

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



Air Force E-8C ACAT ID Program:

Total Number of Systems:	15
Total Program Cost (TY):	\$9.080B
Average Unit Cost (TY):	\$648.6M
Full-rate production:	1QFY97

Prime Contractor

Northrop Grumman

Army CGS ACAT ID Program:

Total Number of Systems:	100
Total Program Cost ((TY):	\$1.2635B
Average Unit Cost (TY):	\$6.582M
Full-rate production:	4QFY99

Prime Contractor

Motorola

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2010

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 radar modes to the battlefield as well as the computer 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 a High Mobility Multi-Purpose Wheeled Vehicle (HMMWV) mounted system. It is required to demonstrate the 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 Services Workstation (JSWS) is not a formal part of the Joint STARS program; however, Motorola and Northrop Grumman have sold several directly to Army and Air Force operational units, bypassing the developer. There has been no operational testing performed on JSWS. JSWS is supposed to perform the functions of an operator's workstation in a CGS.

The Joint STARS program office has planned a series of upgrades for the E-8C, both block upgrades and modifications to improve the supportability of the airplane. The Block upgrades planned are:

- Block 10 consists primarily of Tactical Digital Information Link-Joint (TADIL-J) upgrade and Y2K compatibility.
- Block 20 consists primarily of the Computer Replacement Program (CRP), which replaces the current five-computer system with two Commercial-Off-The-Shelf computers, and facilitates upgrading the E-8's computers in parallel with industry.
- Block 30 includes the integration of satellite communications (SATCOM), the incorporation of additional TADIL-J messages, and the integration of the Improved Data Modem. Only SATCOM integration is currently funded.
- Block 40 consists of the Radar Technology Insertion Program, which replaces JSTARS' radar, adding several significant improvements to both the SAR and moving target indicator radar modes.

The supportability improvements are aimed at modifying components such as the air cycle machine, which are high failure items and require significant maintenance.

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 E-8C under the oversight of DOT&E.

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. IOT&E for CGS was conducted in April 1998. Unfavorable operational effectiveness and operational suitability evaluations caused the postponement 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 one hundred procurement objective have been approved to be built as LRIP systems.

TEST & EVALUATION ACTIVITY

An updated TEMP for JSTARS identified unresolved operational issues and deficiencies discovered during OPERATION JOINT ENDEAVOR. The Air Force conducted regression testing during field and training exercises, operational deployments, technical tests, and CGS IOT&E to address these issues and deficiencies. The focus of regression testing was on the operational suitability of the E-8C aircraft; however, DOT&E intended to gather effectiveness data whenever possible from the exercises in which the 93rd ACW participated to address the inadequacies in testing that supported the E-8C Milestone III decision.

The Air Force also conducted DT&E of the Block 10 upgrade in 1QFY99. The Block 10 upgrade consists primarily of the implementation of TADIL-J messages and making the software Y2K compliant. The 605th TS operationally tested Block 10 combined with DT&E. The dedicated OT&E phase of Block 10 has been delayed because of the 93rd ACW's operational commitments to OPERATION ALLIED FORCE. DOT&E has serious concerns with the test plan, which was not subject to DOT&E approval, the primary concern being its lack of any specific plan to demonstrate intra- and inter-Service interoperability. These deficiencies in the Block 10 OT will have to be addressed in the Block 30 OT&E, which includes the implementation of additional TADIL-J messages. OT&E of Block 20, which primarily consists of CRP, is currently scheduled for 2QFY00.

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 computer software problems in CGS. 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 the 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, in his test approval plan, the Director stated that the plan described test limitations such that favorable results from this test alone may not be able to demonstrate that the CGS is suitable. 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) impact the realism necessary for an adequate test of suitability. An additional event is required using a live E-8C/radar and real interfaces to demonstrate overall CGS suitability and interoperability. It is scheduled in conjunction with the All-Service Combat Identification and Evaluation Team 00 in March 2000.

