



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



China Satellite Navigation Conference 2015

Xi'an, May 12-15

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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

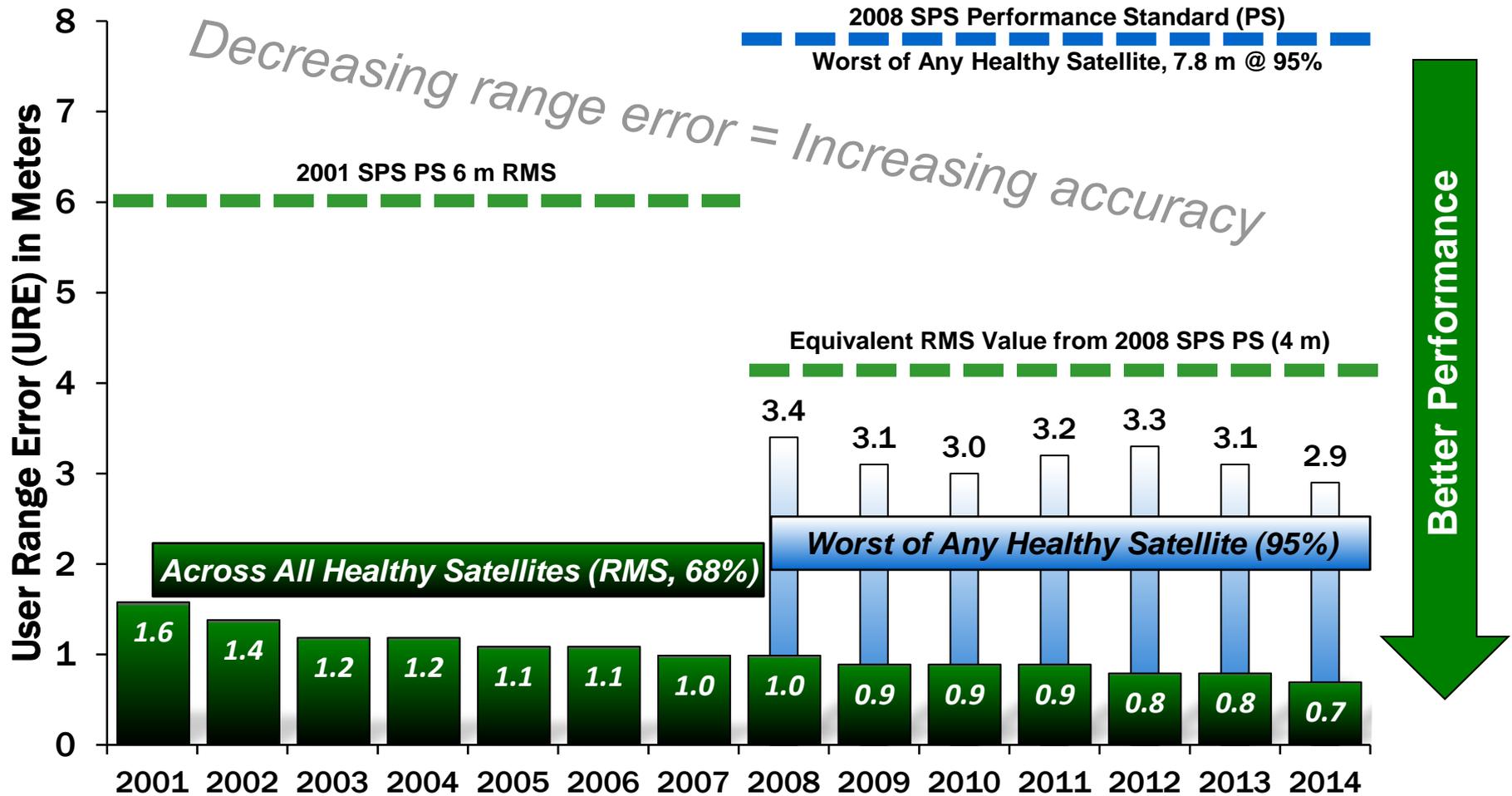
- Global GPS civil service performance commitment continuously met/exceeded since 1993
- Open, public signal structures with public domain documentation necessary to develop receivers
 - Promotes open competition and market growth for commercial GNSS
- A critical component of the global information infrastructure
 - **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



- 4 successful GPS IIF launches in 2014!
 - Latest launch: March 25, 2015
 - 3 more GPS IIFs to launch - SVs 10, 11, and 12
 - Two more GPS IIF launches planned 2015

March 25, 2015 IIF-9 Launch



GPS Modernization Status

- GPS III is the newest block of GPS satellites
 - 4 civil signals: L1 C/A, L1C, L2C, L5
 - First U.S. satellites to broadcast international common L1C signal
 - Three improved Rubidium atomic clocks
 - GPS III SV01 available for launch in CY 2017
- 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
- Next Generation Operational Control System (OCX)
 - Modernized command & control system with M-Code, modern civil, signal monitoring, information assurance infrastructure & improved PNT performance – Raytheon (Aurora, CO) - Prime
 - Civil Signal Performance Monitoring capability scheduled for OCX Block 2 in 2020



