Global Positioning Systems Wing

GPS Program Update to 48th CGSIC Meeting

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Outline

• Constellation Status
• System Performance
• GPS Modernization
• International Cooperation
• Support to Civil Users
• Upcoming Events
Recent Successes

- **Operational Control Segment (OCS)**
  - Architecture Evolution Plan (AEP)/Launch & Early Orbit, Anomaly Resolution & Disposal Operations (LADO) switch over – Sep 07
  - Alternate Master Control Station fully functional at VAFB, CA

- **Next Generation Operational Control Segment (OCX)**
  - Awarded Phase A contracts to Northrop Grumman & Raytheon, Nov 07

- **GPS IIR(M)**
  - 3 Successful launches since Oct 07

- **GPS IIIA**
  - Awarded to Lockheed Martin Space Systems Company (Newton, PA), May 08
GPS Constellation

• 29 space vehicles currently in operation
  • 11 GPS IIA
  • 12 GPS IIR
  • 6 GPS IIR-M
    • Transmitting new second civil signal (L2C)

• Continuously assessing constellation health to determine launch need
  • 2 Block IIR(M) satellites remaining

• Global GPS civil service performance commitment met continuously since December 1993
Current GPS Accuracy

• **Signal-In-Space (SIS) User Range Error (URE)**
  – One-year RMS as of June 08: 0.92 meters

• **Zero Age-Of-Data (AOD) URE**
  – One-year RMS as of June 08: 0.22 meters
Snapshot: Typical UE

Horizontal Position Error at 2008-09-10 16:55:00
UEE = 2.6 m

"Typical UE" = MAGR-2000 Specification

Max 4.92 m
95th Percentile 3.16 m
Median 2.34 m
GPS Modernization Program

Block IIA/IIR
- Basic GPS
  - Standard Service
  - Single frequency (L1)
  - Coarse acquisition (C/A) code navigation
  - Precise Service
  - Y-Code (L1Y & L2Y)
  - Y-Code navigation

Block IIR-M, IIF
- IIR-M: IIA/IIR capabilities plus
  - 2nd civil signal (L2C)
  - M-Code (L1M & L2M)
- IIF: IIR-M capability plus
  - 3rd civil signal (L5)
  - Anti-jam flex power

Block III
- Backward compatibility
- 4th civil signal (L1C)
- Increased accuracy
- Increased anti-jam power
- Assured availability
- Navigation surety
- Controlled integrity
- Increased security
- System survivability

Increasing System Capabilities • Increasing Defense / Civil Benefit
GPS Modernization – New Civil Signals

• Second civil signal “L2C”
  • Designed to meet commercial needs
  • Higher accuracy through ionospheric correction
  • 1st launch: Sep 2006 (GPS IIR-M); 24 satellites: ~2016

• Third civil signal “L5”
  • Designed to meet demanding requirements for transportation safety-of-life
  • Uses highly protected Aeronautical Radio Navigation Service (ARNS) band
  • 1st launch: ~2009 (GPS IIF); 24 satellites: ~2018

• Fourth civil signal “L1C”
  • Designed with international partners for GNSS interoperability
  • Begins with GPS Block III
  • 1st launch: ~2014; 24 satellites: ~2021
Second Civil Signal (L2C)

• Designed to meet commercial needs
  • Higher accuracy via ionospheric correction
  • Expected to generate over $5B in user productivity benefits
• Available since 2005
• On 24 satellites by 2016

Benefits existing professional receivers

Increases accuracy for consumers

Supports miniaturization, possible indoor use
Third Civil Signal (L5)

- Designed to meet demanding requirements for transport safety
  - Uses highly protected Aeronautical Radionavigation Service (ARNS) band
- May also enable global, centimeter-level accuracy using new techniques
- Opportunity for international interoperability
- Demonstration signal to be launched in October 2008
- 24 satellites by 2018
Fourth Civil Signal (L1C)

- Designed with international partners for interoperability
- Modernized civil signal at L1 frequency
  - More robust navigation across a broad range of user applications
  - Improved performance in challenged tracking environments
- Original signal retained for backward compatibility
- Launches with GPS III in 2014
- Transmitted from 24 satellites by ~2021
International GNSS Coordination

GPS is actively coordinating with other GNSS on compatibility and interoperability issues in increasingly crowded frequency bands.
GPS GNSS Coordination Activities

• **Galileo**
  – Ongoing technical working groups
  – Signed major agreement in 2004, including common civil L1 signal

• **QZSS**
  – Ongoing technical working groups

• **GLONASS**
  – Ongoing technical working groups
  – Signed joint statement in 2006 promoting GLONASS/GPS interoperability

• **Compass**
  – Ongoing ITU coordination meetings

• **IRNSS**
  – Ongoing technical working groups
Performance Standards

• The AF, DoD, and U.S. Government are committed to being good stewards of GPS

• GPS Performance Standards define the levels of performance the U.S. Government commits to provide GPS users
  – Precise Positioning Service Performance Standard for military users
  – Standard Positioning Service Performance Standard for civil users
  – Revised SPS PS to be released end of September 2008

• SPS PS available on US Coast Guard Navigation Center website: http://www.navcen.uscg.gov/
Support to Civil Issues via NPEF

- National Space-Based PNT Systems Engineering Forum (NPEF) created by US National Policy for Space-based PNT in 2004
- Permanent technical forum, co-chaired by FAA and GPSW
- Define technical issues and make recommendations
  - Civil codeless/semi-codeless users and backward compatibility
  - Extensive coordination with FAA, NASA, NOAA, DOC, DOT, other agencies
  - Primary Findings
    - Over 300,000 civil semi-codeless users world wide
    - GPS will continue enabling codeless/semi-codeless GPS access until December 31, 2020
    - Details available at: www.space.commerce.gov/gps/semicodeless/
FY09 Planned Events

• **Space Segment**
  – Three launches planned in FY09: IIRM-20, IIRM-21 and IIF-1
  – L5 demo payload on IIRM-20

• **Current Ground Segment**
  – Support for IIF launch and operations
  – Support to SAASM UE and functions
  – Remote site equipment upgrade
  – Position Training Emulator release

• **Next Generation Ground Segment**
  – OCX Modernized Capability Engineering Model (MCEM) demonstration
  – OCX System Design Review with two contractors and down-select

• **User Segment**
  – MGUE Phase A testing
L5 Demo Payload on GPS IIR-20

- Purpose is to secure GPS L5 ITU-R filing
- Will not affect primary or secondary missions
- Signal is not intended for navigation
- Dataless IS-GPS-705 Q5 modulation
- PRN 63
- Scheduled for launch into slot B2
Summary

• GPS has continuously met its commitments to all users since FOC
• GPS has had multiple operational and acquisition successes in the past year
• Modernization of all GPS Segments is on track

Maintaining and Improving GPS Services for All Users is Job #1