



# ***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***



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

- Global Constellations

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



- Regional Constellations

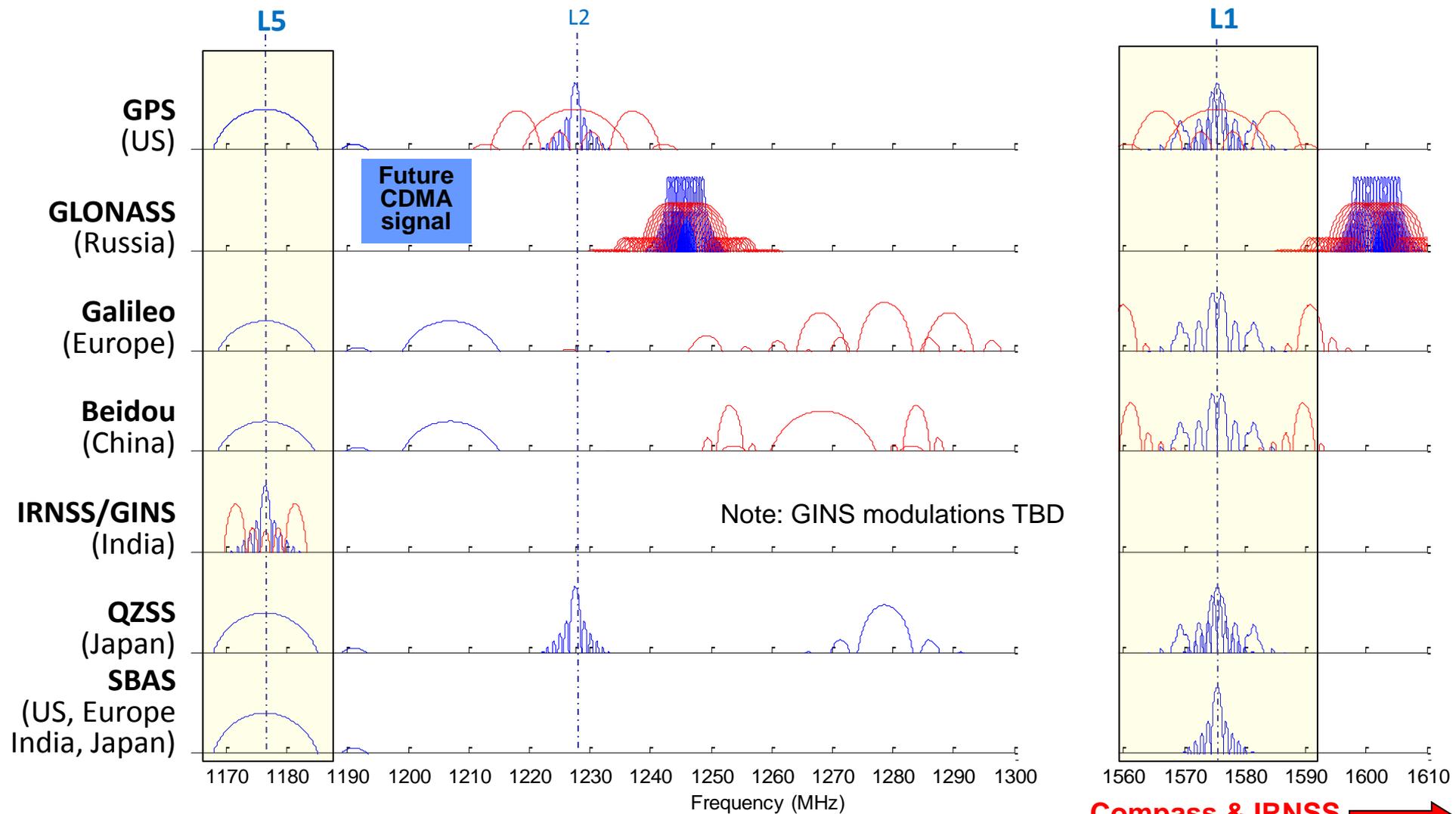
- QZSS (4+3)
- IRNSS (7)

