



# Overview



- National Space Policy
- Compatibility and Interoperability
- Bilateral International Cooperation
- International Committee on GNSS (ICG)
- Improving Interoperability  
(Interchangeability?)
- Summary



# ***New 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



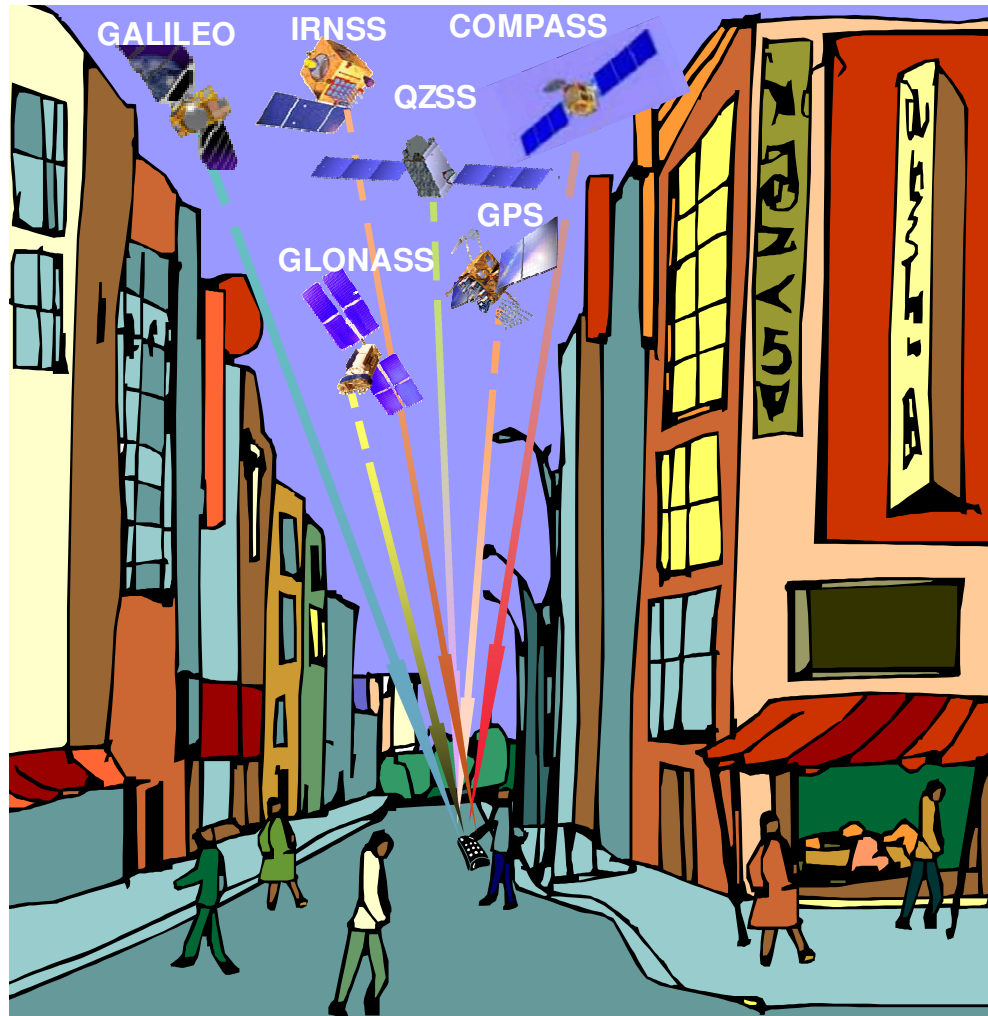
## *U.S. Objectives in Working with Other GNSS Service Providers*

- 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*

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- 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
  - Fifth will occur October 18-22 in Turin, Italy
- 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)*



