# *U.S. GPS Program and Policy Update*

2013 IGNSS Conference

Gold Coast, Australia

***Jeffrey Auerbach***
*Office of Space and Advanced Technology*
*Bureau of Oceans, and International Environmental & Scientific Affairs*
*U.S. Department of State*

***16 July 2013***

# *Overview*

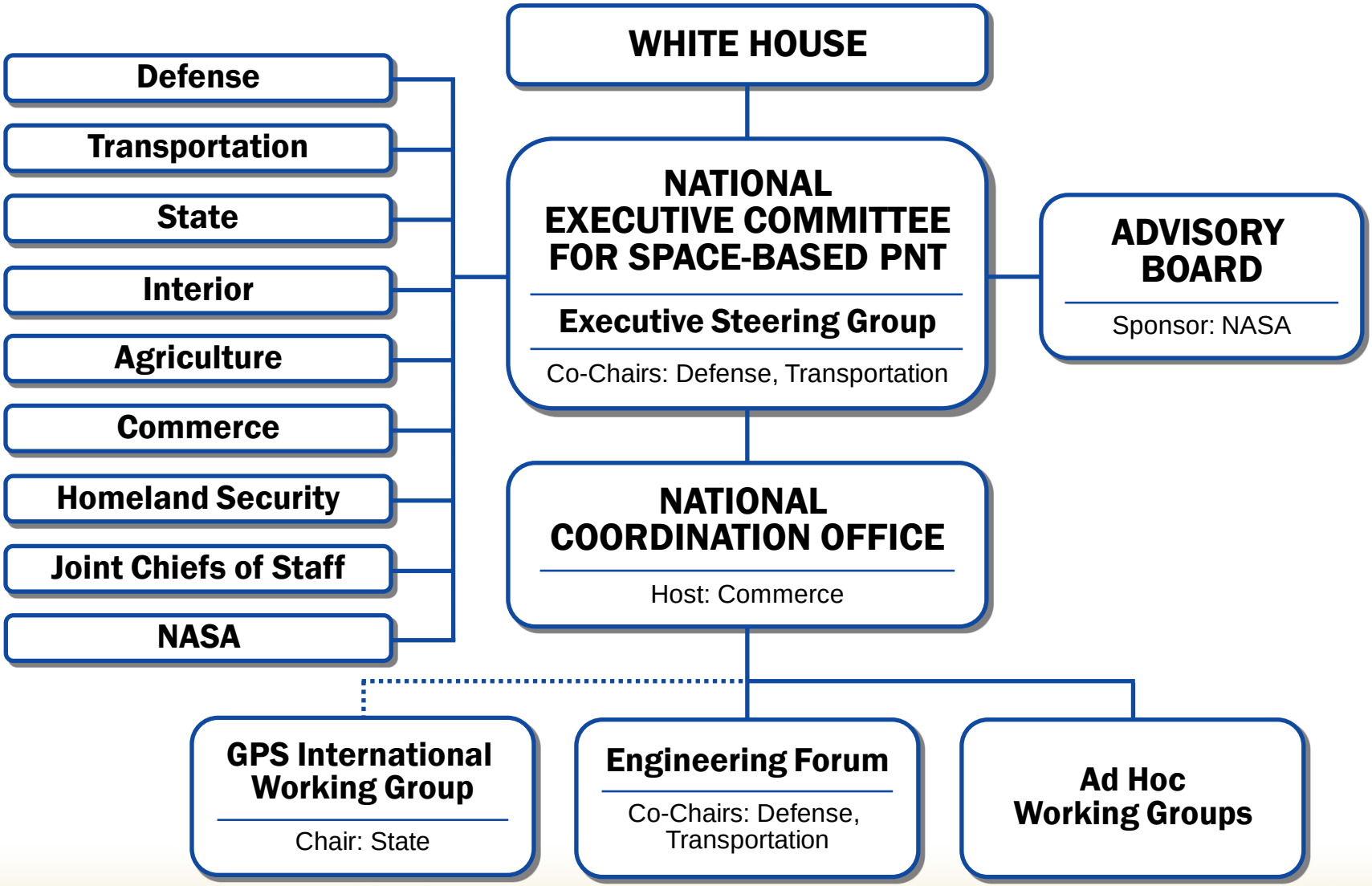
- **U.S. Space-Based PNT Policy**
- GPS Program Status
- International Cooperation Activities
- Summary

# 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

# U.S. Space-Based PNT Organization Structure



# 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

# Economic Benefits of GPS in U.S.

*Excerpted from NDP Consulting report commissioned by the "Save Our GPS Coalition" in 2011*

