



GPS: Enhanced Capabilities – Assured Service

**International Navigation Conference
Manchester Conference Center
Manchester, United Kingdom**

Ray Clore, Senior Advisor

Office of Space and Advanced Technology, U.S. State Department

Harold Martin, Director

*U.S. National Coordination Office for Space-Based
Positioning, Navigation and Timing*

February 24, 2015



Overview

- U.S. Space-Based PNT Policy
- Constellation Status and Modernization
- Complementary PNT



U.S. Policy Promotes Global Use of GPS Technology

- No direct user fees for civil GPS services
 - Provided on a continuous, worldwide basis
- Open, public signal structures for all civil services
 - Promotes equal access for user equipment manufacturing, applications development, and value-added services
 - Encourages open, market-driven competition
- Global compatibility and interoperability with GPS
- Service improvements for civil, commercial, and scientific users worldwide
- Protection of radionavigation spectrum from disruption and interference



Planned GNSS

- 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)





GPS Constellation Status

30 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
 - 8 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
- Global GPS civil service performance commitment met continuously since Dec 1993 (IOC)
 - Best performance 44.8 cm User Range Error (URE) 12 Dec 14; best weekly average 52.7 cm URE 23 Nov 14
 - Performance improving as new satellites replace older satellites



38 Satellites / 30 Set Healthy
Baseline Constellation: 24 Satellites

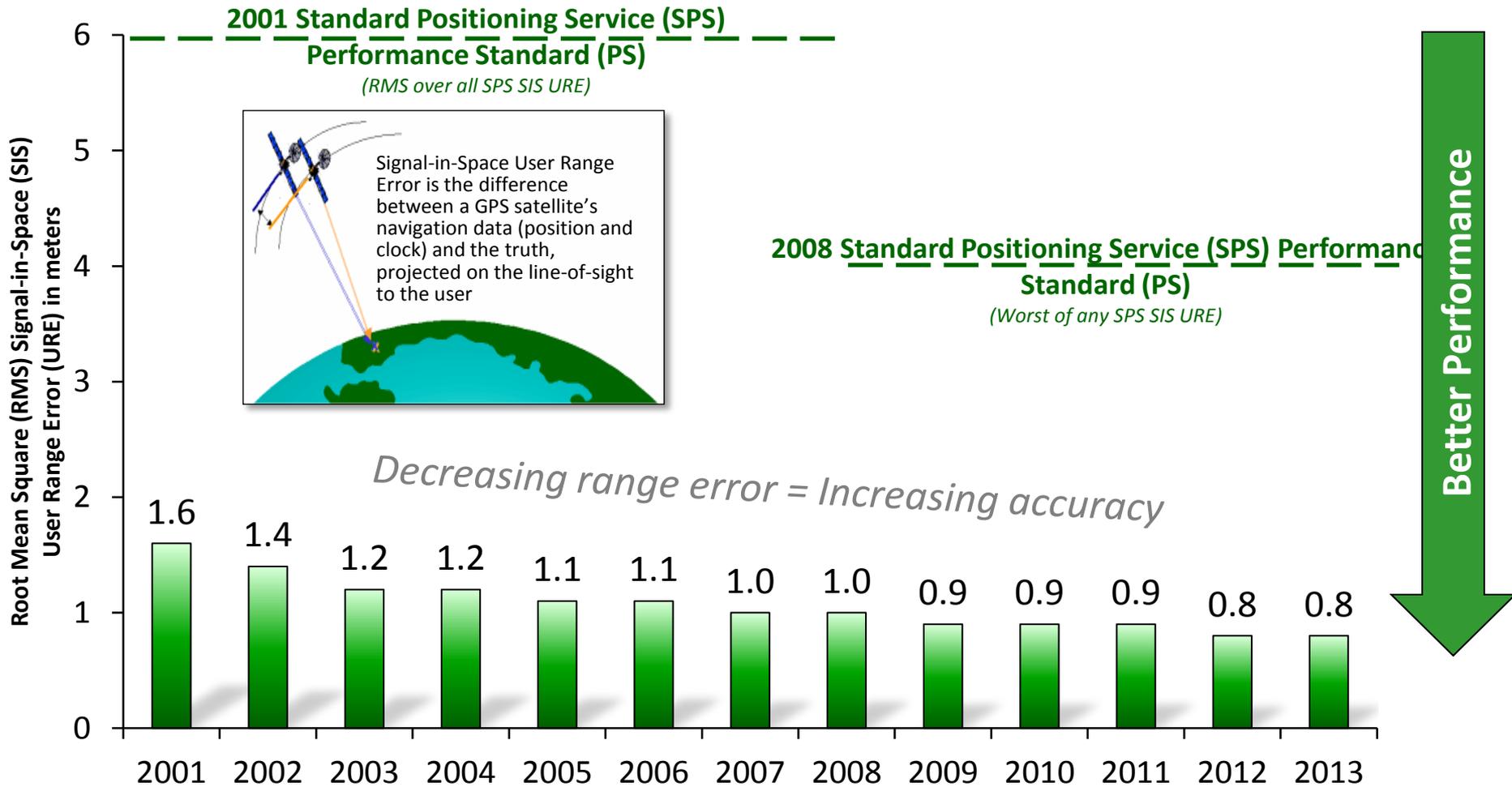
Satellite Block	Quantity	Average Age	Oldest
GPS IIA	3	21.3	24.2
GPS IIR	12	13.1	17.5
GPS IIR-M	7	7.5	9.4
GPS IIF	8	1.8	4.7
Constellation	30	9.6	24.2

