# NAVSTAR Global Positioning System (GPS)

The NAVSTAR Global Positioning System (GPS) is an Air Force-managed joint Service program that provides highly accurate, real-time, all-weather, passive, common-reference grid position and time information to military and civilian users worldwide. It consists of three segments: space, control, and user equipment (UE). The control segment consists of a master control station; four ground antennas; a pre-launch capability station; and five geographically dispersed monitoring stations, and it monitors satellite downlink signals and uploads corrections to diminish errors broadcast to users. The user segment consists of numerous types of GPS receivers that use satellite downlink signals to determine position, velocity, and precise time. These receivers are hosted on a multitude of platforms.

The space segment consists of a nominal 24-satellite constellation in semi-synchronous orbit. The Air Force Space Command has launched three blocks of NAVSATR GPS satellites:

- Block I satellites (Developmental) – 11 satellites were launched from 1982 through 1992. Satellite 7 experienced launch failure and was not usable.
- Block II/IIA – 9 Block II satellites were launched between 1986 and 1990; 19 Block IIA versions were launched between 1990 and 1997. Improvements included radiation-hardened electronics, greatly increased navigation message data storage capacity, and selective availability and anti-spoof modes for more signal security.
- Block IIR – 9 satellites have been launched between 1997 and March 2003. Block IIR satellites gained inter-satellite ranging capabilities, increased satellite autonomy and radiation hardness, and more launch responsiveness, with the ability to be launched into any required GPS orbit with 60 days notice. There are 12 additional Block IIR launches planned, with as many as eight of those being the modernized or Block IIR-M version.

Future planned NAVSTAR GPS satellite blocks include:

- Block IIR-M — The first Block IIR-M satellite launch is planned for late FY04. The IIR-M capabilities include developmental military-use-only M-code on the L1 and L2 signals and a civil code on the L2 signal.
- Block IIF – also under development, with the first launch planned for mid-FY06. The Block IIF satellites are functionally equivalent to the IIR/IIR-M satellites and pave the way towards operational M-code after IOT&E in 2010. Block IIF will also add a new separate signal for civilian use, designated L5. This variant will also have increased, adjustable signal power.

The Air Force Operational Test and Evaluation Center conducted an operational assessment of the first Block IIR satellite in late 1997. Although the this satellite met all navigation and timing requirements, the report detailed a significant problem with the improved cross-link capabilities. The program office has incorporated an interim fix for the problem on the second and third IIR satellites, and they are applying a more robust resolution to the remaining Block IIR/IIR-M satellite family. Active UE programs include continuing Miniaturized Airborne GPS Receiver 2000 platform installations in FY03 and beyond;

*Delays in developing and testing the GPS Operational Control System are DOT&E's chief concerns. Control segment software development continues to be a moderate to high-risk area with an ambitious schedule.*

Defense Advanced GPS Receiver deliveries beginning in FY03; and M-code receiver deliveries beginning in FY10. All receivers produced after FY02 are to have the Selective Availability Anti- Spoofing module capability installed.

**TEST & EVALUATION ACTIVITY**

FY03 activity included continued test planning meetings and combined developmental/operational testing (DT/OT) of GPS Modernization backward compatibility with legacy user equipment.

Future testing includes a series of combined DT/OT events and operational assessments in support of the development and fielding of the new operational control system, the launch of the first IIR-M and IIF satellites, and M-code fielding.

The next round of IOT&E will occur when 24 operational Block IIR-M and Block IIF satellites are on-orbit and control segment software Version 6 is declared operational.

IOT&E will be a system-wide test of the space and control segments. Legacy and modernized (M-code capable) UE and is scheduled to take place in FY10.

**TEST & EVALUATION ASSESSMENT**

Ground testing and on-orbit tests continue to indicate that the proposed solution to the Block IIR cross-link problem is being resolved satisfactorily. However, it is still too early to report a final determination of the effectiveness and suitability of the entire series of IIR satellites.

Delays in developing and testing the GPS Operational Control System are DOT&E's chief concerns. Control segment software development continues to be a moderate to high-risk area with an ambitious schedule. There is little time for regression testing in between software builds, and some significant capabilities will not be tested until the first operational build is released. Adequate operational flavor must be added to this contractor-led testing throughout the test program to increase robustness and mitigate risk.

The November 2001 Test and Evaluation Master Plan and associated test planning documents are being revised by the GPS test community to accommodate the introduction of variable satellite signal power settings and increases in signal strength. The proposed test approach to be incorporated into a new version of the GPS Test and Evaluation Master Plan calls for extensive DT/OT to ensure early and adequate insight into the new capabilities planned for inclusion into the GPS mission (i.e., control segment software and M-code functionality, second and third civil signals, and signal protection for U.S. and allied forces). DOT&E feels that fielding the new operational control system and M-code availability warrant not just combined DT/OT, but dedicated operational assessments.

DOT&E continues to advocate the testing of new and legacy GPS receivers as early in the program as possible. These receivers must be integrated into representative platforms (e.g., ships, aircraft, and land vehicles) and tested in operational environments. Development of M-code-capable UE lags behind the development of the space and control segments, and this may induce delays in testing the Block IIR-M and IIF systems, along with the attendant M-code and civil signal capabilities. Before that time, backward compatibility will be tested using legacy receivers and initial M-code performance will be tested using prototype receivers.