



Worldwide GNSS Interoperability

***Civil Global Positioning System
Service Interface Committee***

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September 21, 2009***



U.S. Space-Based PNT Policy

(Excerpts focused on International Relations)

Goals:

- U.S. space-based PNT systems and services remain essential components of internationally accepted PNT services
- Promote U.S. technological leadership in applications involving space-based PNT services

To achieve this, the United States Government shall:

- Encourage foreign development of PNT services/systems based on GPS
 - Seek to ensure foreign space-based PNT systems are **interoperable** with civil GPS and augmentations
 - At a minimum, ensure **compatibility**

The Secretary of State shall:

- Promote the use of civil aspects of GPS and its augmentation services and standards with foreign governments and other international organizations
- Lead negotiations with foreign governments and international organizations regarding civil PNT matters



Planned GNSS, Regional Systems and Augmentations

- Global Constellations
 - **GPS (24)**
 - GLONASS (30)
 - Galileo (27)
 - Compass (30 global and 5 regional satellites)
- Regional Constellations
 - QZSS (3)
 - IRNSS (7)
- Satellite-Based Augmentations
 - **WAAS (2+1)**
 - MSAS (2)
 - EGNOS (3)
 - GAGAN (2)
 - SDCM (2)



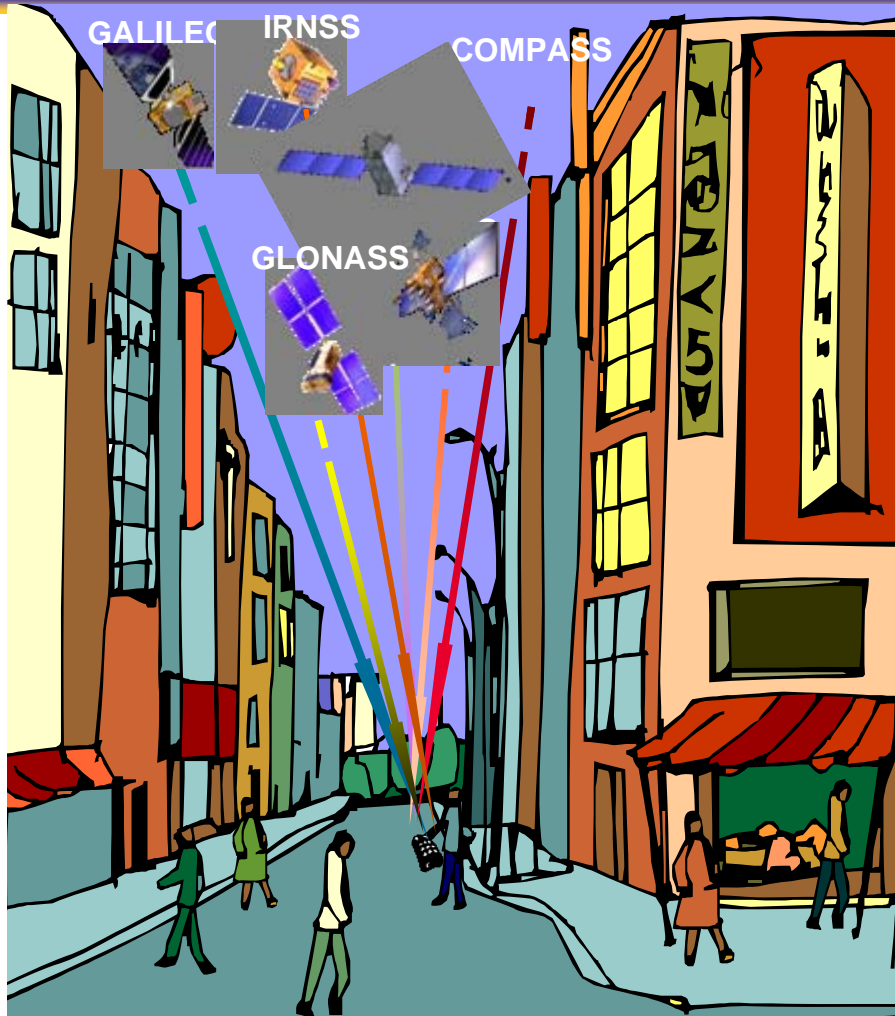
U.S. Objectives in Working with Other GNSS Service Providers

- 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
 - Primary focus on the common L1C and L5 signals
- Ensure a level playing field in the global marketplace

Pursue through Bi-lateral and Multi-lateral Cooperation



The Goal of RNSS Civil Interoperability



- Ideal interoperability allows navigation with **one signal each** from four or more systems with **no additional receiver cost or complexity**

