

ICG International Committee on
Global Navigation Satellite Systems



GNSS Interoperability through International Cooperation

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Overview



- U.S. National Space Policy
- Compatibility and Interoperability
- Bilateral International Cooperation
- International Committee on GNSS (ICG)
- Improving Interoperability
(Interchangeability?)
- 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 augment and strengthen the resiliency of 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



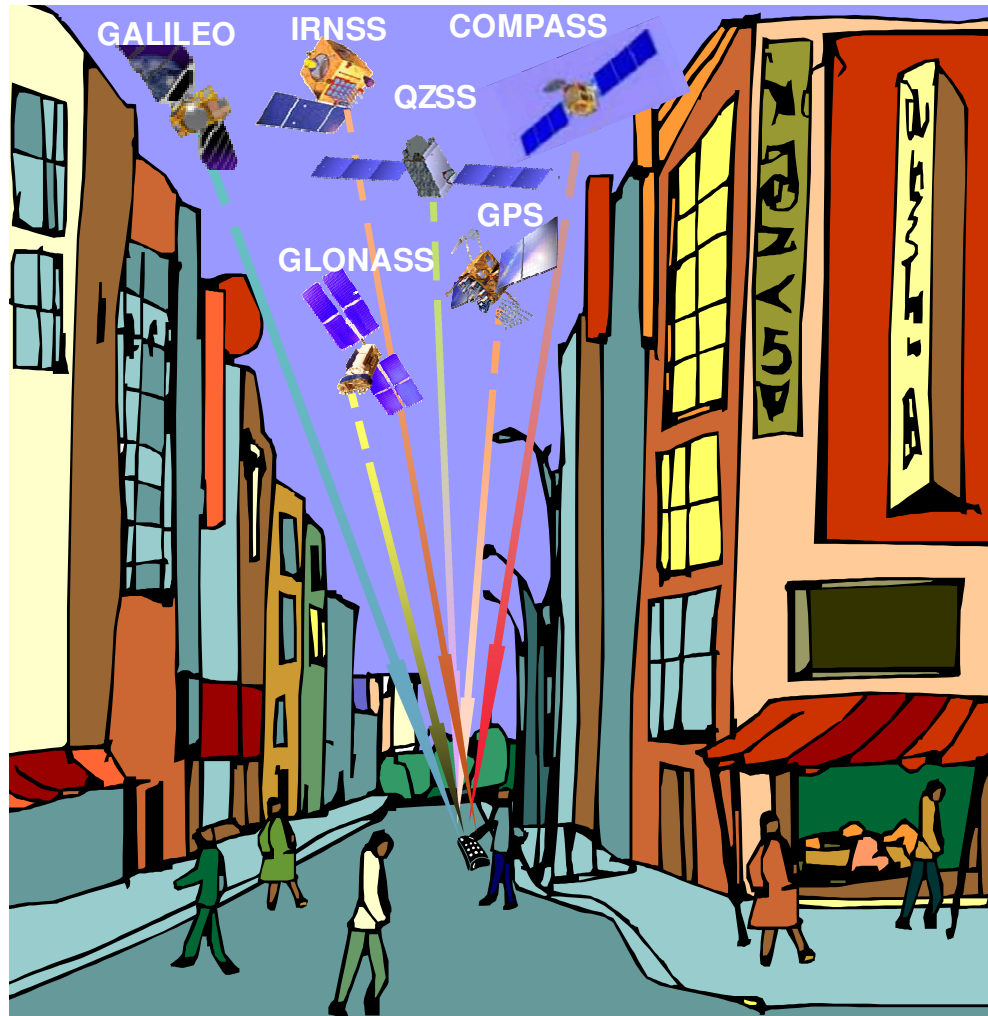
U.S. Objectives in Working with Other GNSS Service Providers

- 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

Pursue through Bilateral and Multilateral Cooperation



The Goal of Civil GNSS 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



Bilateral Cooperation

- 1998 **U.S.-Japan** Joint Statement on GPS Cooperation
- **U.S.-EU** GPS-Galileo Cooperation Agreement signed in June 2004
- **U.S.-Russia** Joint Statement issued December 2004
- **U.S.-India** Joint Statement on GNSS Cooperation in 2007
- **U.S.-China** operator-to-operator coordination under ITU auspices
- **U.S.-Australia** Joint Delegation Statement on Cooperation in the Civil Use of GPS in 2007