- Satellite-Based Augmentations

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



# Current International Signal Plans



Compass & IRNSS  
In S-band



# *Bilateral Cooperation: China*

- First bilateral space-based PNT related meeting on civil cooperation topics held 19 May 2014 in Beijing
  - Topics 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
- Second bilateral space-based PNT meeting held 4-5 June 2015 in Washington, D.C.
  - Topics included: Aviation applications, compatibility and interoperability discussions, civil service provision and multilateral issues



# *Bilateral Cooperation: Europe*

- GPS-Galileo Cooperation Agreement signed in 2004
  - Third Plenary meeting in Torrejon, Spain in June 2014
  - Four working groups established under the Agreement – continue to meet regularly as needed
- ITU compatibility coordination completed under Working Group A in July 2014
- Working Group B (Trade & Civil Applications) met June 2015 in Vienna, Austria
- Working Group C met June 2015 – Discussion focused on ARAIM and convergence toward compatible formats for both GPS and Galileo service performance commitments
- 8<sup>th</sup> U.S.-EU Space Dialogue scheduled for December 2015 in Washington, D.C.



# *Bilateral Cooperation: India*

- U.S.–India Joint statement signed in 2007
- Discussions on emerging IRNSS and spectrum use
- ITU compatibility coordination completed between GPS and IRNSS
- U.S.-India Civil Space Joint Working Group (CSJWG)
  - 5<sup>th</sup> meeting held 23-24 September 2015 in Bangalore, India, produced positive results and calls for increased bilateral GNSS cooperation



# *Bilateral Cooperation: Japan*

- Presidential/Prime Minister level Joint Statement signed in 1998
- U.S. continues to host QZSS monitoring stations in Hawaii and Guam
- ITU compatibility coordination between GPS and QZSS (four satellite configuration) completed in April 2015
- Sixth U.S.-Japan Civil Space Dialogue held September 10 in Tokyo
- Third U.S.-Japan Comprehensive Dialogue on Space held September 11 in Tokyo



# *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 GNSS discussions
  - 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
  - The U.S. continues to engage Russia on GNSS issues in various multinational fora



# ***Additional Bilateral Cooperation***

- *Australia:* Joint Delegation Statement on Cooperation in the Civil Use of GPS in 2007
  - Last bilateral dialogue held in Oct. 2010
- *Canada:* Civil GNSS meeting held May 6, 2015 in Ottawa
  - Agreed to expand cooperation on interference detection and mitigation, jammer enforcement, and geodetic network ground station coverage in Canada
- *Republic of Korea:* 1<sup>st</sup> Civil Space Dialogue took place in Washington, D.C., July, 2014
  - Korea's interest in developing/deploying an SBAS and potential cooperation discussed
- *Vietnam:* 1<sup>st</sup> Civil Space Dialogue held December 18, 2014 in Washington, D.C.
  - GNSS applications discussed among other topics



# *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.unoosa.org/oosa/en/ourwork/icg/icg.html>



# *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-9 Meeting in Prague, November 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



# ***ICG-10: November 1-6, 2015***

- **U.S. will host in Boulder, Colorado**

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**

- NOAA, [Space Weather Prediction Center](#)
- UNAVCO
- NIST, Time and Frequency Laboratory

- **PNT Advisory Board Meeting**

- October 30-31
- Boulder, CO (UCAR)



**UCAR Center Green Facility**



# *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)



# 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



# 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 menu including 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 أهلا وسهلا 歡迎光臨 Bienvenue" 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". The Français section includes links for "Accueil", "Le Système de Positionnement Mondial", "Compléments GPS", and "Applications du GPS". To the right of the multilingual content, there is a section for "GPS Cooperation with Other Nations" listing countries like Australia, China, Europe, India, Japan, Russia, and International Committee on GNSS. Below this, there are images of "GPS Outreach Handouts" and a section for "International GPS User Support" with a logo for the U.S. Coast Guard Navigation Center (NAVCEN) and text explaining its role in providing GPS user support to civilians outside the United States.

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