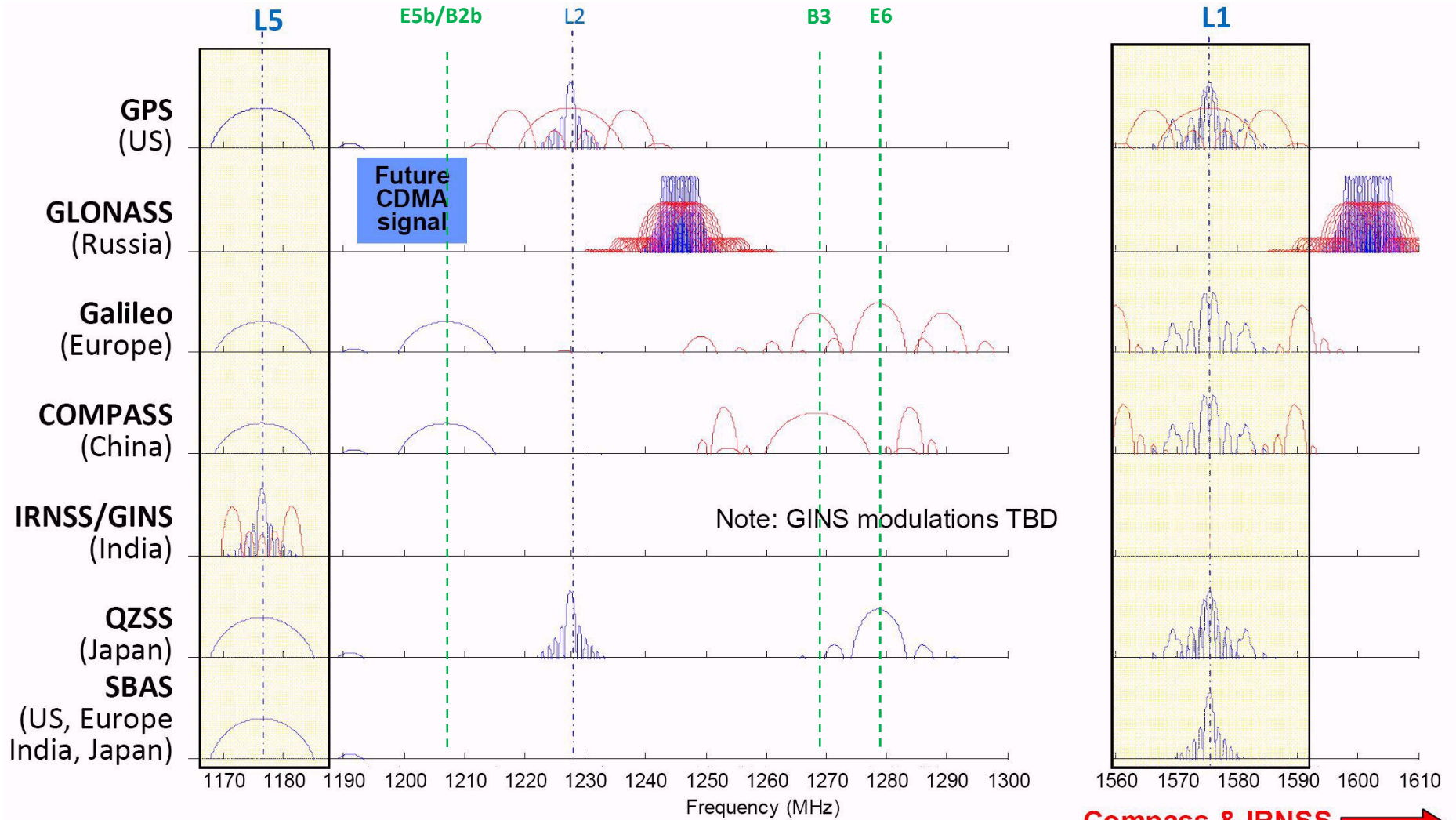
- Geodetic reference frames of individual systems appear to be converging to within centimeters
  - Maintaining alignment of reference frames with ITRF should ensure this trend continues
- A GNSS ensemble time could be realized by the monitoring of all constellations from common sites
  - Individual 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 