TEST AND EVALUATION ASSESSMENT

DOT&E found that the E-8C was operationally effective for operations other than war; however, the limited operations in Bosnia during OPERATION JOINT ENDEAVOR were not conducive to resolving the critical operational issues relating to operational effectiveness of JSTARS during combat. There were no large-scale movements of opposing forces within Bosnia during the winter of 1996; the ground situation was fairly static. Furthermore, mountainous terrain and poor weather conditions posed significant operational challenges and severely limited the ability of JSTARS to provide intelligence information. In addition, there were limited, simulated target attack missions during the operations in Bosnia that did not adequately demonstrate this capability, and there was limited use of JSTARS to support battle management. DOT&E also found that the E-8C was not operationally suitable.

The evaluation during OPERATION JOINT ENDEAVOR identified modifications, fixes, and future testing requirements that must be accomplished to fully integrate the capabilities of JSTARS into the forces of the United States Air Force and Army. OPERATION JOINT ENDEAVOR also revealed that several operational sub-issues must be resolved before Air Force and Army commanders and units fully understand, use, and realize the capabilities of JSTARS.

Most of the unresolved operational issues and deficiencies were tested and evaluated during the E-8C regression test. Although the operational suitability of the E-8C aircraft has improved, it still does not meet many of its requirements including reliability, ground fix rate, all built-in test requirements, and on-station time. Additionally, although regression testing did demonstrate that the E-8C can effectively perform some operational missions, it did not provide adequate data to demonstrate the E-8C can perform its surveillance, target attack missions or battle management as well as required in the ORD or COEA. For example, during Foal Eagle, DOT&E, using a version of the Joint Services workstation at Kadena AFB, observed the E-8C conducting surveillance of a marine landing on a beach on the east coast of Korea. DOT&E received all data available on the E-8C's performance of this mission. The E-8C clearly detected the landing on the correct beach, demonstrating accuracy to within a few kilometers. However, the data available do not include any information on the vehicles that actually participated in the landing, which would enable an assessment of how completely the E-8C detected that landing. Additionally, the data do not indicate if or when a report was made by either E-8C or ground station operators to enable an assessment of how timely the information reached the relevant intelligence or C2 nodes. Similar deficiencies exist in the data available to assess the E-8C's ability to support target attack missions by

air-to-ground aircraft. During Foal Eagle, the E-8C directed numerous attack aircraft against ground targets it detected within the exercise area. DOT&E received data from the 93rd ACW on all target attacks supported by the E-8C during Foal Eagle. However, DOT&E has not received any independent data to determine if the aircraft actually attacked the targets the E-8C directed them against. Finally, the data provided to DOT&E was inadequate to assess the E-8C's ability to correlate its sensor information with off-board data in the support/ conduct of battle management. The data provided to DOT&E made it impossible to tell whether the targets that the fighters were directed against were hostile, friendly or neutral. Finally, regression testing clearly demonstrated that some requirements; e.g., the amount of airlift required to deploy the E-8C, are unattainable. These requirements are being re-examined by the Air Force.

Although the interim software release used for regression testing was implemented and improved system stability, deficiencies continue to exist. An operational certification process has been developed to fully test and evaluate future software releases. The interim software release tested during the regression test was not Y2K compliant, although the software release currently on all operational aircraft is Y2K compliant. Additionally, software, in particular the programmable signal processors (PSP), accounts for the majority of the E-8C's downtime when it is on-station. Finally, satellite communications and Constant Source—a source of national- and theater-level intelligence data—were poorly integrated in the software; these issues may not be addressed until Block 30.

The remanufactured 707 airframes, especially the engines and air cycle machine, continue to be a maintenance burden and will continue to require considerable maintenance manpower and resources. Consequently, the mission reliability rate and ground fix rate did not meet the user's criteria during the regression testing. Furthermore, the remanufacturing of the 30-year-old airframes has resulted in cost overruns and schedule delays in delivery from the contractor. The Air Force has reduced the contractor's requirements for remanufacturing, which may result in an additional maintenance burden. The analysis of suitability was also limited because the maintenance data on the E-8C from the Core Automated Maintenance System was found to be inaccurate during the regression testing. Finally, an operational test and evaluation on the JSTARS Integrated Maintenance Information System needs to be conducted when the automated maintenance system is ready for use.