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
 - First Meeting held in 2006
 - Next meeting – September 4-9, 2011 in Tokyo, Japan
- Members include:
 - **GNSS Providers** (U.S., EU, Russia, China, India, Japan)
 - Other interested Member States of the United Nations
 - International organizations/associations

<http://www.unoosa.org/oosa/en/SAP/gnss/icg.html>



ICG International Committee on
Global Navigation Satellite Systems

ICG Providers Forum

- Six current space segment providers are members
 - Focused discussions on **compatibility and interoperability**, encouraging development of complimentary systems
 - Exchange detailed information on systems & service provision plans and views on the ICG work plan and activities
- Agreement that all GNSS signals & services must be compatible and **open signals & 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, system time and geodetic reference frame considerations



ICG Working Group on Compatibility and Interoperability (WG-A)

- Co-Chaired by the United States and the Russian Federation
- Work plan focused on assisting Providers in the pursuit of complementary systems
 - *Compatibility and Interoperability* - consider the perspective of various user applications and equipment manufacturers
 - *Open Service Information Sharing* - pursue **Principle of Transparency**: *every GNSS provider should publish documentation that describes the signal and system information, the policies of provision and the minimum levels of performance offered for its open services*
 - *Service Performance Monitoring* - potential cooperation in the development of the necessary ground infrastructure to monitor signal and service performance for open services
 - *Spectrum Protection - Interference Detection, and Mitigation* - develop a strategy for supporting mechanisms to detect and mitigate sources of electromagnetic interference



WG-A Interoperability Questionnaire

- **Purpose:** obtain worldwide technical input from the GNSS industry, academic institutions, and other user community representatives regarding interoperability and the combined use of signals from multiple systems
 - Circulated by WG-A after ICG-3, Dec 08, and discussed with user community at four meetings
 - Posted online by GPS World, March 2010
- Results to date:
 - **Benefits** of interoperability include better availability, accuracy, and ability to support RAIM
 - **Priorities** include common carrier frequencies, common time scale & reference frames, common modulation, and collocation of reference stations



Ideal Interoperability (Interchangeability?)



- **Definition:** Navigation with one signal each from four or more systems with no additional receiver cost or complexity
- Do users and manufacturers want it?
 - Not clear
- Is it of value?
 - Maybe for some users
 - Receivers can self-correct for most system differences with enough satellites in view
- **If** it is desirable to improve interoperability ...

Improving Interoperability (1)