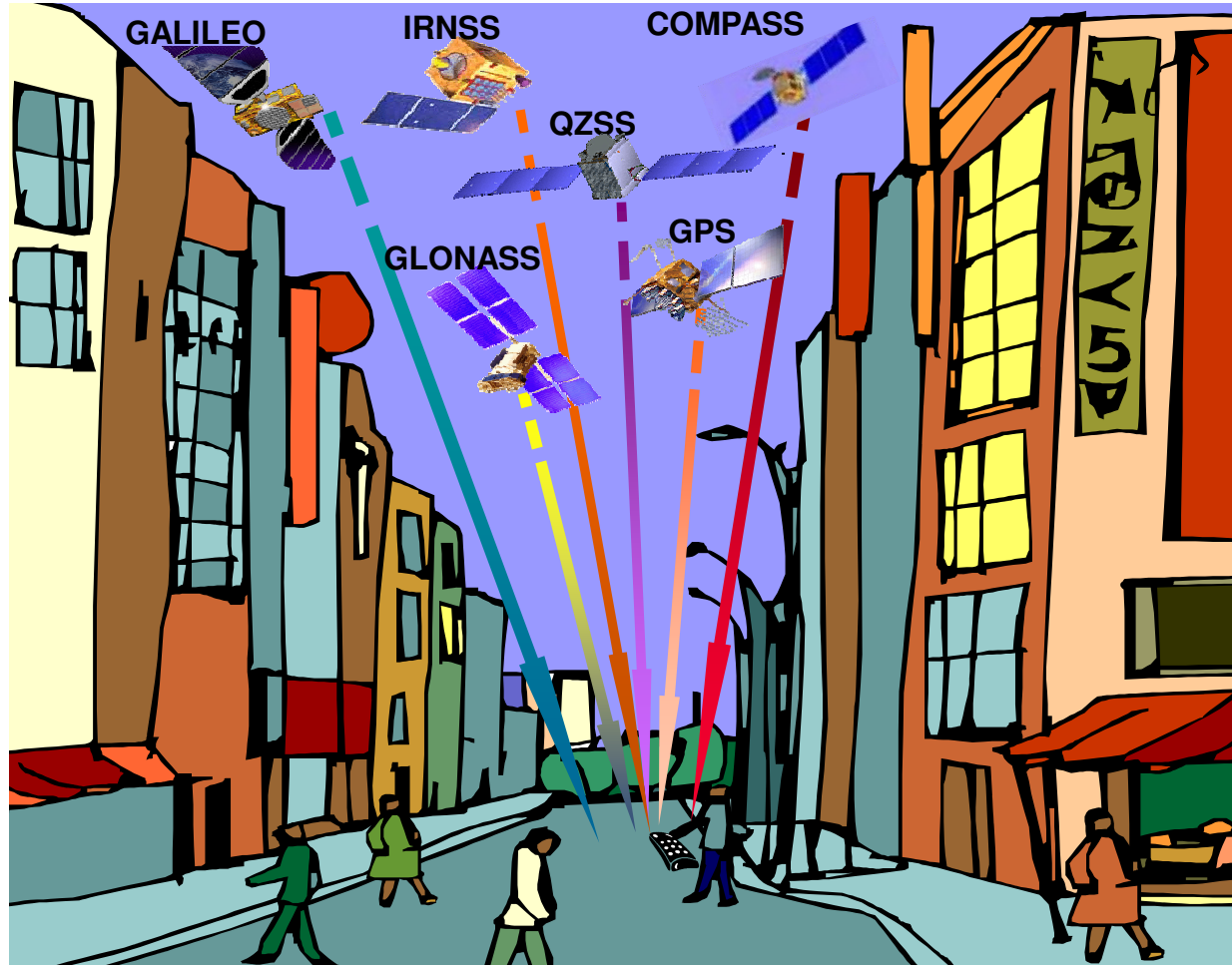


# *Almost Ideal Interoperability*



**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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