- "We estimate that the value to the U.S. economy of the productivity gains and input cost reductions alone amounts to between $68 billion and $122 billion per year, or 0.5 to 0.9 percent of annual U.S. gross domestic product."
- The report estimates **$67.6 billion in direct economic benefits** due to annual productivity increases and cost savings in precision agriculture ($19.9 billion), engineering construction ($19.9 billion), transportation ($28.2 billion), and other commercial GPS uses ($28.2 billion).
- "In addition, GPS technology creates direct and indirect positive spillover effects, such as emission reductions from fuel savings, health and safety gains in the work place, time savings, job creation, higher tax revenues, and improved public safety and national defense.
- Today, there are **more than 3.3 million jobs that rely on GPS technology**, including approximately 130,000 jobs in GPS manufacturing industries and 3.2 million in the downstream commercial GPS-intensive industries."

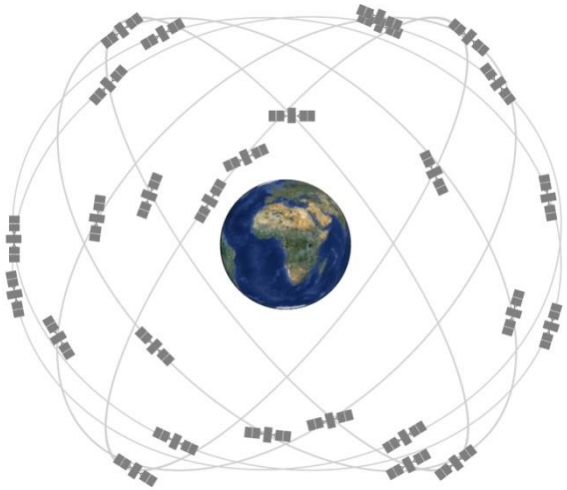
# *Overview*

- U.S. Space-Based PNT Policy
- **GPS Program Status**
- International Cooperation Activities
- Summary

# GPS Constellation Status

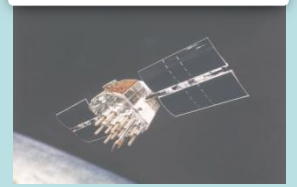
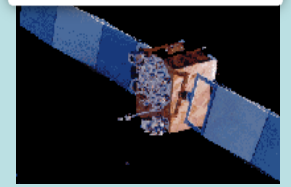
## 31 Operational Satellites
### As of 27 June 2013

- "Expandable 24" configuration (27 slots)
- 8 Block IIA
- 12 Block IIR
- 7 Block IIR-M
- 4 Block IIF
- 4 residuals on orbit
- Continuously assessing constellation health to determine launch need



