. This testing evaluated the operational effectiveness of the software changes that implement the Tactical Digital Information (TADIL-J) upgrade (TJU). The operational phase of testing consisted of transmitting and receiving data with an Airborne Warning and Control System (AWACS) E-3 aircraft during a JSTARS helicopter detection test. This test event did not include the E-8C performing its normal ground surveillance mission.

During the first half of FY00, the Air Force tested the Computer Replacement Program (CRP), the Block 20 upgrade to the E-8 aircraft. The focus of the testing was to demonstrate that the CRP did not degrade the performance of the E-8C or adversely impact its ability to conduct its operational missions. The testing was not intended to demonstrate the operational effectiveness and suitability of the Block 20 E-8C. The test was conducted as a combined DT/OT. The test included one sortie flown during the All-Service Combat Identification Evaluation Team (ASCIET) 2000 exercise and several sorties during the F-15E Fighter Data Link OT&E.

A Milestone II decision for RTIP was passed in January 2000. As part of this effort the Air Force produced a separate RTIP TEMP, which was approved by DOT&E on January 28, 2000. During CY00, the Air Force subsequently restructured the RTIP program as a Multi-Platform RTIP (MP-RTIP) program. MP-RTIP will design and develop modular, scalable radars that can be used on a variety of airborne platforms such as Global Hawk and the large-body Wide Area Surveillance platform as well as the NATO Transatlantic Advanced Radar project platform. Current plans call for integration work to be accomplished on Joint STARS aircraft (T-3) for airborne testing, however a U.S. Air Force airborne platform decision in FY02 could alter that approach. Regardless of platform choice, the Air Force will produce a separate TEMP for platform integration in conjunction with the Milestone II decision in FY03.

Two T&E events and operational field assessments of the CGS supported the full-rate production decision made in August 2000. These included the CGS IOT&E, an Operational Reliability Demonstration Test (ORDT) and evaluation of CGSs deployed in Korea, and a Limited User Test (LUT).

The CGS IOT&E was conducted at Ft. Huachuca, AZ from March 15-April 13, 1998. The test was scheduled to start in November 1997, but was delayed due to CGS computer software problems. Developmental testing of CGS in 1997, which preceded CGS IOT&E, was characterized by schedule slips and software problems.

Initial Operational Test and Evaluation consisted of two test phases: a live flight phase and a simulation phase. During the live flight phase, CGS operators used radar imagery from a JSTARS E-8C aircraft to respond to surveillance and targeting taskings. The taskings required CGS operators to detect, locate, track, and identify various ground targets throughout Southeastern Arizona. The taskings were representative of how CGS would operate in wartime, and were developed by experienced Army intelligence officers based on Army doctrine. The targets were representative of stationary and moving targets that JSTARS is expected to locate and track during actual operations. There were eight missions, each approximately 5 hours in duration, in which E-8C provided imagery to the CGSs.

During the simulation test phase, a JSTARS simulator was used to emulate radar information received from an E-8C aircraft, thus eliminating the need to fly the aircraft. The simulation provided JSTARS imagery of Southwest Asia. This test phase was conducted over 96 continuous hours.

A subsequent test, called the Operational Reliability Demonstration Test (ORDT), was conducted in February 1999 at the Motorola factory in Scottsdale, AZ. The purpose of the ORDT was to assess whether some of the specific failures identified during the CGS IOT&E had been corrected. However, the number and extent of the limitations (e.g., lack of an E-8C and realistic radar usage by CGS crews adequately trained to the latest tactics, techniques and procedures, use of incomplete one-way simulations for interfaces) impacted the realism necessary for an adequate test of suitability.

From February 7-17, and again from March 21-28, 2000, a team of DOT&E personnel observed the operations of CGSs deployed to U.S. and allied forces in Korea. The CGSs were supporting intelligence staffs at the Combined Analysis Control Center, Camp Humphreys; the 2nd Infantry Division

Analysis Control Element, Camp Red Cloud; the Deployable Intelligence Support Element with the Third Republic of Korea Army, Yong-in; and at a 6th Cavalry Brigade training exercise, Camp Humphreys. The CGSs received radar imagery during missions flown by a JSTARS E-8 aircraft and an Airborne Reconnaissance Low (ARL) aircraft. The operations observed in March 2000 were a part of the annual Winter Surge exercise.

The CGS Limited User Test (LUT) was conducted from February 24-March 9, 2000, in conjunction with the ASCIET 2000 exercise at Ft. Stewart, GA. The ASCIET exercise consisted of ten days of "battles" between blue and red forces made up from all four branches of the United States armed services. The exercise included land, sea, and air operations.

Three CGSs were tested during the ASCIET exercise. The CGSs received information from the JSTARS E-8, Hunter Unmanned Aerial Vehicle, Rivet Joint, Navy EP-3, and Guardrail Common Sensor via the Commander's Tactical Terminal. The blue forces also had several other sensors that did not provide feeds via the CGS.

