

Space and Missile Systems Center



Global Positioning Systems Directorate

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

9 Sep 2014

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Deputy Director, GPS Directorate



Global Positioning Systems Directorate

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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

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- Civil representatives integral members of GPS team
 - Resident in the GPS Directorate – DOT (1), FAA (1), NASA (1/2)
- 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

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- Robust constellation
 - 31 space vehicles currently in operation
 - 5 GPS IIA, 12 GPS IIR, 7 GPS IIR-M, 7 GPS IIF
 - 7 additional satellites in residual status, 1 in test status
- Extensive International and Civil Cooperation
 - Agreements with 57 international customers
 - 1 billion+ civil/commercial users
 - Countless applications...and growing
- Global GPS civil service performance commitment met continuously since Dec 1993
 - Best performance 46.6 cm User Range Error (URE) 8 Jun 13; best weekly average 58.7 cm URE 18 Aug 14
 - Performance improving as new satellites replace older satellites

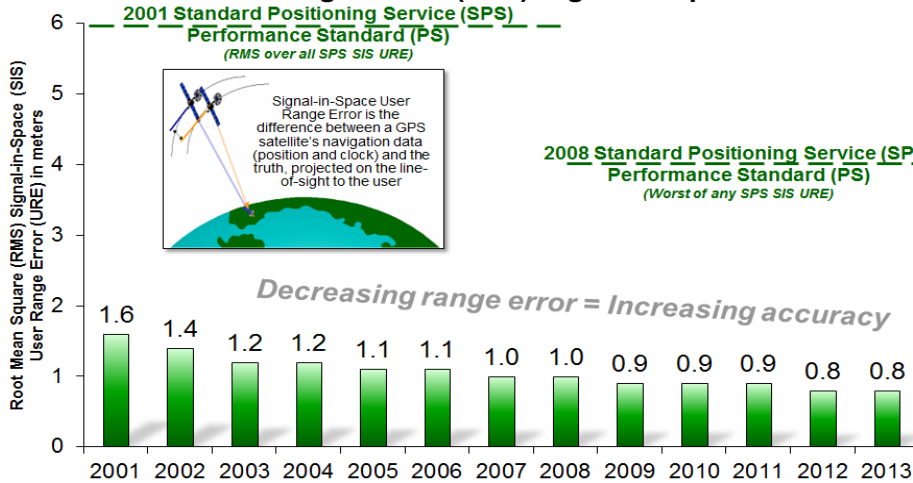




GPS Signal in Space Performance

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



Mining and Construction



Precision Agriculture

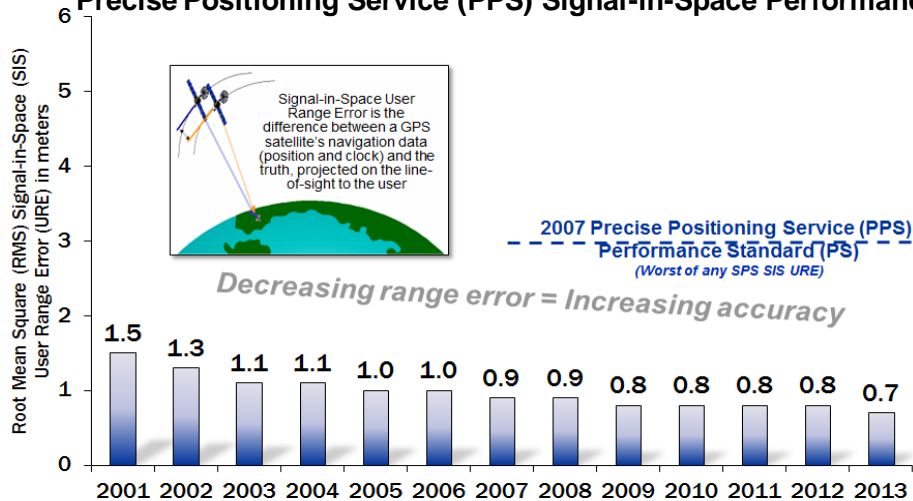


Aviation



Wildlife Research

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



Precision Navigation



System accuracy exceeds published standard



GPS IIF Status

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- What a year!
- Launched GPS IIF-5 on 21 Feb 14
 - Satellite Vehicle Number 64, PRN 30
- Launched GPS IIF-6 on 15 May 14
 - Satellite Vehicle Number 67, PRN 6
- Launched GPS IIF-7 on 1 Aug 14
 - Satellite Vehicle Number 68, PRN 9
- 7 total GPS IIFs on orbit
 - Continued demonstration of Flex Power capability
- 5 more GPS IIFs in the pipeline
 - SV-8 scheduled for launch in Oct 2014
 - SVs 10, 11, and 12 are in storage
 - SV-9 is in production testing
 - Improved Rubidium clocks on SVs 3 and 5-12





GPS III Status

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- Newest block of GPS satellites
 - 4 civil and 4 military signals:
L1 C/A, L1C, L2C, L5; L1/L2 P(Y), L1/L2M
 - First satellites to broadcast common L1C signal
 - Three improved Rubidium atomic clocks
- SV07/08 contract awarded 31 Mar 14
- Navigation Payload Panel in acceptance testing
- 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 starting Jan 2016