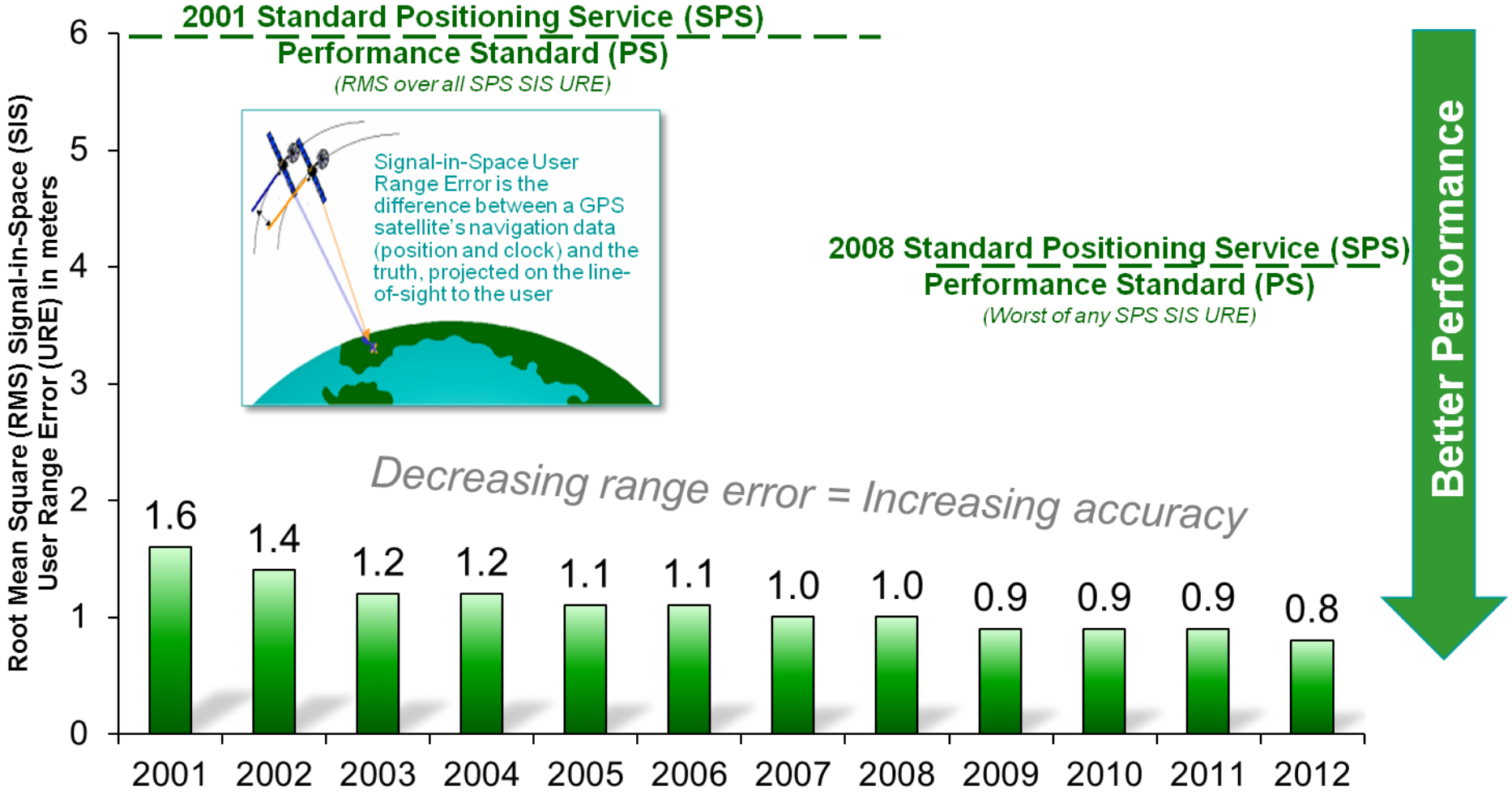
***Next GPS IIF Launch planned for October 2013***

# GPS Program Evolution

| 1978 - 1985 | 1989 – 1997 | 1997- 2004 | 2005 - 2009 | 2010 - Present | 2014 – 2024 |
|---|---|---|---|---|---|
|  |  |  |  |  |  |
| **Block I** | **Block II/IIA** | **Block IIR** | **Block IIR-M** | **Block IIF** | **Block III** |
| **11 (10) Satellites** | **28 Satellites** | **13 (12) Satellites** | **8 Satellites** | **12 Satellites** | **32 Satellites** |
| **Demonstration system** | **Basic GPS<br>Provides Initial Navigation Capabilities** | **IIA/IIR Capabilities "Plus"** | **IIR -M Capabilities "Plus"** | **IIF Capabilities "Plus"** | |
| • L1 (CA) Navigation signal<br>• L1 & L2 (P Code) Navigation Signal<br>• 5 Year Design Life | • Standard Service<br>• Single Frequency (L1)<br>• C/A code Navigation<br>• Precise Service<br>• Two Frequencies (L1 & L2)<br>• P (Y) -Code Navigation<br>• 7.5 Year Design Life | • 2nd Civil Signal L2 (L2C)<br>• Earth Coverage M-Code on L1/L2<br>• L5 Demo<br>• Anti-Jam Flex Power<br>• 7.5 Year Design Life | • 3rd Civil Signal L5<br>• Increased Accuracy Requirement<br>• 12 Year Design Life | SV 1-8<br>• Increased Accuracy (4X better User Range Error than IIF)<br>• Navigation Integrity<br>• Increased Earth Coverage Power<br>• 15 Year Design Life<br>• 4th Civil Signal (L1C) | |

**Increasing Space System Capabilities – Increasing User Benefits**

# GPS SPS Signal in Space Performance




**Global GPS service performance commitment met continuously since December 1993**

# Status of GPS III and OCX

- GPS Block III, Satellites 1-8
  - Non-Flight Satellite Testbed completed testing
  - First 4 satellites now in production
- GPS Block III, Satellites 9+
  - On track to add search and rescue payload (SAR-GPS) and satellite laser retroreflectors
  - Studying options for dual launch and other cost savings
- Next Generation Operational Control System (OCX)
  - Block 0 (GPS III launch and checkout): 2014
  - Block 1 (CNAV for L2C and L5): 2016
  - Block 2 (L1C and M-Code): 2017

