



# ***International Developments in Global Navigation Satellite Systems (GNSS)***

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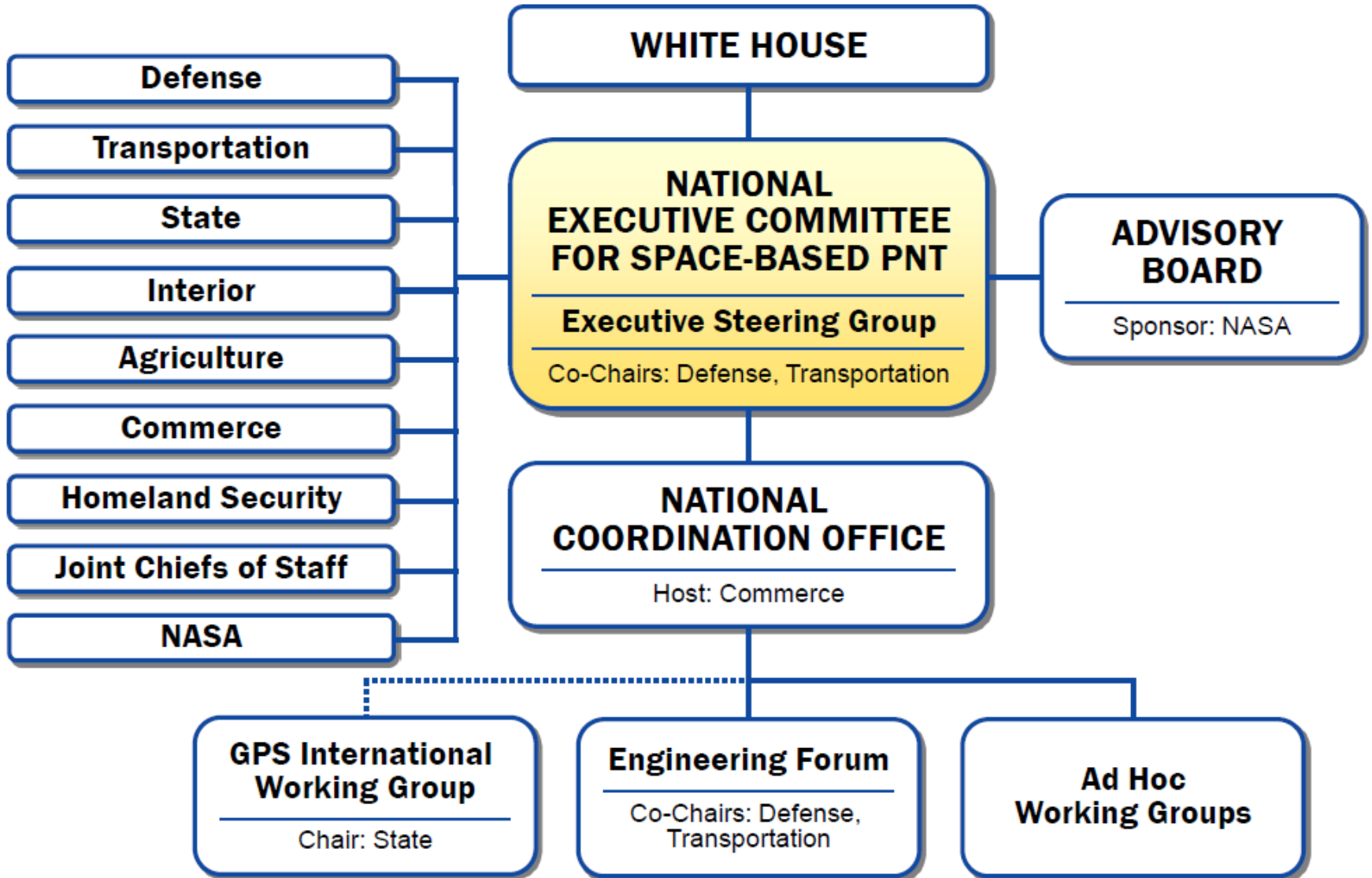
# *U.S. National Space Policy*