Interoperable = Better Together than Separate



International Cooperation Venues

- **Bilateral to include**
 - Europe
 - Russia
 - Japan
 - India
 - Others
- **Multilateral**
 - International Committee on GNSS (ICG)
 - Asia Pacific Economic Cooperation (APEC)
 - ICAO, IMO, and ITU





U.S. - Europe Cooperation

- 2004 U.S.-EU agreement provides foundation for cooperation
- Four working groups were set up under the agreement:
 - Technical, trade, next generation systems and security issues groups
- Improved new civil signal (MBOC) adopted in July 2007
- First Plenary Meeting successfully held in October 2008



Oct. 22, 2008 , EU-U.S. Plenary delegations meeting under the auspices of the GPS-Galileo Cooperation Agreement



Signing ceremony for GPS-Galileo Cooperation Joint Statement, Oct. 23, 2008
(Michel Bosco, European Commission;
Kenneth Hodgkins, U.S. Department of State)



U.S. - Japan Bilateral Cooperation

- U.S.-Japan Joint Statement on GPS Cooperation in 1998
 - Japan's Quasi Zenith Satellite System (QZSS) designed to be fully compatible and highly interoperable with GPS
 - Bilateral agreement, and MOU to set up QZSS monitoring stations in Hawaii and Guam, respectively.
- Guam station completed!**
- Propose to establish a **GPS-MTSAT** Work Group at November 2009 Plenary Meeting in Washington D.C.





Additional Bilateral Cooperation

- **U.S.-Russia Joint Statement issued in Dec. 2004**
 - Negotiations for a U.S.-Russia Agreement on satellite navigation cooperation underway since late 2005
 - Working Groups on compatibility/interoperability, search and rescue
- **U.S.-India Joint Statement on GNSS Coop. in 2007**
 - Technical Meetings focused on GPS-India Regional Navigation Satellite System (IRNSS) compatibility and interoperability held in 2008 and 2009



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 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
- Providers agree that all GNSS signals/services be compatible and open signals/services should also be interoperable to the maximum extent possible; *seeking performance commitment*
 - 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 steorage considerations
 - *Every GNSS provider should establish documented civil performance commitments to inform users about minimum levels of service*



ICG -4 – St. Petersburg, Russia Sept. 14-18, 2009

- **Progress on implementing ICG Work Plan within established working groups:**
 - A. Compatibility and Interoperability**
 - B. Enhancement of performance of GNSS services**
 - C. Information dissemination and capacity building**
 - Regional UN Centres for Space, Science and Technology Education act as ICG Information Centers (**Mexico, India, Morocco**)
 - ICG and UNOOSA supported regional workshops, displays
 - D. Interaction with monitoring & reference station network organizations**
 - Task Forces on Geodetic References & Time References established
 - ICG and IGS to host Asia Reference Frame workshop in 2010
 - **Accepted Japan's proposal for multi-GNSS MS Demo. Project in Asia/Oceania region in 2010**

ICG-5 to meet in Oct. 18-22, 2010 in Turin, Italy



APEC GIT Cooperation

- The Asia-Pacific Economic Cooperation (APEC) forum facilitates economic growth, cooperation, trade and investment in the Asia-Pacific region for its 21 member economies
- The APEC GNSS Implementation Team (GIT) has focused on air traffic control and aviation issues
 - The group has broadened its focus to the application of GNSS in all transportation sectors
 - Additional participation of GNSS government and industry experts at APEC GIT-13 at Singapore in July 2009; project proposal made on surface transportation
 - APEC GIT-14 meeting will be held in Seattle, Washington in June 21-24, 2010





Summary

- **International cooperation** in the context of U.S. National Space -Based PNT Policy is a **top priority** for the U.S. Government
- The U.S. actively engages in **bi-lateral, and multi-lateral cooperation** on satellite navigation issues
- As new and restored global and regional space-based navigation systems emerge, **interoperability** continues to be the key to “**success for all**”



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–BACK-UP Charts



ICG Providers Forum Definition of Compatibility

Compatibility refers to the ability of global and regional navigation satellite systems and augmentations to be used separately or together without causing unacceptable interference and/or other harm to an individual system and/or service

- **The International Telecommunication Union (ITU) provides a framework for discussions on radiofrequency compatibility. Radiofrequency compatibility should involve thorough consideration of detailed technical factors, including effects on receiver noise floor and cross-correlation between interfering and desired signals.**
- **Compatibility should also respect spectral separation between each system's authorized service signals and other systems' signals. Recognizing that some signal overlap may be unavoidable, discussions among providers concerned will establish the framework for determining a mutually-acceptable solution.**
- **Any additional solutions to improve compatibility should be encouraged.**