AS OF 2 FEB 2015



Accuracy Performance: Civil Commitments

Standard Positioning Service Performance Standard

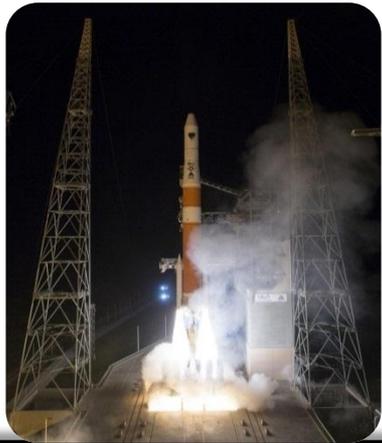


System accuracy better than published standard



GPS IIF Status

- 4 successful GPS IIF launches in 2014!
- 8 total GPS IIFs on-orbit
- 4 more GPS IIFs in the pipeline
 - Three GPS IIF launches planned 2015
 - SVs 10, 11, and 12 now in storage
 - SV-9 is in production testing



20 Feb: IIF-5



16 May: IIF-6



1 Aug: IIF-7



29 Oct: IIF-8



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
- User-Range Error (URE) CNAV Performance
 - Daily uploads consistent with or exceed LNAV performance





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
- Russia: No current bilateral GNSS related discussions
 - Engagement in multilateral fora such as ICG continues
- 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



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-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 (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