## ***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***



# National Space-Based PNT Organization





# *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 Space-Based Positioning, Navigation and Timing (PNT) Systems

- **Global Constellations**

- **GPS (24+3)**
- **GLONASS (24+)**
- **Galileo (24+3)**
- **Compass (27+3 IGSO + 5 GEO)**



- **Regional Constellations**

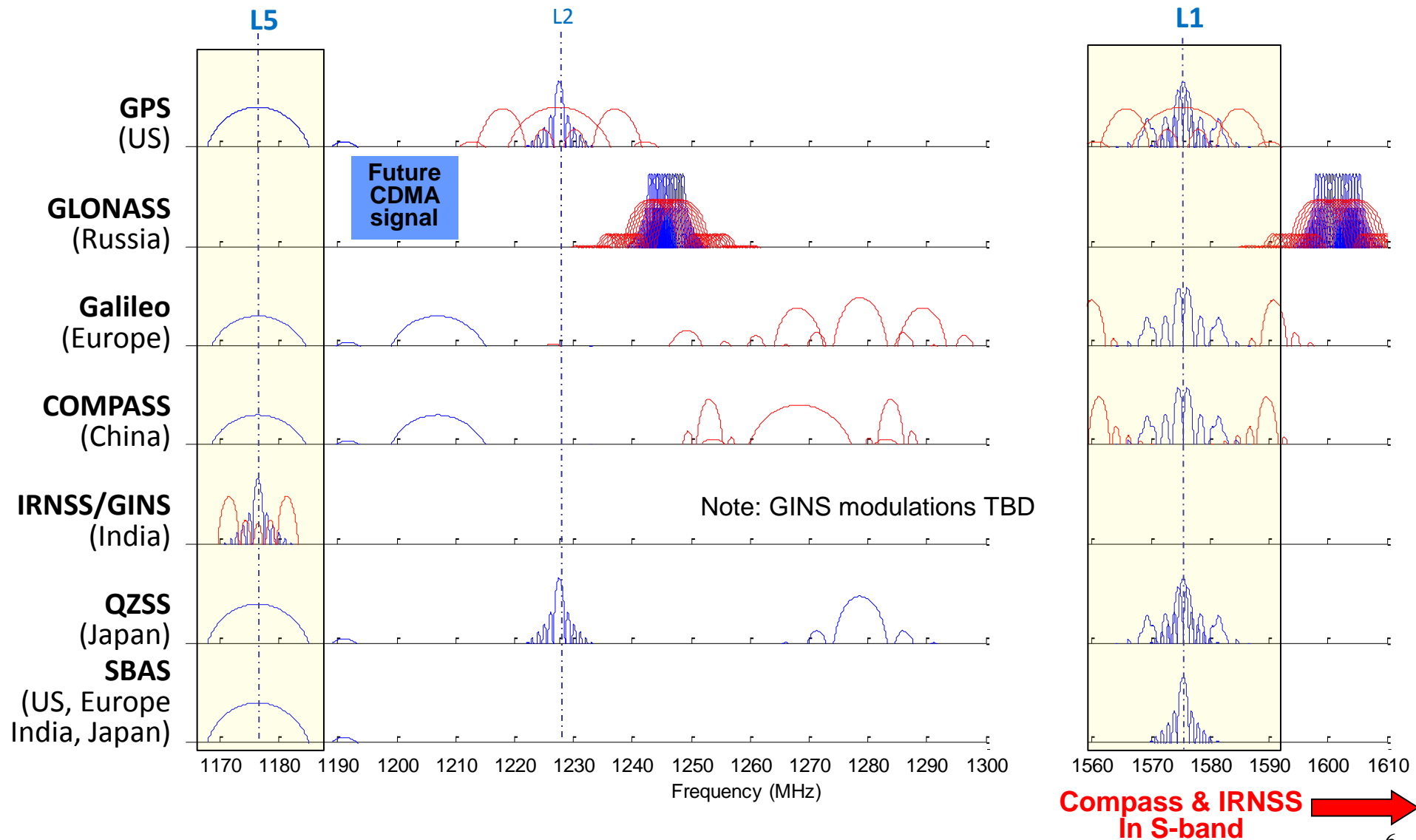
- **QZSS (4+3)**
- **IRNSS (7)**

- **Satellite-Based Augmentations**

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



# Current International Signal Plans





# *Bilateral 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
- China-U.S. Strategic and Economic Dialogue (S&ED)
  - Agreement on two items related to “satellite collision avoidance” and “establishing bilateral government-to-government consultation mechanisms and holding regular meetings on outer space activities.”



