NAVSTAR GLOBAL POSITIONING SYSTEM (GPS)

Air Force ACAT IC Program

Total Number of Systems:	118 satellites
Total Program Cost (TY$):	$9,602M
Average Unit Cost (TY$):	$66M
Full-rate production:	3QFY89 (Block IIR)

Prime Contractor

Block II, IIA - Rockwell
Block IIR – Lockheed Martin
Block IIF - Boeing

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2010

The NAVSTAR Global Positioning System (GPS) is a 24-satellite constellation that provides highly accurate, real-time, all weather, passive, common-reference grid position and time information to military and civilian users worldwide. GPS enables the military forces to precisely determine their position, velocity, and time to: (1) enhance command and control and coordinate battle tactics and support; (2) engage in strategic and tactical warfare; (3) maneuver efficiently on the battlefield; (4) provide accurate and timely fire support; and (5) facilitate combat service support operations. In addition, knowledge of exact position and time is essential to reconnaissance and intelligence missions. GPS provides the precision, velocity, and time element of ***information superiority***, and serves as the cornerstone of the warfighter's ability to execute the ***Joint Vision 2010*** concept of ***precision engagement***.

GPS is an Air Force-managed Joint Service program and comprises three segments: space, control, and user equipment. The space segment consists of 24 satellites in semi-synchronous orbits around the earth. The original Block I satellites were replaced with Block II/IIA satellites. Currently, Block II/IIA satellites are being replaced with Block IIR as the II/IIA satellites fail on-orbit. The control segment consists of a master control station, four ground antennas, a pre-launch capability station, and five geographically dispersed monitoring stations. The control segment monitors satellite downlink signals and uploads corrections to diminish errors broadcast to users. The user segment consists of numerous forms of GPS receivers that use satellite downlink signals to determine position, velocity, and precise time. These receivers are hosted on a multitude of platforms and are classified into three general categories: high-dynamic sets (5+ channels); medium-dynamic sets (2 channels); and low-dynamic sets (usually single channel). The 5-channel sets are used primarily by the Air Force and Navy on aircraft, ships, and submarines. The 2-channel sets are used mainly by the Army in heliborne configurations. The single-channel sets are generally used in hand-held applications.

BACKGROUND INFORMATION

DoD approved the NAVSTAR GPS program in December 1973. Full-scale development began in June 1979. By 1985, the Joint Program Office had launched ten Block I satellites and developed the associated ground-control system software to support system test and checkout. The first production satellite launched successfully in February 1989. The Block I satellites were followed by 27 Block II/IIA satellite launches. The initial operational capability, which included the control segment, was declared on December 8, 1993.

The first Block IIR satellite was destroyed during launch when its Delta rocket exploded just after lift-off on January 17, 1997. The first successful launch of a Block IIR satellite was on July 22, 1997, from Cape Canaveral Air Force Station, FL. The GPS IIR satellites provide the same functionality as earlier satellites, with added capabilities requiring less man-in-the-loop monitoring for on-orbit operations. There are 19 additional Block IIR launches planned. Block IIF satellites are under development, with the first IIF satellite launch planned for 2002. They are planned as functional equivalents to the current GPS IIR satellites and will sustain the GPS constellation through 2010.

GPS user equipment development began in June 1979, with receiver testing (using Block I satellites) in a variety of land, sea, and air vehicles. Since then, numerous versions of single-, 2-, and 5-channel receivers have undergone development and fielding. GPS user equipment achieved full-rate production approval in January 1992. Full operational capability was declared in November 1995, after completion of Phase III IOT&E.

TEST & EVALUATION ACTIVITY

Space and control segment testing occurred in three phases. Phase I IOT&E was conducted from 1989-1990; Phase II IOT&E from 1990-1992; and Phase III from 1992-1994. Each test phase was successful and progressively led to an approved final operational capability, with a complete 24-satellite configuration. The Block IIA satellite constellation and ground system completed all operational test activities in prior years and are fully operational. There was no operational testing of these satellites or their control function during FY99.

The GPS TEMP was scheduled to be updated by February 1998 to cover test activities for GPS IIR and IIF satellites. It has been completed and is in Air Force staffing for approval prior to sending to OSD for approval. OSD approval is expected in early 2000.

An OA originally scheduled to begin in January 1997, was delayed because of the launch failure of the first Block IIR satellite. The operational assessment was conducted from July 23-28, 1998, after successful launch of the first IIR satellite. Although the IIR satellite met all navigation and timing requirements, a significant problem with the improved cross-link system of the GPS IIR satellite was found. During the AFOTEC operational assessment, it was discovered that spurious radio frequency interference/noise was being sensed by the new cross-link system of the GPS IIR satellite. All GPS IIR launches were postponed until the problem was identified and a solution found. The next IIR launch was on October 7, 1999. Final OT&E for the GPS IIR satellites requires a minimum of five GPS IIR satellites on-orbit to fully test all features of the improved GPS IIR cross-link, and is planned for November 2004. The control segment software will not be ready until then.

TEST & EVALUATION ASSESSMENT

Although ground testing indicates that the proposed solution to the GPS IIR cross-link problem will resolve all issues, it is premature to report a final determination of the effectiveness and suitability of the Block IIR satellites. The successfully launched Block IIR satellite is performing its navigation mission without any reported problems, and is expected to exceed all navigation requirements for the satellite.

The Block IIR initial operational test and assessment of the Block IIR portion of the GPS constellation is scheduled for 2000. This is based on a projected launch rate of four satellites per year and implementation of full functionality, including auto-navigation capability with a fully functional GPS IIR cross-link. Based on the history of the GPS program, the results of the operational assessment and the efforts to correct the interference problem, DOT&E believes that the Program Office is progressing toward fielding an effective and suitable system.

The follow-on Block IIF satellites are currently in production and scheduled for first launch in 2002. An operational assessment of the space and control segment will take place with the first successful launch of a Block IIF satellite. IOT&E of a partial constellation (minimum of 5-6 satellites) will occur in the 2003-2004 timeframe.

Unfortunately, the Operational Control System support contractor continues to experience problems in development of the replacement ground system. There is no delay margin in the schedule. Delays are starting to result in shortfalls to user requirements and probable delays to implementing ground system upgrades to the follow-on IIF satellites in the on-orbit constellation. While there are no direct impacts on planned operational test activities, continuing problems in the GPS Operational Control Segment make this the number one DOT&E concern. In addition to the delays in the GPS IIR ground system portion of the program, the planned upgrades to the ground system supporting GPS IIF satellites are being delayed. Thus, we are starting to see ripple effects to other portions of the GPS program. Significant progress has been made this year in finalizing the requirements for GPS modernization and the technical solutions for implementing them. The planned test approach is straightforward and well thought out. In addition, extensive joint developmental/operational testing is planned to ensure adequate insight into new capabilities planned for inclusion into the GPS mission; i.e., a second civilian frequency and a signal protection capability for U.S. and allied forces.