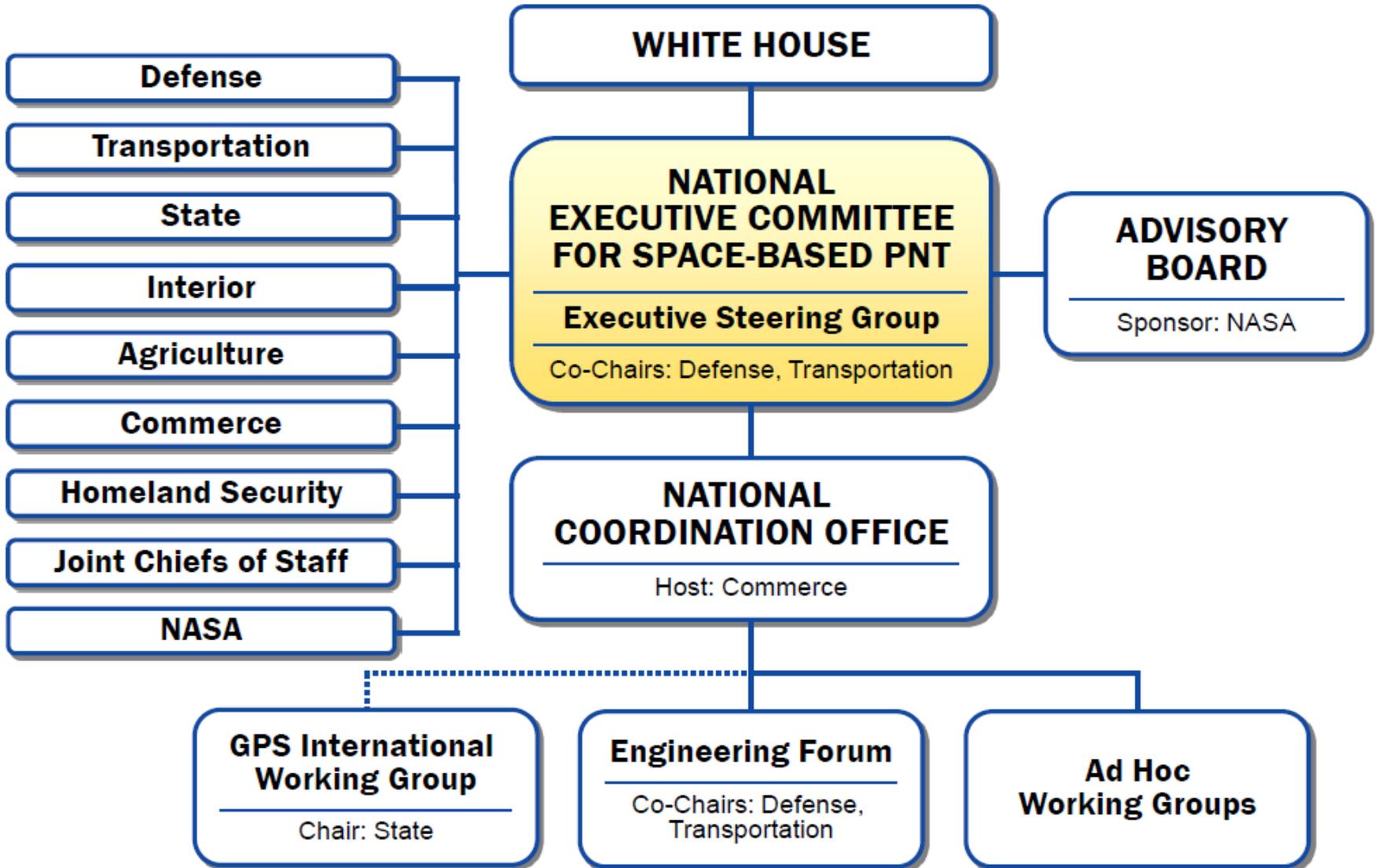
- **U.S. will host in Boulder, Colorado**
 - 45 km from Denver
- Meeting Venue: University Corporation for Atmospheric Research (UCAR)
 - Consortium of more than 100 member colleges and universities focused on atmospheric research and Earth system sciences
 - UCAR manages the National Center for Atmospheric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



UCAR Center Green Facility



National Space-Based PNT Organization





Complementary PNT



- EXCOM looked at need for complement 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 in development for public stakeholder engagement



Summary

- U.S. policy encourages worldwide 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 success in GNSS Programs



For Additional Information...

Welcome to GPS.gov x
www.gps.gov/internationals/

English Español Français 中文 عربي

GPS.gov

Official U.S. Government information about the Global Positioning System (GPS) and related topics

Search:

HOME WHAT'S NEW SYSTEMS APPLICATIONS GOVERNANCE MULTIMEDIA SUPPORT

For General Public
For News Media
For Congress
For Internationals
For Professionals
For Students

U.S. and UK Reach Understanding on GPS Patents

The United States and United Kingdom successfully reached an understanding on intellectual property rights that will ensure GPS civil signals remain free and openly available for users worldwide.

[LEARN MORE...](#)

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.

Español

- [Página Principal](#)
- [El Sistema de Posicionamiento Global](#)
- [Ampliaciones al GPS](#)
- [Aplicaciones del GPS](#)

中文

- [首页](#)
- [全球定位系统](#)
- [GPS的增强系统](#)
- [GPS的应用](#)

GPS Cooperation with Other Nations

- [Australia](#)
- [China](#)
- [Europe](#)
- [India](#)
- [Japan](#)
- [Russia](#)
- [United Kingdom](#)
- [International Committee on GNSS](#)
- [Other International](#)

www.gps.gov