# *Bilateral Cooperation: Europe*

- GPS-Galileo Cooperation Agreement signed in 2004, ratified by EU in December 2011
  - Four working groups established under the Agreement
  - Working groups continue to meet regularly
- Third bilateral Plenary meeting held June 2014 in Torrejon, Spain
- ITU coordination agreement on compatibility between GPS and Galileo signed, July 2014
- Working Group A (compatibility and Interoperability) met Sep 15-16
  - Agenda included pseudolite interference, timing offset and spectrum issues





# *Bilateral Cooperation: India*

- U.S.–India Joint statement signed in 2007
  - Cooperation on GPS and augmentations
  - Expanded effort to ensure interoperability between GPS/WAAS and GAGAN
- ITU compatibility coordination – Meeting in early 2013
- U.S.-India Civil Space Joint Working Group (CSJWG) bilateral meeting held in Washington, D.C. in March 2013
  - Agreement was reached on measures to ensure the compatibility of the U.S. Global Positioning System (GPS) and its Indian counterpart GNSS program (IRNSS)



# *Bilateral Cooperation: Japan*

- Presidential/Prime Minister level Joint Statement signed in 1998
- Cooperation focuses on compatibility and interoperability between GPS and Japan's Quasi-Zenith Satellite System (QZSS)
- U.S. continues to host QZSS monitoring stations in Hawaii and Guam
- GPS-QZSS Technical Working Group met in May 2014 to discuss compatibility coordination under the ITU auspices
- Second U.S.-Japan Comprehensive Space Dialogue held in Washington, D.C., May 2014
  - Included GNSS discussions



# *Bilateral Cooperation: Russia*

- GPS-GLONASS discussions since 1996, Joint Statement issued December 2004
- Working Group on search and rescue discussed next generation MEOSAR capabilities
- The U.S. is not currently engaged with Russia in any bilateral discussions regarding the potential placement of GLONASS monitoring stations in the United States
  - Current U.S. law requires DoD and ODNI certification or waivers before the installation of new foreign GNSS monitoring stations on U.S. soil can be pursued
  - We remain open to constructive discussions with Russia on civil space cooperation in the area of GNSS, in particular with regard to data from scientific stations currently in place in both the United States and Russia



# *International Committee on GNSS (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.icgsecretariat.org>



# ICG Providers Forum

- Six space segment providers listed previously are members
- Purpose:
  - Focused discussions on **compatibility and interoperability**, encouraging development of complimentary systems
  - Exchange detailed information on systems & service provision plans
  - Exchange views on ICG work plan and activities
- Providers have agreed that all GNSS signals and services should be compatible and open signals and services should also be interoperable to the maximum extent possible
  - Working definition of **compatibility** includes respect for spectral separation between each system's authorized service signals and other systems' signals
  - **Interoperability** definition addresses signal, geodetic reference frame realization, and system time steerage considerations



# ***ICG-8 Meeting in Dubai: Nov 10-14, 2013***

- Interference Detection and Mitigation (IDM) Task Force established
  - Focus on developing a common set of information to be reported to GNSS civil service centers – U.S. and China are Task Force Leads
- Interoperability Task Force established – U.S. & China are TF Leads
  - Focus on analyzing the results of Interoperability Workshops
- Multi-GNSS monitoring: International GNSS Monitoring and Assessment (IGMA) Task Force to focus on:
  - Identifying what service parameters should be monitored
  - Defining the level and methods for carrying out the monitoring
- 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-9 will be hosted by the EU in Prague, November 2014***  
***ICG-10 to be hosted by the U.S. in Colorado, November 2015***



# *ICG Interoperability Workshops*

- First Workshop held April 2013, hosted by the U.S. in Honolulu
- Three other workshops held in 2014
  - Russia hosted Workshop in April
  - China hosted Workshop in May
  - Japan hosted Workshop in August
- Workshops focused on getting industry/user feedback on GNSS Interoperability
- IDM Task Force created under Working Group A
  - Future objective is to analyze data from the workshops and address what the results mean to each system