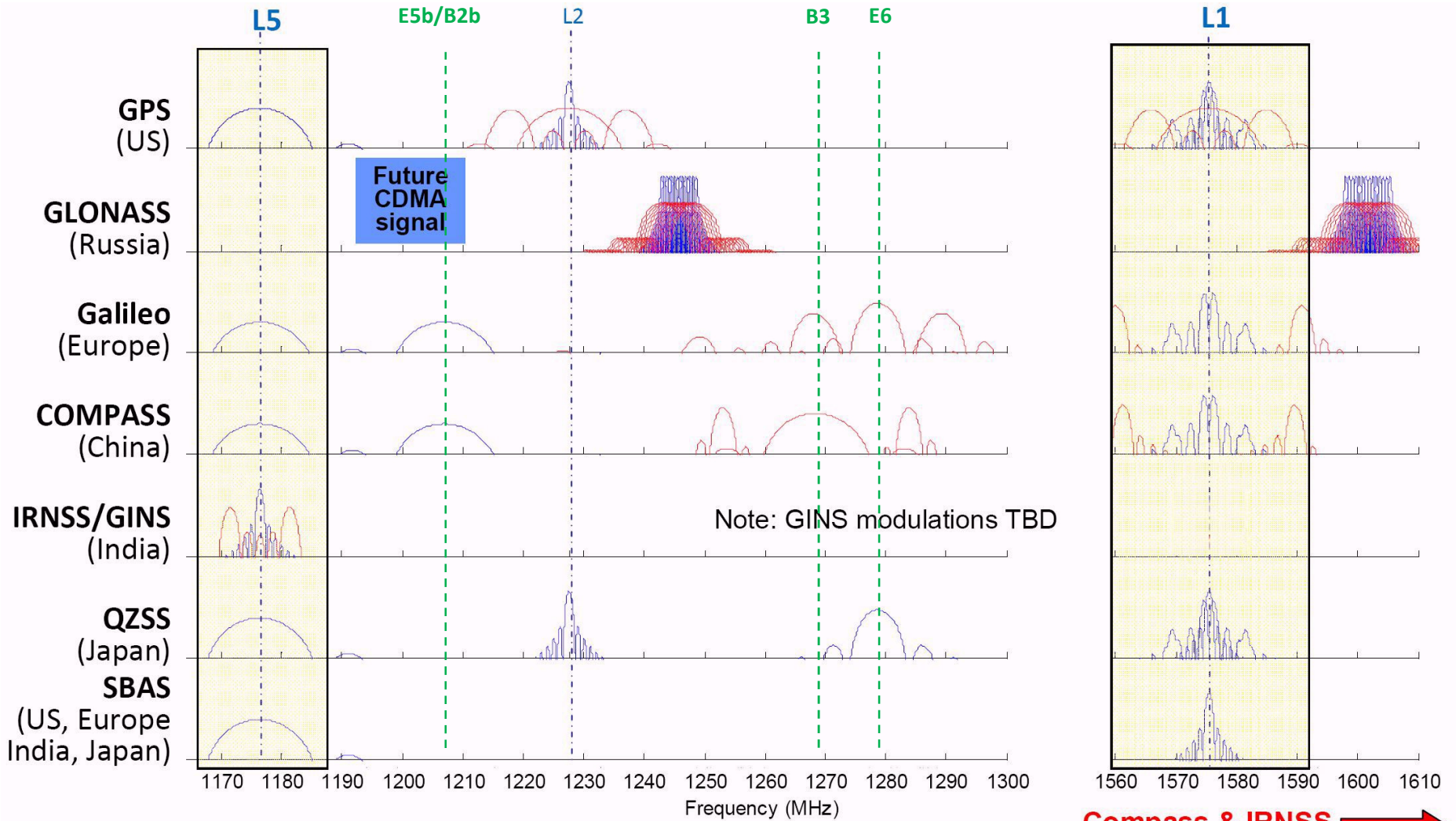
- Geodetic reference frames of individual systems appear to be converging to within centimeters
 - Maintaining alignment of reference frames with ITRF should ensure this trend continues
- A GNSS ensemble time could be realized by the monitoring of all constellations from common sites
 - Individual system times could then be compared to this “GNSS time” and the resulting corrections could be made available for broadcast through multiple channels
 - Core global constellations, regional systems, SBAS, and the internet are all possibilities

Improving Interoperability (2)



- More Frequency commonality with common signal spectrum
 - Simplifies multi-constellation monitoring
 - Reduces cost of consumer-grade receivers
 - Minimizes time and frequency biases
- Greater service provision transparency
 - Timely and widely available interface specifications and performance standards for individual constellations
 - Transparent operation of common monitoring stations and widely available information on obtaining corrections

