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

China Satellite Navigation Conference 2015

Xi'an, May 12-15

David A. Turner – Deputy Director
Office of Space and Advanced Technology
U.S. Department of State

Presented by Tom Stansell in Krasnoyarsk on 18 May 2015

May 13, 2015

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

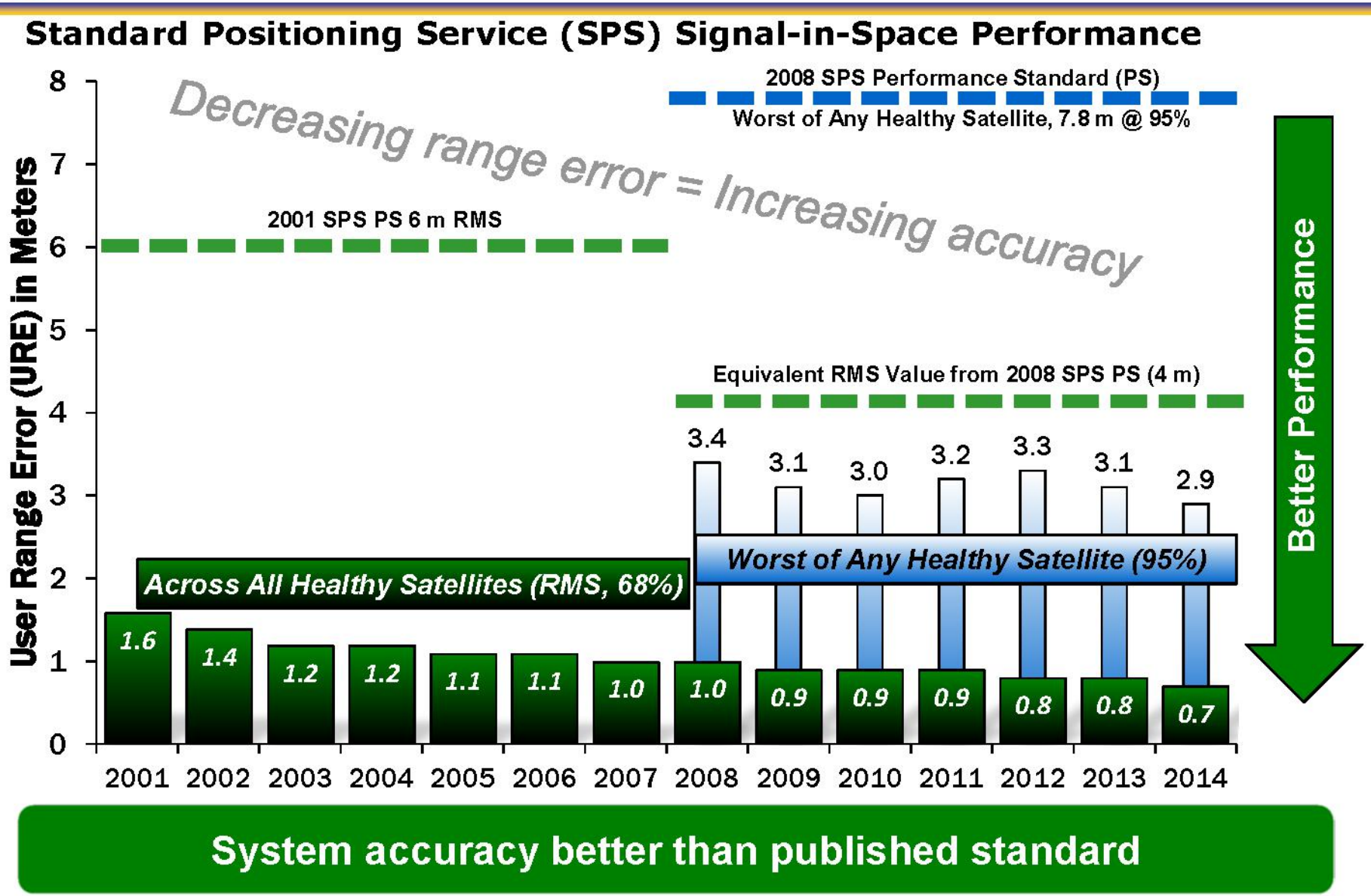
- Provide civil GPS services, free of direct user charges
  - Available on a continuous, worldwide basis
  - Maintain constellation consistent with published performance standards and interface specifications
  - Foreign PNT services may be used to augment and strengthen the resiliency of GPS
- Encourage 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



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- **Constellation Status and Modernization**
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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

Lockheed-Martin (Waterton, CO) – Prime

- 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

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

http://www.oosa.unvienna.org/oosa/en/SAP/gnss/icg.html

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 @ UCAR 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

For Additional Information…

www.gps.gov