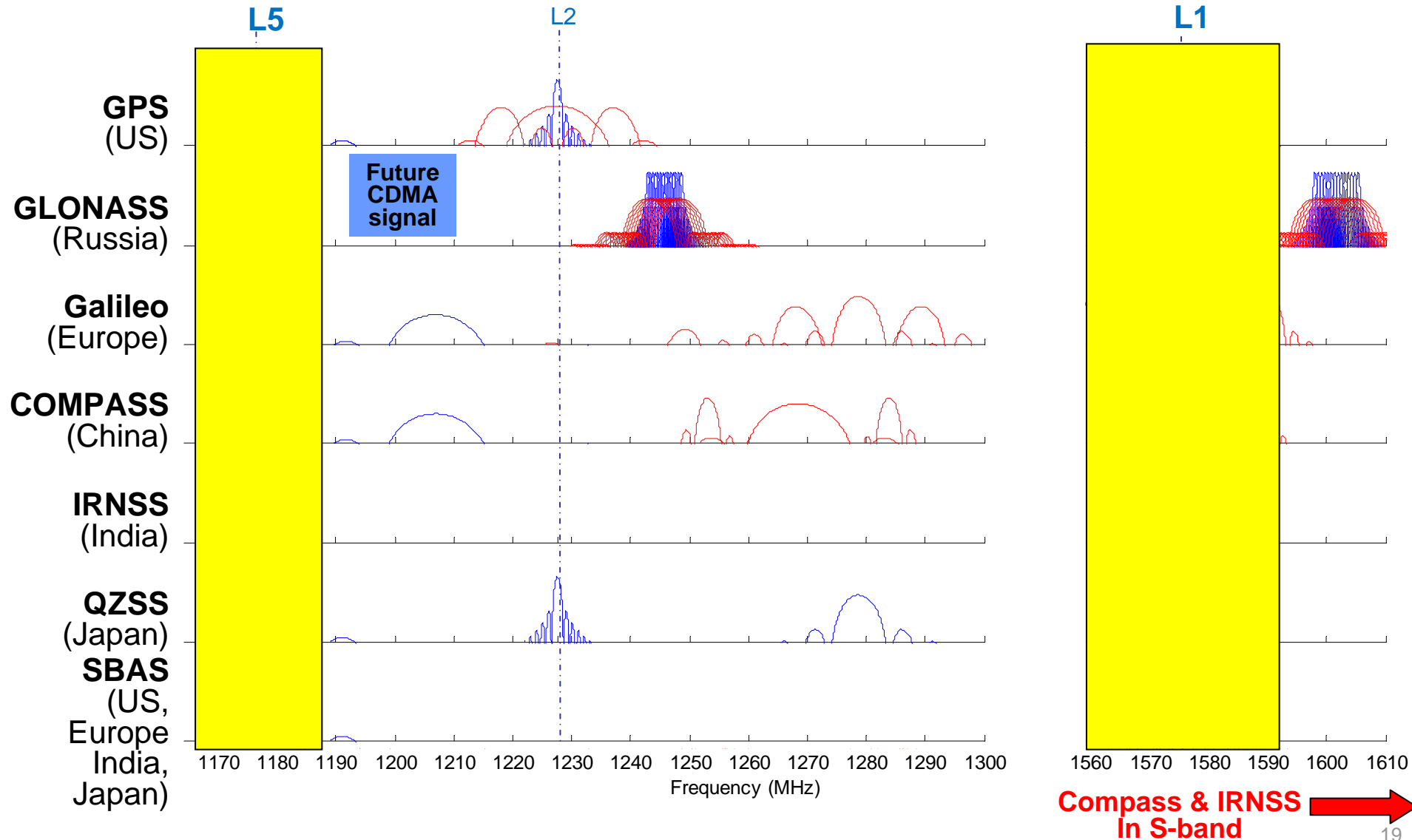
ICG Providers Forum Definition of Interoperability

Interoperability refers to the ability of global and regional navigation satellite systems and augmentations and the services they provide to be used together to provide better capabilities at the user level than would be achieved by relying solely on the open signals of one system

- Interoperability allows navigation with signals from different systems with minimal additional receiver cost or complexity.**
- Multiple constellations broadcasting interoperable open signals will result in improved observed geometry, increasing end user accuracy everywhere and improving service availability in environments where satellite visibility is often obscured.**
- Geodetic reference frames realization and system time steerage standards should adhere to existing international standards to the maximum extent practical.**
- Any additional solutions to improve interoperability are encouraged.**



Current International Signal Plans





U.S.-China Coordination

- Operator-to-operator coordination under ITU auspices
- Coordination Meetings at Geneva June 2007; Xian, China May 2008; Geneva October 2008; Beijing China, December 2009
- Discussions at multi-lateral **Providers Forum** in Bangalore, India, September 2007; Pasadena, California, December 2008; and St. Petersburg, Russia, September 2009