Lockheed-Martin (Waterton, CO) – Prime



Ground Segment Status

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- 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
 - OCX Block 0 supports launch & checkout for GPS III and is in integration & test; Raytheon (Aurora, CO) - Prime
 - OCX Block 1 supports transition from OCS in 2018
 - Successfully completed 3 GPS III launch exercises



Monitor Station



Ground Antenna



GPS Modernization – New Civil Signals

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- Second civil signal “L2C”
 - Designed to meet commercial needs
 - Available since 2005 without data message
 - Phased roll-out of CNAV message
 - Currently 14 SVs broadcasting L2C



- Third civil signal “L5”
 - Designed to meet transportation safety-of-life requirements
 - Uses Aeronautical Radio Navigation Service band
 - Currently 7 SVs broadcasting L5

- Fourth civil signal “L1C”
 - Designed for GNSS interoperability
 - Specification developed in cooperation with industry
 - Launches with GPS III in 2016
 - Improved tracking performance



Urban Canyons

Improved performance in challenged environments

Early CNAV test conducted in Jun 2013



CNAV Pre-Operational Deployment

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- Initiated continuous CNAV message broadcast (L2C & L5) on 28 Apr 14
- CNAV Data message uploaded twice a week initially; with daily uploads expected by Dec 2014
- Position accuracy not guaranteed during pre-operational deployment of CNAV signals; “use at own risk”
 - L2C message currently set “healthy”
 - L5 message set “unhealthy” until sufficient monitoring capability established (signal verification)
- Expected Performance for users:
 - During first 24 hours after upload, CNAV performs as LNAV
 - Expect divergence between CNAV & LNAV as CNAV data ages until next CNAV upload

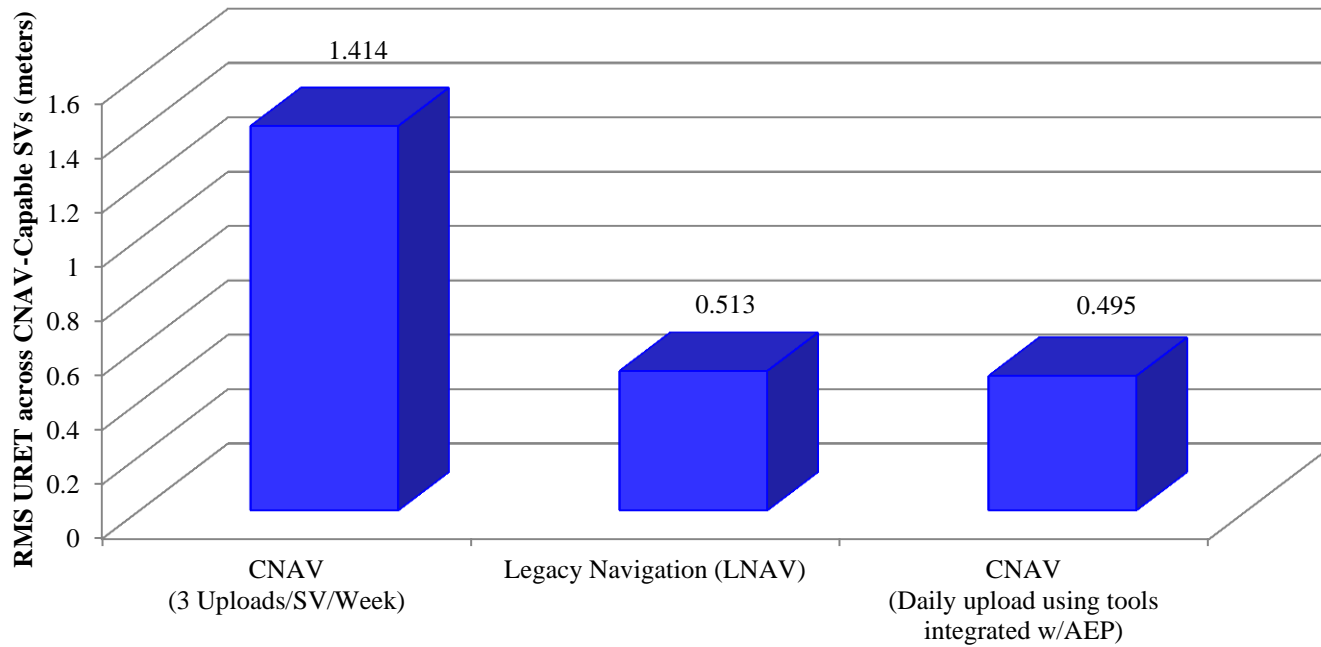


Effect of Upload Frequency on CNAV User Range Error

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- Improved tools reduce age of data & CNAV User Ranging Error (URE)
- Initial, twice-a-week upload (Apr 2014) drives high CNAV URE

RMS URE Driven by Upload Latency & Integration with AEP



Integrated solutions will broadcast CNAV URE comparable to Legacy in Dec 2014



GPS Summary

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- Modernized signal development in progress
 - 14 L2C, 7 L5 and 14 M-Code capable SVs on orbit
 - OCX will implement full C2 of L1/L2M, L2C, L5
 - Continuous L2C, L5 CNAV message broadcast began Apr 2014
 - Expect the first L1C SV launch in 2016
 - Continued progress to M-Code early use ~2017
- Modernization of all GPS Segments making progress but still with technical challenges commensurate with the advanced tech
- Working domestically, internationally and with Industry to simultaneously protect GNSS services and release spectrum for mobile services



Maintaining the world's "Gold Standard" PNT service is Job #1