Planned GNSS Signals



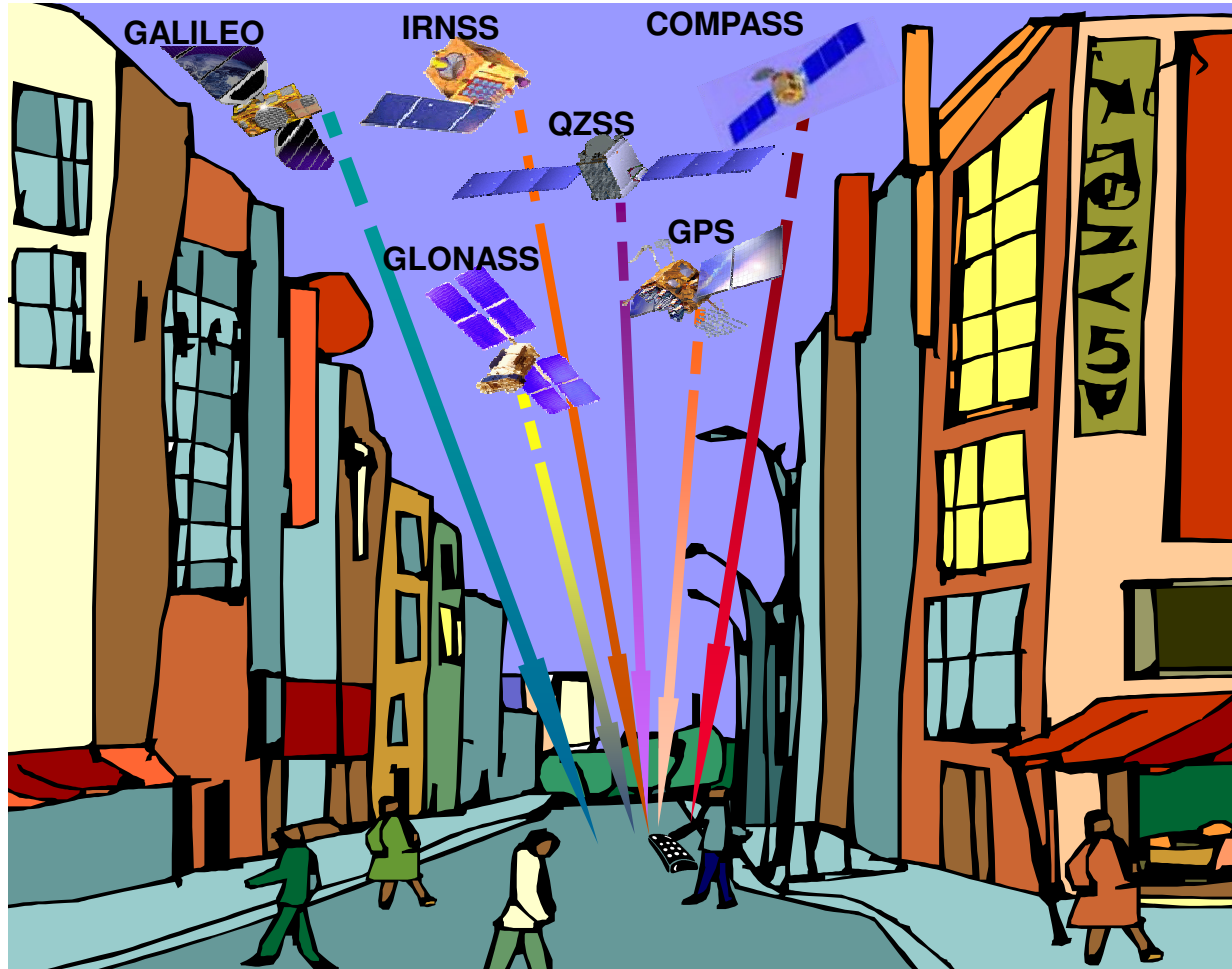
Compass & IRNSS
In S-band 

Almost Ideal Interoperability



Greater frequency commonality with transparency

Geodetic Alignment



Ensemble Time Offsets

Almost Interchangeability

Summary



- U.S. Space-Based PNT Policy encourages **compatibility and interoperability** with GPS
 - Pursued through bilateral and multilateral cooperation
- The U.S. supports the ICG principles of compatibility, interoperability, and transparency
- Efforts to better understand industry and user views on interoperability continue through the ICG
 - **Your input is welcome and encouraged**
- **Ideal Interoperability** or “Interchangeability” and the means to achieve it deserves further consideration
 - Multi-GNSS constellation monitoring will be necessary

Thanks!



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Progress in GNSS Service Provision

- ✓ Providers Forum
 - ✓ Providers Forum System Report
 - ✓ Principles of Compatibility, Interoperability, and Transparency
 - Template for Performance Standards (and ICDs)
 - *Postulated Performance Standards for future services*
 - Service Assurances or Commitments
 - *Monitoring of service performance*
 - *Interference monitoring*