Lockheed-Martin (Waterton, CO) – Prime



Monitor Station



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: China

- First bilateral space-based PNT related meeting to discuss civil cooperation topics held 19 May 2014 in Beijing
 - Topics of discussion included: interoperability, service monitoring, interference detection, spectrum protection, and civil aviation applications
 - Agreement to establish a civil satellite navigation cooperation working group for additional discussions on topics of mutual interest
 - Joint Statement signed



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** (14th) 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

The United States will Host ICG-10 in Boulder, Colorado, November 1-6, 2015



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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International Committee on Global Navigation Satellite Systems

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

Photo: Martin Hlauka (Pescan)

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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Multilingual Content

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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GPS Cooperation with Other Nations

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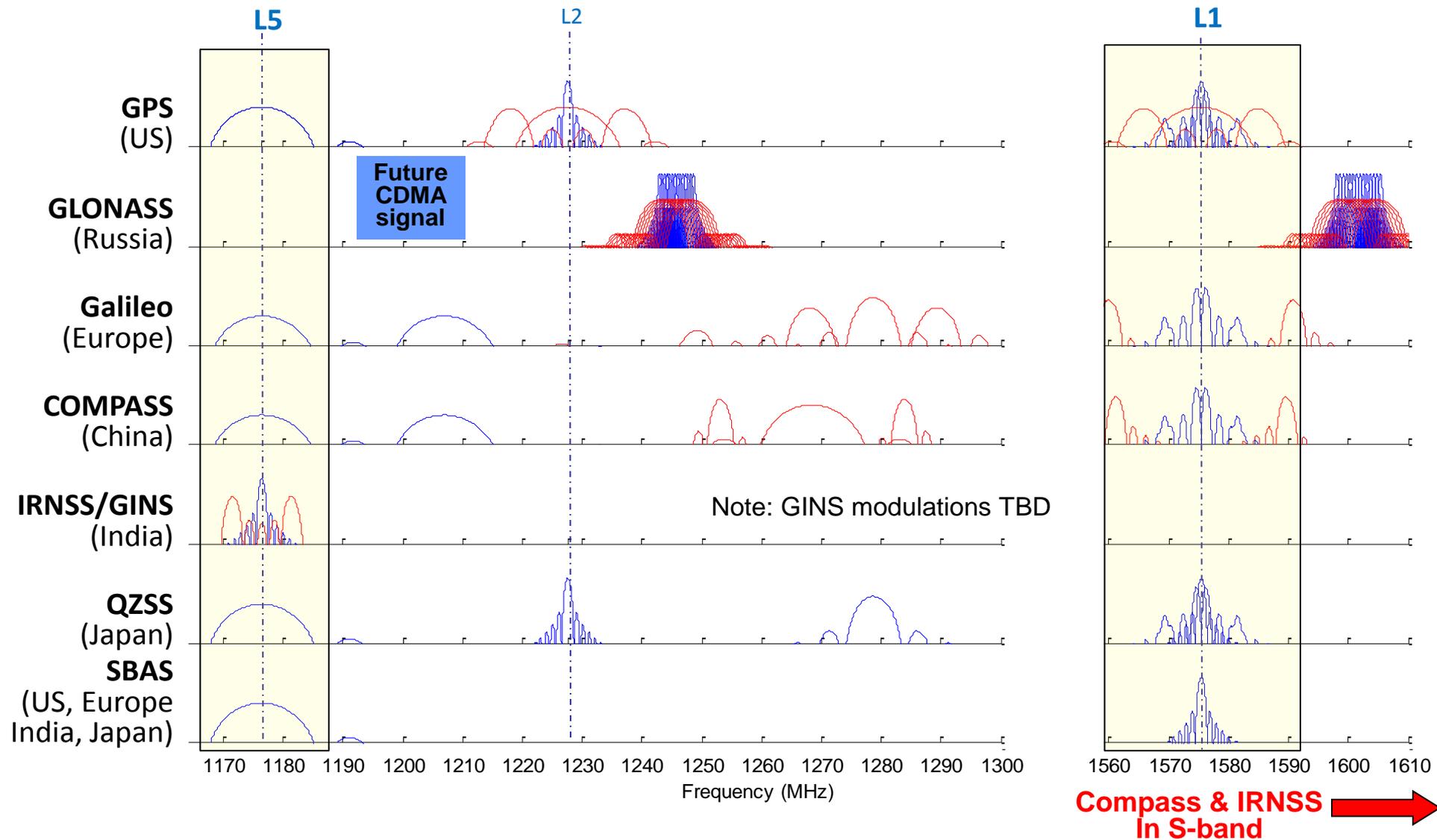


Bilateral GNSS Cooperation

- 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



Current International Signal Plans





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



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



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*



Complementary PNT



- The EXCOM is assessing the need for a complementary service to GPS
 - Assessment driven by many factors: from policy to technology
 - U.S. coverage for GPS outage from natural or man-made events
- Current Activity: Identify and assess alternatives
 - Assessed a broad mix of terrestrial RF and autonomous PNT technologies
- Decision timeline: No earlier than summer 2015
 - Supports FY17 investment decisions
- *Federal Register* Notice published to solicit public stakeholder engagement