Global Positioning Systems Directorate

GPS Program Update to Civil GPS Service Interface Committee (CGSIC)

17 Sep 2013

Col Bill Cooley
Director, GPS Directorate
Mission:
Acquire, deliver and sustain reliable GPS capabilities to America’s warfighters, our allies, and civil users.

Col Bill Cooley

Deliver and Sustain Global Navigation and Timing Service
GPS Program Partnership

• Civil representatives integral members of GPS team
  – Resident in the GPS Directorate – DOT (1), FAA (1), NASA (½)

• Support program, Interface Control Document and Specification reviews
  – Civil GPS Service Interface Committee (CGSIC)
  – Signal Monitoring Working Group (SMWG)
  – Interface Control Working Group (ICWG)
  – L1C Product Implementation Teams
  – Positioning Signal Integrity and Continuity Assurance (PSICA) Team
  – Interagency Forum for Operational Requirements (IFOR)
  – National Space-Based PNT Engineering Forum (NPEF)
  – Nation Space-Based Coordination Office (NCO)

*Interagency partnerships are critical to GPS modernization success!*
GPS Constellation

• Robust constellation
  – 31 space vehicles currently in operation
    • 8 GPS IIA, 12 GPS IIR, 7 GPS IIR-M, 4 GPS IIF
    – 4 additional satellites in residual status, 1 in test status

• Extensive International and Civil Cooperation
  – Agreements with 56 international customers
  – 1 billion civil/commercial users
  – Countless applications…and growing

• Global GPS civil service performance
  commitment met continuously since Dec 1993
GPS Signal in Space Performance

Standard Positioning Service (SPS) Signal-in-Space Performance

  - RMS over all SPS SIS URE
- **2008 Standard Positioning Service (SPS) Performance Standard (PS)**
  - Worst of any SPS SIS URE

- Decreasing range error = Increasing accuracy

- System accuracy exceeds published standard

Precise Positioning Service (PPS) Signal-in-Space Performance

- **2007 Precise Positioning Service (PPS) Performance Standard (PS)**
  - Worst of any PPS SIS URE

- Decreasing range error = Increasing accuracy

- Better Performance

Applications:
- Precision Agriculture
- Mining and Construction
- Aviation
- Wildlife Research
- Precision Navigation
• Launched GPS IIF-4 on 15 May 13
  – Satellite Vehicle Number 66, PRN 27
  – Set healthy 21 Jun 13
  – Fourth operational L5 signal
  – Providing enhanced GPS clock performance
• 4 total GPS IIFs on orbit
  – Continued demonstration of Flex Power capability
• 8 more GPS IIFs in the pipeline
  – SV-3 scheduled for 17 Oct 13 launch
  – SVs 6-9 are in storage
  – SVs 10-12 are accepted pending testing
  – Improved Rubidium clocks on SVs 3 and 5-12
GPS III Status

• Newest block of GPS satellites
  – First satellite to broadcast common L1C signal
  – Multiple civil and military signals; L1 C/A, L1 P(Y), L1M, L1C, L2C, L2 P(Y), L2M, L5
  – Three Rubidium clocks
• Achieved SV01 initial power turn-on 27 Feb 13
• GPS Satellite Simulator delivered to support OCX, 21 May 13
• Shipped GPS Non-Flight Satellite Testbed to Cape Canaveral (19 Jul); will undergo launch processing
Enabling Affordability & Capability

• Dual launch of GPS III satellites significantly reduces launch costs
  • GPS and Launch Directorates are coordinating on final requirements for a GPS-specific dual payload adapter and mission profile requirements
    – Early studies indicate only minor changes needed to support this capability, with minimal changes in the production line of GPS III SV09+

• Future Size, Weight, Power (SWAP) considerations
  – Battery & Solar Array Efficiency, Efficient Amplifiers, etc…

• Added Capability
  – Search and Rescue/GPS
  – Laser Retroreflector Arrays
Ground Segment Status

- Current system Operational Control Segment (OCS)
  - Flying GPS IIA/IIR/IIR-M/IIF constellation with AEP 5.8.2 and LADO 2.11.2A currently deployed

