



# ***GPS Civil Service Update & U.S. International GNSS Activities***

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ION®

Pacific PNT 2015  
Honolulu, Hawaii



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# *Overview*

- **Policy and Service Provision**
  - Constellation Status and Modernization
  - International Cooperation



# *U.S. National Space Policy*

## ***Space-Based PNT Guideline: Maintain leadership in the service, provision, and use of GNSS***

- Provide civil GPS services, free of direct user charges
  - Available on a continuous, worldwide basis
  - Maintain constellation consistent with published performance standards and interface specifications
  - Foreign PNT services may be used to complement services from GPS
- Encourage global ***compatibility*** and ***interoperability*** with GPS
- Promote transparency in civil service provision
- Enable market access to industry
- ***Support international activities to detect and mitigate harmful interference***



# *GPS Civil Service Provision*

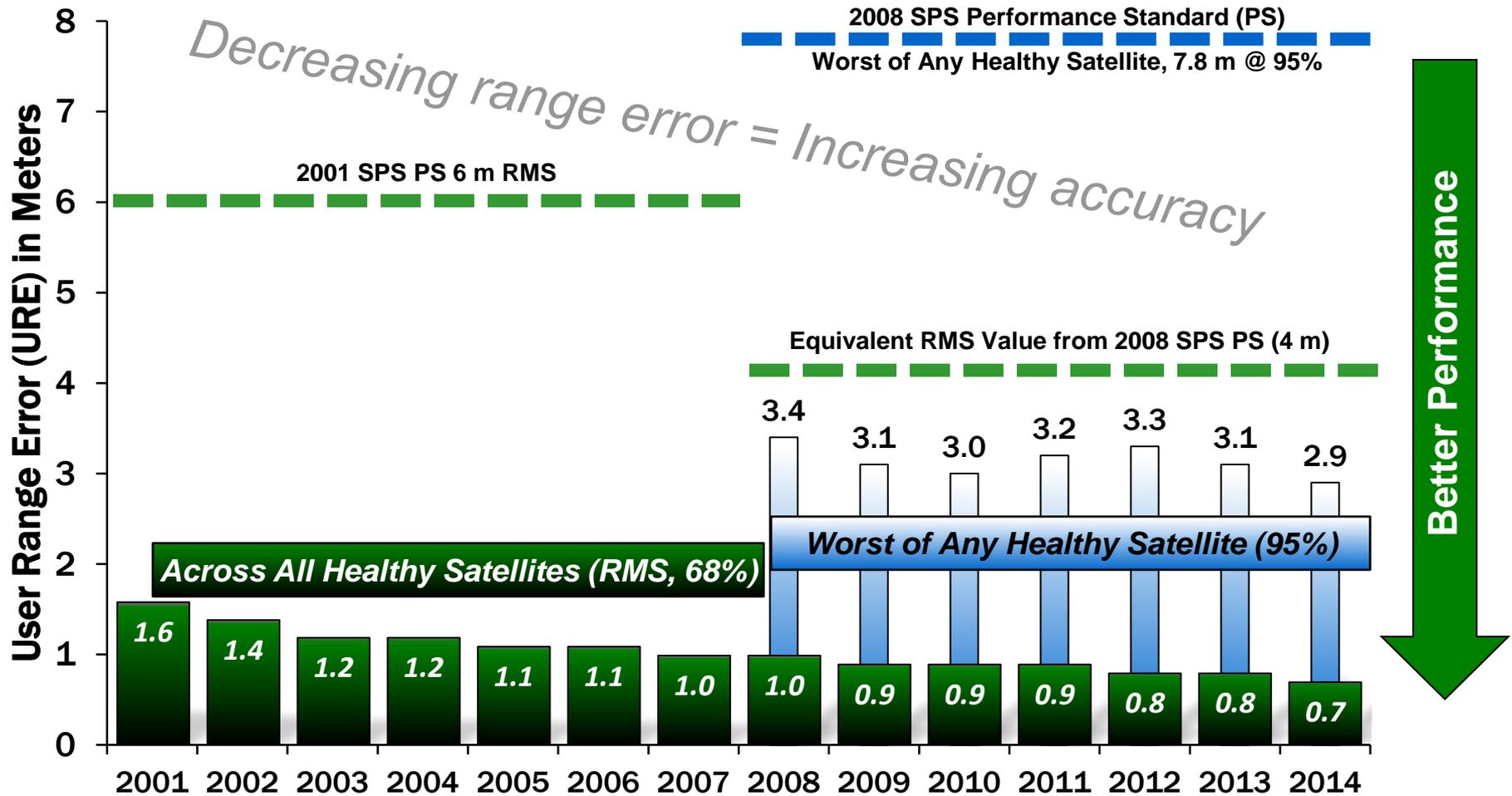
- Global GPS civil service performance commitment continuously met/exceeded since 1993
- Open, public signal structures with public domain documentation necessary to develop receivers
  - Promotes open competition and market growth for commercial GNSS
- A critical component of the global information infrastructure
  - **Compatible** with other satellite navigation systems and **interoperable** at the user level
  - Guided at a national level as multi-use asset
  - Acquired and operated by Air Force on behalf of the USG

