Space and Missile Systems Center

GPS Update for PNT Advisory Board

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GPS Constellation Status

30 Operational Satellites (Baseline Constellation: 24+3)

- Robust operational constellation
  - 4 GPS IIA – L1 C/A, L1 P(Y), L2 P(Y) signals
  - 12 GPS IIR – same signals as IIA
  - 7 GPS IIR-M – adds L2C, L1M, L2M signals
  - 7 GPS IIF – adds L5 signal
- 8 additional satellites in residual/test status, and 1 in early orbit test (IIF-8)
- Global GPS civil service performance commitment met continuously since Dec 1993 (IOC)
  - Best performance 46.2 cm User Range Error (URE) 17 Nov 2014; best weekly average 55.2 cm URE 17 Nov 2014
  - Performance improving as new satellites replace older satellites

Satellite Block | Quantity | Average Age | Oldest
---|---|---|---
GPS IIA | 4 | 21.5 | 24.0
GPS IIR | 12 | 12.9 | 17.4
GPS IIR-M | 7 | 7.3 | 9.2
GPS IIF | 7 | 1.9 | 4.5
Constellation | 30 | 10.2 | 24.0

AS OF 19 NOV 2014
2014 Banner Year for GPS IIF
4 Successful Launches!

- 8 total GPS IIFs on-orbit
- 4 more GPS IIFs in the pipeline
  - SVs 10, 11, and 12 are in storage
  - SV-9 is in production testing

Most GPS launches in a single year since 1993

20 Feb: IIF-5
16 May: IIF-6
1 Aug: IIF-7
29 Oct: IIF-8

SVN 66 thru 69
System accuracy exceeds published standard

- US Law: (10 U.S.C. § 2281) “SecDef shall provide GPS for both military & civilian purposes”
- The Standard Positioning Service (SPS) Performance Standard defines commitment to civil users and is approved by PNT EXCOM
- Information is for the user community – in particular, aviation users for receiver certification
- Last updated in 2008
GPS Modernization Program

Legacy GPS IIA/IIR
- Single Frequency (L1)
- Coarse acquisition (C/A) code
- Y-Code (L1Y & L2Y)

GPS IIR-M
- 2nd Civil Signal (L2C)
- M-Code (L1M & L2M)

GPS IIF
- 3rd civil signal (L5)
- 2 Rb + 1 Cs Clocks
- 12 year design life

GPS III
- 4th civil signal (L1C)
- 4x better User Range Error than GPS IIF
- Increased availability
- Increased integrity
- 15 year design life

Legacy Operational Control Segment (OCS)
- Mainframe system
- Command & Control
- Signal monitoring

Architecture Evolution Plan (AEP)
- Distributed architecture
- Increased signal monitoring
- Security
- Accuracy
- Launch and disposal ops

Next Generation Operational Control System (OCX) Block 0
- Launch & On-Orbit Checkout of GPS III

OCX Block 1
- Transition to OCX for all GPS command and control operations

Increasing system capabilities - Increasing user benefit
GPS III Status

- Newest block of GPS satellites
  - 4 civil signals: L1 C/A, L1C, L2C, L5
    - First satellites to broadcast common L1C signal
  - 4 military signals: L1/L2 P(Y), L1/L2M
  - Three improved Rubidium atomic clocks
- SV07/08 contract awarded 31 Mar 14
- SV09/10 planned to be purchased under current Lockheed contract
- Navigation payload panel began space environment testing at Lockheed Martin’s Colorado facility Sep 14
- GPS III Non-Flight Satellite Testbed accomplished launch processing at Cape Canaveral; reduced risk for integration & test and launch processing
- GPS III SV01 available for launch CY 2016

Lockheed-Martin (Waterton, CO) – Prime
Military GPS User Equipment (MGUE)

- Building next-generation of military GPS receivers that incorporate M-Code (required in statute by FY17)
- Direction from USD(AT&L) to accelerate MGUE Increment 1
- Requirements approved by JROC July 2014
- Successfully completed Preliminary Design Reviews for MGUE Increment 1 contractors Aug-Sep 2014
- Security Certification Underway
- Updated Lead Platforms
  - Army: Raven to DAGR Distributed Device (D3)
  - Air Force: F-15E to B-2 Spirit (B-2)
• Current system Operational Control Segment (OCS)
  – Flying GPS constellation on Architecture Evolution Plan (AEP) and Launch & early orbit, Anomaly, and Disposal Operations (LADO) software systems
  – Cyber security enhancements in progress

• Next Generation Operational Control System (OCX)
  – Modernized command & control system with M-Code, modern civil signal monitoring, info assurance infrastructure and improved PNT performance: Raytheon (Aurora, CO) - Prime
  – Successfully completed four GPS III launch exercises
  – OCX Block 0 supports launch & checkout for GPS III; currently in integration & test; delivery expected Jan 2016
  – OCX Block 1 supports transition from OCS in 2019
  – Civil Signal Performance Monitoring capability scheduled for OCX Block 2 in 2020
Now on The Air: Modernized Civil Signals

• U.S. initiated continuous CNAV message broadcast (L2C & L5) on 28 Apr 2014; began with twice-a-week uploads and moving to daily (nominal) uploads on 15 Dec 2014
  – Position accuracy not guaranteed during pre-operational deployment
  – L2C message currently set “healthy”
  – L5 message set “unhealthy” until sufficient monitoring capability established

• User-Range Error (URE) CNAV Performance
  – CNAV URE within 3 meters of LNAV performance with 3x per week uploads
  – Daily uploads consistent with or exceed LNAV performance

• Currently 14 L2C- and 7 L5-capables satellites on orbit