- Next Generation Operational Control System (OCX) on track
  - Exercise 3 completed on schedule, demonstrated:
    - End to end capability from satellite separation to on orbit planning
    - Successful anomaly resolution
  - OCX Block I Ready to Transition to Operations planned for 2016

- OCX development successes:
  - Interim Authority to Test granted to Launch and Checkout System by Space Designated Accreditation Authority (Jun 2013)
  - Demonstrated reduction in navigation estimation error (JPL Data)

- OCX to GPS III Integration Status
  - Initiated Hardware in the Loop (HWIL) testing using OCX LCS
  - Communicated with Ground Non-flight Satellite Testbed at Cape Canaveral
  - Actively working System Integration demonstrations highlighting key system interactions
GPS Modernization – New Civil Signals

• Second civil signal “L2C”
  – Designed to meet commercial needs
  – Available since 2005 without data message
  – Phased roll-out of CNAV message
  – Currently 11 SVs broadcasting L2C

• Third civil signal “L5”
  – Designed to meet transportation safety-of-life requirements
  – Uses Aeronautical Radio Navigation Service band
  – Currently 4 SVs broadcasting L5

• Fourth civil signal “L1C”
  – Designed for GNSS interoperability
  – Specification developed in cooperation with industry
  – Launches with GPS III in 2015
  – Improved tracking performance

Early CNAV test conducted in Jun 2013
US Gov’t Committed to Civil Signals

• The modernized civil signal deployment is in progress
  – 11 L2C and 4 L5 capable SVs on orbit
  – OCX will implement full command & control of L2C & L5
  – Expect the 1st L1C SV launch in 2015

• Intend to maintain semi-codeless phase relationships until 31 Dec 20
  – Documented in Federal Register Notice Vol. 73, No. 185 (Ref. 31) 23 Sep 08

• Semi-codeless users should start transitioning to L2C
  – Most high-precision manufacturers already offer L2C capable receivers
  – Significant benefits available now

• Complete civil signal constellation implementation limited by:
  – Constellation health – currently enjoy a robust combination of legacy signals
  – Launch opportunities – acceleration possible with dual launch of GPS III

The PNT EXCOM drives civil signal implementation
• GPS has continuously met its commitments to all users
• GPS had multiple operational and acquisition successes in the past year
• Modernization of all GPS Segments is on track
• Striving to continually improve navigation and timing services while maintaining backward compatibility with legacy equipment

Maintaining and improving GPS services for all users is Job #1
On Aug 2, the FCC proposed a fine of nearly $32,000 for an individual whose illegal use of a GPS jamming device on the highway outside Newark Airport interfered with an aviation safety system.

New Additions to GPS.gov

- Aug 6: Presentations from APEC GIT/18 and IGNSS 2013
- Jul 30: U.S.-Japan cooperation announcement
- Jun 26: Videos on WAAS and NextGen
- Jun 25: GPS national risk estimate fact sheet and updated summary
- Jun 13: Redesigned what’s new and website history pages

View All Website Updates

Test Your GPS Knowledge

True or false? GPS satellites continuously send out signals. Learn more.
OCX Estimated Performance

- JPL has employed OCX core Kalman filter for over 6 months
- User Range Error = Satellite Ephemeris Error + Satellite Clock Error

Aug. 5-15, 2012 Zero Age of Data RMS URE

* Zero Age of Data is a current estimation, not a prediction
• GPS CNAV testing publicized in advance through various PNT conferences and online at GPS.gov
• First CNAV live-sky test broadcast with civil input
  – Demonstrated CNAV messaging on GPS IIR-M & GPS IIF SVs (L2C, L5)
  – Focused on basic PNT functionality
• Broadcast populated messages for two weeks
  – Contents included: CNAV ephemeris, clock, almanac, and non-navigation message types
• Perfect opportunity to identify or explore any CNAV message issues in order to implement fixes before operations
• CNAV message set unhealthy at the conclusion of testing
• Further CNAV tests will be conducted to continue to troubleshoot before CNAV message is set healthy