***GPS provides continuously improving, predictable, and dependable Global Public Service***



# Civil Service Accuracy: Standard Positioning Service Performance Standard

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



System accuracy better than published standard



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# GPS Constellation Status

**31 Operational Satellites**  
**(Baseline Constellation: 24+3)**

- Robust operational constellation
  - 3 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
  - 9 GPS IIF – adds L5 signal
- 8 additional satellites in residual/test status
- Modified Battery Charge Control has extended GPS IIR and IIR-M life by 1-2 years per SV
  - Best performance 44.8 cm User Range Error (URE) as of 12 Dec 14
  - Best weekly average 52.7 cm URE as of 23 Nov 14
  - Performance improving as new satellites replace older satellites





# *GPS IIF Status*

- 4 successful GPS IIF launches in 2014!
- Latest launch: March 25, 2015
- 9 total GPS IIFs on-orbit
- 3 more GPS IIFs in the pipeline
  - SVs 10, 11, and 12
  - Two more GPS IIF launches planned 2015



March 25, 2015  
IIF-9 Launch





# GPS III Status

- Newest block of GPS satellites
  - 4 civil signals: L1 C/A, L1C, L2C, L5
    - First U.S. satellites to broadcast international 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 Martin contract
- Mission Data Unit completed Thermal Vacuum testing with an expected delivery of Feb 2015
- Space Vehicle 01 successfully completed System Module System Performance Test and is on track for Core Mate in Mar 2015
- GPS III SV01 available for launch starting CY 2017



Lockheed-Martin (Waterton, CO) – Prime



# Ground Segment Status

- 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



Monitor Station



Ground Antenna



# Now on the Air: Modernized Civil Signals

- The U.S. initiated continuous CNAV message broadcast (L2C & L5) on 28 Apr 14
- On December 31, 2014, the Air Force started transmitting CNAV uploads on a daily basis. L2C and L5 should continue to be considered pre-operational and should be employed at the user's own risk
  - Position accuracy not guaranteed during pre-operational deployment
  - L2C message currently set "healthy"
  - L5 message set "unhealthy" until sufficient monitoring capability established





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# ***U.S. Objectives in Working with Other GNSS Service Providers***

- Ensure **compatibility** — ability of U.S. and non-U.S. space-based PNT services to be used separately or together without interfering with each individual service or signal
  - Radio frequency compatibility
  - Spectral separation between M-code and other signals
- Achieve **interoperability** – ability of civil U.S. and non-U.S. space-based PNT services to be used together to provide the user better capabilities than would be achieved by relying solely on one service or signal
- Promote fair competition in the global marketplace

***Pursue through Bilateral and Multilateral Cooperation***



# *GNSS: A **Global Navigation Satellite System of Systems***

- Global Constellations

- **GPS (24+3)**
- GLONASS (24+)
- GALILEO (24+3)
- BDS/BEIDOU (27+3 IGSO + 5 GEO)

- Regional Constellations

- QZSS (4+3)
- IRNSS (7)

- Satellite-Based Augmentations

- **WAAS (3)**
- MSAS (2)
- EGNOS (3)
- GAGAN (2)
- SDCM (3)





# ***Bilateral GNSS Cooperation***

- Europe: GPS-Galileo Cooperation Agreement signed 2004
  - ITU coordination agreement between GPS and Galileo: 2014
  - Current issues include pseudolite interference, spectrum
- China: First civil GNSS bilateral held May 2014
  - Issues include spectrum protection, civil aviation applications
  - U.S.-China Strategic and Economic Dialogue agreed to regular meetings on outer space activities – GNSS meeting planned
- Japan: Regular plenary and technical WG meetings
  - U.S. hosts QZSS monitoring stations in Hawaii and Guam
- India: Discussion on emerging IRNSS and spectrum use
  - ITU compatibility coordination completed
- Russia: No current bilateral GNSS related discussions
  - Engagement in multilateral fora such as ICG continues