# *Active International Organizations*

- **United Nations Platform for Space-based Information for Disaster Management and Emergency Preparedness – [un-spider.org](http://un-spider.org)**
- **United Nations Office of Outer Space Affairs – [www.unoosa.org](http://www.unoosa.org)**
- **International Association of Geodesy (IAG)**
- **International GNSS Service (IGS)**
- **African Reference Frame (AFREF)**



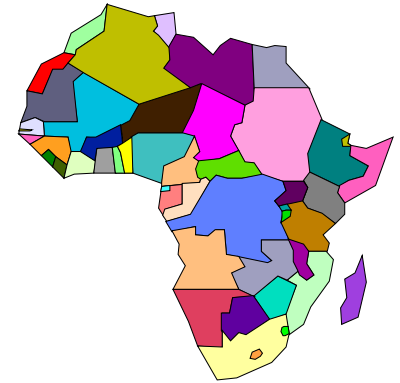


# Realizing a Continental Reference Frame for Africa

## AFREF

***Communication and internet*** are critical to success & sustainability of GNSS infrastructure

- access to information, global data, products, and technology advances
- increase knowledge base, capacity building



Training, education, access to resources, retention of quality personnel and stability are issues

Collective approach within African nations

- each adopting similar methodologies and technology
- permits progress where practical, implementing a network of GPS stations
- support and training envisioned by IGS/ITRF - seeking resources



# ***AFREF - African Reference Frame***

- Establish a ***continental reference*** system – with sustainable technology
- Provides the geodetic infrastructure for development throughout Africa
- Key to modernizing national reference systems through satellite and space geodesy: GPS, SLR, GLONASS, future GNSS (Galileo)
  - Three dimensions, horizontal and vertical, and velocities
- Includes gravity measurements as an essential component
- IGS/ITRF methodology at global and regional scales: EUREF (European), SIRGAS (South America) examples of approach and realization



# International Terrestrial Reference Frame (ITRF)

- ITRF is one of the key activities of the International Earth Rotation and Reference System (IERS) an International Association of Geodesy (IAG) Service
- ITRF is defined by combination of technique observations, analysis and products
- Website available, please visit
  - <http://www.ensg.ign.fr/ITRF/>
- ITRF expresses strong support for AFREF
  - Notes the need to integrate existing permanent GPS stations into the International GNSS Service (IGS) Network, the backbone of AFREF



# *APEC GNSS Implementation Team (GIT)*

- Established in 2002
- Reports to Transportation Working Group (TPT-WG) through the ITS and Inter-modal Experts Group (IIEG)
- Adopted a GNSS Strategy designed to promote implementation and adoption of GNSS technologies, including regional augmentation systems, throughout the Asia Pacific region
  - Focus is on seamless intermodal transportation
- 19<sup>th</sup> GIT meeting held April 2014 in Christchurch, New Zealand
  - Much interest in Multi-GNSS demonstration for ITS applications and GNSS interference, detection, and mitigation



# Summary

- U.S. policy encourages **worldwide use of civil GPS and augmentations**
- **International cooperation** at all levels is a priority
- **Compatibility, interoperability, and transparency** in open service provision are critical

The screenshot shows the GPS.gov website with a navigation bar including links for HOME, WHAT'S NEW, SYSTEMS, APPLICATIONS, POLICY & FUNDING, MULTIMEDIA, and SUPPORT. A search bar is located in the top right corner. The main content area features a large banner with the text "Bienvenidos Welcome أهلاً وسهلاً Bienvenue 歡迎光臨" and an image of people holding hands around a globe. Below the banner, there is a section for "Multilingual Content" with links for Español, Français, and 中文. The 中文 section includes links for "首页", "全球定位系统", "GPS的增强系统", and "GPS的应用". To the right, there is a section for "GPS Cooperation with Other Nations" listing countries like Australia, China, Europe, India, Japan, Russia, and the International Committee on GNSS. Below this, there are images of "GPS Outreach Handouts" and a section titled "International GPS User Support" with a logo for the U.S. Coast Guard Navigation Center (NAVCEN) and text explaining its role in providing support to international users.

<http://www.gps.gov/>



***THANK YOU!***

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