The effectiveness testing consisted of 93rd ACW participation in the following exercises and tests: ASCIET, Foal Eagle, Purple Dragon, and CGS IOT&E. During these exercises and tests, the E-8C demonstrated its ability to conduct surveillance and support airborne target attack and battle management; however, it is not possible to determine whether the E-8C can meet its operational requirements as specified in the ORD and in the COEA using the data from the exercises. For example, during Foal Eagle the E-8C directed air-to-ground attack aircraft against ground targets the E-8C detected, but because there are no data available on the locations of ground vehicles or the attack aircraft, it is not possible to determine whether the aircraft attacked the correct target. However, the exercises did clearly demonstrate the importance of the Joint Services Workstation (JSWS) to the commanders. JSWS is essentially a CGS workstation with all the software functionality of CGS. As was evident during the exercises, JSWS has not been developmentally or operationally tested. This critical system should be tested as soon as possible.

DOT&E observed some of the Block 10 DT&E. The system performed well during DT&E, demonstrating interoperability with other Air Force platforms: Rivet Joint and the Airborne Warning and Control System. One serious deficiency of the planned operational testing is the lack of testing designed to demonstrate joint interoperability via Link-16 (TADIL-J).

The CGS IOT&E revealed serious operational shortfalls in effectiveness and suitability of 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 reporting success rate during the IOT&E was 14 percent overall. The criteria for the CGS being operationally effective was 50 percent in support of surveillance of moving (demonstrated 21 percent) and stationary targets (demonstrated 7 percent) and targeting of moving targets (demonstrated 11 percent), and 60 percent in support of targeting for stationary targets (demonstrated 7 percent). The success rate in predictive time of arrival was 2 percent. The operators were unable to discern stationary targets from their background in the SAR mode of the radar. It is anticipated that this capability will not be available until Block 40. 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. The CGS operators could not effectively use the SAR imagery received from the E-8C. Operational effectiveness was also hampered by the poor coordination between Army and Air Force operators of the JSTARS. In sum, the JSTARS CGS failed to meet the operational requirements and expectations stated in the Operational Requirements Document, Cost and Operational Effectiveness Analysis, and other documents.

CGS provides Army and Joint Force commanders with a display of the radar data from the JSTARS E-8C aircraft. The radar picture contains information on large-scale movements of ground targets over a large area of hostile territory. Thus, the commanders now have a measure of situational awareness that they previously did not have without the JSTARS E-8C and CGS. This additional capability alone has been enough for commanders to consistently praise the JSTARS CGS in nearly every operational deployment or operational field exercise.

The reliability, availability, and maintainability of CGS did not meet operational requirements and significantly degraded effectiveness. 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. It is used by the CGS to carry a generator to supply electricity to the prime mission equipment while stationary and for on-the-move operations. The ORDT was conducted in an environment that was not operationally realistic. A significant limitation was the use of recordings (from IOT&E) of previous JSTARS missions. In these previous missions, if the operators had not tasked the radar for products with which they may have had more successful reports, then of course the additional radar products were not received in the ORDT. Therefore, the test was not adequate to determine the suitability of the CGS when it is being used effectively.

Initial Operational Test and Evaluation tested only a sub-set of the operational capabilities proposed for the CGS. The improved data modem link to the Apache LONGBOW was not tested because the link was not yet ready to support an operational test. Numerous upgrades are planned. These upgrades, along with the deficiencies identified from the CGS IOT&E, must be operationally tested to determine whether they will be effective and suitable in combat. A rigorous operational test program must be developed by the Army and approved in an updated TEMP. DOT&E will maintain oversight of the CGS, including approving the subsequent operational tests in the TEMP and individual test plans.

CONCLUSIONS

After the E-8C Regression Test, DOT&E finds that the operational suitability of the E-8C aircraft has improved, but E-8C still does not meet many of its requirements, including the requirement to be able to stay on-station for eight hours without refueling. Additionally, although regression testing did demonstrate that E-8C can effectively perform many operational missions, it did not provide adequate data to demonstrate that E-8C can effectively perform its surveillance or target attack missions as required in the ORD or COEA. The Air Force is addressing the deficiencies found during testing with multiple upgrades and by replacing high-maintenance items.