# New Civil GPS Signals

| Signal | Benefits | # of Satellites Broadcasting Now | Availability on 24 Satellites |
|---|---|---|---|
| L2C | Meets commercial needs for ionospheric correction, higher effective power, etc. | 11 | ~2018 |
| L5 | Meets requirements for safety-of-life transportation; enables triple-frequency positioning techniques | 4 | ~2021 |
| L1C | GNSS interoperability; performance improvements in challenged environments | Will start with GPS III in 2015 | ~2026 |

***Testing of new Civil Signal Navigation Message (CNAV) for L2 and L5 signals began 15 June 2013***

# Wide Area Augmentation System (WAAS) Architecture


38 Reference Stations

3 Master Stations

6 Ground Earth Stations

3 Geostationary Satellite Links

2 Operational Control Centers

# WAAS Status

- **Phase III: Full LPV-200 Performance (2009 – 2013)**
  - Development, modifications, and enhancements to include tech refresh
  - Steady state operations and maintenance
  - Transition to FAA performed 2nd level engineering support
  - Begin GPS L5 transition activities
- **Phase IV: Dual Frequency (L1, L5) Operations (2014 – 2028)**
  - Complete GPS L5 transition
  - Will significantly improve availability and continuity during severe solar activity
  - Will continue to support single frequency users
  - Steady state operations and maintenance

# *Overview*

- U.S. Space-Based PNT Policy
- GPS Program Status
- **International Cooperation Activities**
- Summary

# Planned GNSS

- Global Constellations
  - **GPS (24+)**
  - GLONASS (30)
  - Galileo (27+3)
  - Compass (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)

# 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***

# *Bilateral Cooperation*

- **Australia:** Joint Delegation Statement on Cooperation in the Civil Use of GPS in 2007; Bilateral meeting held in the U.S. in 2010; GNSS and applications to be included in future expanded space cooperation discussions
- **China**: On going discussions with China (CSNO & CNAGA) on the margins of multilateral international meetings
- **European Union**: GPS-Galileo Agreement signed in 2004, ratified by EU in December 2011
- **India**: Joint statement on GNSS cooperation signed 2007; continuing discussions under the Joint Civil Space Cooperation Working Group

# Bilateral Cooperation (continued)

- **Japan**: Joint statement signed in 1998; cooperation focuses on compatibility and interoperability between GPS and Japan's Quasi-Zenith Satellite System (QZSS)
- **Russia**: GPS-GLONASS discussions ongoing since 1996; Joint Statement issued Dec. 2004; discussions underway regarding monitoring of GLONASS/SDCM from United States territory

# 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-7 Outcomes

- Endorsement of two Workshops (Honolulu, HI, U.S. – April 2013)
  - Second Workshop on Interference Detection and Mitigation, following a successful first Workshop in June 2012
  - Interoperability Workshop focused on industry feedback regarding signal design and parameters
- Multi-GNSS monitoring: Tasks and a Work Plan for the ICG International GNSS Monitoring and Assessment (IGMA) Subgroup were approved
  - Identify what service parameters should be monitored
  - Define the level and methods for carrying out the monitoring
- ICG to adopt the International Terrestrial Reference System (ITRS) as the theoretical reference system for the alignment of GNSS terrestrial reference frames
- Consensus that achieving a fully interoperable GNSS space service volume would provide significant performance benefits that no single system could provide on its own

***ICG-8 will be hosted by the UAE in Dubai, November 2013***

# APEC GNSS Implementation Team (GIT)

- Established in 2002
- Promote implementation of regional GNSS augmentation systems to enhance inter-modal transportation and recommend actions to be considered in the Asia Pacific Region
- Reports to Transportation Working Group (TPT-WG) through the Inter-modal Experts Group (IEG)
- Adopted a GNSS Strategy designed to promote adoption of GNSS technologies throughout the Asia Pacific region, especially with regard to transportation
- 18th GIT meeting held 2-4 July 2013 in Bali, Indonesia

# *Overview*

- U.S. Space-Based PNT Policy
- GPS  Program Status
- International Cooperation Activities
- **Summary**

# Summary

- GPS performance is better than ever and will continue to improve
  - Testing of new civil GPS signals has begun
  - More space and control segment upgrades coming
- U.S. policy encourages worldwide GPS use
  - International cooperation is a priority
  - Bilateral and Multilateral cooperation is ongoing

# For Additional Information…


**www.gps.gov**

# *THANK YOU!*

*Jeffrey Auerbach*

*GNSS Policy Advisor*
*Space and Advanced Technology*
*U.S. Department of State*

*OES/SAT, SA-23, Suite 410*
*Washington, D.C. 20520*
*202.663.2397 (office)*
*auerbachJM@state.gov*

***http://www.state.gov/e/oes/sat/***