# *International Committee on Global Navigation Satellite Systems (ICG)*

- Emerged from 3rd UN Conference on the Exploration and Peaceful Uses of Outer Space July 1999
  - Promote the use of GNSS and its integration into infrastructures, particularly in developing countries
  - Encourage compatibility and interoperability among global and regional systems
- Members include:
  - **GNSS Providers:** (U.S., EU, Russia, China, India, Japan)
  - Other Member States of the United Nations
  - International organizations/associations





# *ICG Provider Forum*

- Members include the U.S., EU, Russia, China, India, and Japan
  - Focused discussions on **compatibility and interoperability**, encouraging development of complimentary systems
  - Exchange detailed information on systems and service provision plans
- Consensus reached on Principles of **compatibility, interoperability and transparency** in civil service provision
  - Compatibility definition includes spectral separation between each system's authorized service signals (e.g. U.S. M-code) and other systems' signals
- Providers are leading efforts to promote GNSS *radio-frequency interference detection and mitigation*
- The Next **Provider's Forum** (14<sup>th</sup>) Meeting will take place in June in Vienna, Austria



# ***ICG-9 Meeting in Prague - Nov 9-14, 2014***

- Interference Detection and Mitigation (IDM)
  - Nations should evaluate & implement existing/emerging **IDM capabilities** and work with the telecom industry on standards for crowd sourcing IDM techniques
  - The ICG Secretariat and IDM taskforce will organize UN-sponsored workshops on **RNSS spectrum protection** and IDM for user community member nations
  - IDM Task Force initiated a discussion on **GNSS as critical infrastructure**
- International Multi-GNSS monitoring and assessment (IGMA)
  - Existing civil service centers should establish a link to a new ICG web portal allowing users to easily find GNSS monitoring information and products
  - Conduct a workshop in 2015 focused on **multi-GNSS open service monitoring**, parameters to be monitored, and an organizational approach
- Interoperability Task Force and System **Providers** should continue to assess industry feedback received at 4 **interoperability** workshops
- **Providers** should develop a booklet defining the characteristics of a fully **interoperable space service volume**
- **Providers** will continue discussing the topic of **fair "Market Access"**



# ***ICG-10 - November 1-6, 2015***

- **U.S. will host in Boulder, Colorado**
  - 45 km from Denver
- Meeting Venue: University Corporation for Atmospheric Research (UCAR)
  - Consortium of more than 100 member colleges and universities focused on atmospheric research and Earth system sciences
  - UCAR manages the National Center for Atmospheric Research (NCAR) on behalf of the National Science Foundation
- **Tour Sites confirmed**
  - National Oceanic and Atmospheric Administration, [National Space Weather Prediction Center](#)
  - UNAVCO: University-governed consortium, which facilitates geoscience research and education using geodesy
  - National Institute of Standards and Technology, Time and Frequency Laboratory



**UCAR Center Green Facility**



# ***ICG WG-A Interoperability Workshops***

- First Workshop held April 2013, hosted by the U.S. in Honolulu - @ Pacific PNT 2013
- Three other workshops held in 2014
  - Russia hosted Workshop in April
  - China hosted Workshop in May
  - Japan hosted Workshop in August
- Europe just hosted their workshop in March 2015
- Workshops are focused on receiving industry/user feedback on Interoperability and multi-GNSS use
- The interoperability task force will be meeting this week on the margins of Pacific PNT 2015



# *Progress at ICG in GNSS Civil Service Provision*

## ✓ Providers Forum

### ✓ Providers Forum System Report

#### ✓ Principles of Compatibility, Interoperability, and Transparency

#### ➤ Template for Performance Standards (and ICDs)

#### ➤ *Postulated Performance Standards for future services*

- Service Assurances or  
Commitments

- *Monitoring of service  
performance*

- *Interference monitoring*



# *Summary*

- U.S. policy encourages worldwide civil GPS/GNSS use
  - International cooperation to ensure **compatibility, interoperability, and transparency** is a priority
- GPS and augmentations continue to provide enhanced capabilities while maintaining backward compatibility for all users
- Assured service, policy stability, transparency, and continuous improvement are the keys to successfully providing a **Global Public Service** like GPS civil service
- The ICG, with strong U.S. participation, is pursuing a **Global Navigation Satellite System-of-Systems** to provide civil GNSS services that benefit users worldwide



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**U.S. Attends ICG-9 in Prague, November 9-14**

International Committee on Global Navigation Satellite Systems

The United States participated in the 9th meeting of the International Committee on GNSS (ICG), which convened in Prague, Czech Republic.

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To improve global understanding about GPS, we are pleased to offer key portions of this website in multiple languages. Please note that some pages link back to English content.

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