A JSTARS E-8 aircraft flew during the ASCIET battles and provided radar data to the CGSs. A backup E-8 aircraft also flew during every mission because of aircraft problems experienced during the pilot test. The E-8 surveilled the area in which the blue ground force and the opposing red ground force fought the battles during the ASCIET exercise. This area was approximately 10 kilometers by 15 kilometers in size, which is significantly less than 1 percent of the ground area covered by JSTARS conducting wide area surveillance when supporting a corps. The red force consisted of 30 to 40 tanks, armored personnel carriers, and air defense units.

TEST & EVALUATION ASSESSMENT

In the JSTARS E-8 B-LRIP, DOT&E assessed the E-8C as operationally effective in operations other than war. The radar picture contains information on large-scale movements of ground targets over a corps-sized area of interest. The commanders provided with this feel they have a measure of situational awareness that they previously did not have without the JSTARS E-8C.

During the operational phase of Block 10 testing, interoperability problems were observed in exchanging information with AWACS aircraft—the only platform that participated in the test. The AWACS E-3 aircraft had not implemented the TADIL-J message sets to receive target tracks from the JSTARS E-8C aircraft. Thus, the operational phase of the Block 10 test was inadequate for evaluating interoperability. Block 10 testing did find that there were man-machine interface deficiencies, primarily in the areas of track maintenance and with tabular displays of information on the operator's monitors.

The CRP OT&E demonstrated that CRP did not degrade the performance of the E-8C or adversely affect its ability to perform its operational mission. Some of the CRP DT/OT sorties were conducted jointly with the F-15E Fighter Data Link OT&E. During these sorties, the E-8C demonstrated the ability to find targets in a benign environment and pass that target information via TADIL-J to F-15Es that then successfully engaged the targets. During ASCIET, the Block 20 E-8C performed its assigned mission on day five of the 10-day exercise as well as the Block 10 E-8Cs performed the other nine days of the exercise. Additionally, during ASCIET, both the Block 10 and Block 20 E-8Cs participated in the JTIDS network, exchanging data with other Army, Navy, and Air Force participants. The operational interoperability of TADIL-J, however, was not evaluated during ASCIET. That is, the ability to use the exchanged information for mission accomplishment was not assessed. Finally, the new processor in radar of the Block 20 upgrade was far more reliable and required less maintenance than the troublesome

radar processor in the Block 10 E-8C. Consequently, the Block 20 E-8 had a higher effective time on station than the Block 10 aircraft.

The CGS was adequately tested to support the full-rate production decision. Testing and field operations show that the CGS provides a useful military capability and is effective for battle management and surveillance of large moving target sets (20 – 30 vehicles). When compared to the Critical Operational Issues and Criteria, Operational Requirements Document, and Cost and Operational Effectiveness Analysis, the CGS cannot be considered operationally effective in the accomplishment of target attack missions and surveillance of company-sized target sets (8 – 11 vehicles). The CGS is not operationally suitable for its more stressing intended missions because of reliability, training, and the inability to operate on the move.

The operational tests showed that the resolution of SAR imagery from the E-8C is inadequate for CGS operators to distinguish small tactical formations of vehicles from their background. This limits the ability of the CGS to support the surveillance and targeting of small tactical formations such as Scud missile units. Test results show that the CGS did not consistently and successfully target moving vehicles.

The CGS is not suitable for tactical employment because it is incapable of on the move operations without additional power from the 10-kilowatt generator in its trailer. Safety problems with its trailers have caused the Army to replace the intended two trailers with an additional HMMWV as an interim solution. Training of the operators, non-commissioned officers, crew, and staff is inadequate to fully exploit the capabilities of the CGS. The CGS exceeds its operational availability requirement of 0.75 with a demonstrated value of 0.83. The demonstrated mean time between system abort is 39 hours, which is less than its requirement of 48 hours.

For additional details on the CGS IOT&E, see the DOT&E B-LRIP report dated August 16, 2000.

CONCLUSIONS, RECOMMENDATIONS AND LESSONS LEARNED

The RTIP program that upgrades the radar on-board the JSTARS aircraft is a major defense acquisition program. The operational test program for RTIP will be defined during the coming years. The future test program must include full participation by the Army to involve CGS and Common Data Link. The Army needs to continue integrating the CGS into its intelligence and fire support process. We recommend that (1) the remote work station be fully upgraded to the same capability as the operator work stations inside the CGS shelter; (2) training shortfalls be corrected with a viable and constructive simulation to support and sustain training for operators, non-commissioned officers, crew and staff in addition to robust training events with an E-8C; and (3) the maintenance concept be reviewed with respect to improving the built-in test equipment and reliability.

Further, we recommend improvements be made to the CGS system and its tactics, techniques, procedures and training for the following areas: (1) the capability of the CGS to support Army staff with targeting missions including (a) the ability of the CGS to identify, track, and predict the arrival time of targets, and (b) pass that targeting information through the fire support command structure so that fire support units can engage and kill enemy targets, especially fleeting targets such as Scud missile units; (2) the capability to support surveillance and targeting missions against stationary targets; and (3) the capability to operate on the move.

When these shortfalls are corrected, FOT&E is required to assess the improvements made. Interoperability between the CGS and the Army's automated intelligence and targeting systems in the digital Army of the future should also be tested. FOT&E of the CGS, except for stationary targets, should not wait until the Air Force's operational test of the JSTARS upgrade program—RTIP. RTIP OT&E is not expected to take place for many years.