



International Committee on
Global Navigation Satellite Systems

ICG Perspective on Compatibility and Interoperability

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ICG International Committee on
Global Navigation Satellite Systems

Definitions (from ICG)

- 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
- 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



Improving Interoperability

Interoperability allows navigation with signals from different systems with minimal additional receiver cost or complexity

- Alignment of Geodetic reference frames of individual systems
 - Alignment of reference frames with International Terrestrial Reference System (ITRS)
- Realize a GNSS ensemble time by monitoring all constellations from common sites
 - Individual system times can be compared to this “GNSS time” and the resulting corrections made available for broadcast through multiple channels
- More Frequency commonality with common signal spectrum
 - 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



ICG Providers Forum Accomplishments

- Providers have agreed that all GNSS signals and services need be **compatible**, and open signals and services should also be **interoperable** to the extent possible
- Agreement on the **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



ICG Mission Statement (2013)

- Promote voluntary cooperation on matters of mutual interest related to civil satellite-based positioning, navigation, timing, and value-added services
- Contribute to the sustainable development of the world
- Encourage coordination among GNSS Providers to ensure greater *compatibility, interoperability, and transparency*
- Promote the introduction and utilization of GNSS services in developing countries, by assisting with the integration into their infrastructure
- Assist GNSS users with their development plans and applications, by encouraging coordination and serving as a focal point for international information exchange



ICG Working Groups

2006 Terms of Reference and Work plan:

4 Working Groups Established

- A. WG-S: Systems, Signals and Services (Co-Chairs: U.S. & Russia)
 - Focus on compatibility and interoperability, encouraging development of complimentary systems
 - Exchange information on systems and service provision plans, spectrum protection
- B. WG-B: Enhancement of GNSS Performance, New Services and Capabilities (Co-Chairs: China, India & European Space Agency)
 - Focus on system enhancements (multipath, integrity, interference, etc.) to meet future needs, interoperable GNSS Space Service Volume, space weather
- C. WG-C: Information Dissemination and Capacity Building (Chair: UN Office for Outer Space Affairs)
 - Focus on training/workshops, promoting scientific applications, outreach
- D. WG-D: Reference Frames, Timing and Applications (Co-Chairs: IAG, IGS & FIG)
 - Focus on monitoring and reference station networks, timing issues



ICG Working Group on Systems, Signals and Services (WG-S)

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



Compatibility and Spectrum Protection

- Seek common understanding on ***appropriate methods to determine compatibility*** among all GNSS
- ***Review existing ITU regulations and recommendations*** related to the avoidance of harmful interference to GNSS
 - ***Propose new questions or studies for ITU consideration***, as necessary, to protect all GNSS from harmful interference
- ***Develop educational material*** on sources of interference to GNSS, in an effort to educate governments of user community member nations on GNSS spectrum protection and management



Interference Detection & Mitigation (IDM)

- Develop a ***strategy to support mechanisms to detect and mitigate sources of electromagnetic interference***
- Focus on worldwide effort to ***implement coordinated interference detection and mitigation capabilities at the national level***
- Develop ***standards for interference reports submitted to GNSS Civil Service National Centers*** and establish routine communications among the centers
- ***Recommend standards for IDM capabilities to be implemented*** by national governments and industry
- ***Facilitate information exchange*** among system providers on positioning, navigation, and timing capabilities to complement GNSS





Addressing Spectrum Protection and IDM within ICG



- Establishment of Compatibility Subgroup in 2011
 - Focused on compatibility issues to include spectrum protection and IDM
- Objectives of the Subgroup
 - Compatibility Collaboration and Consultation (CCC) regarding the protection of GNSS spectrum from interference from other radio services, as well as Interference Detection and Mitigation (IDM) efforts;
 - Document agreed results in the form of findings, reports, or other alternative means that may be appropriate for the case;
 - Provide proposals to WG-S on findings related to compatibility issues, for discussion and decision.





ICG Recommendations Related to IDM and Spectrum Protection



Recent Recommendations Adopted by the ICG

2014/2017	Crowdsourcing capabilities analysis for IDM
2015/2016/2017	UN regional workshops on GNSS spectrum protection and IDM
2015/2016	Campaign of Protection of RNSS operations – GNSS providers and GNSS user community member states promote spectrum protection
2015/2016	UN COPUOS multi-year agenda item focused on National Efforts to protect RNSS Spectrum, and develop IDM capability
2017	Encourage national regulators to use the protection criteria in relevant ITU-R Recommendations
2019	Produce a draft booklet on GNSS/RNSS spectrum Protection based on material used for the ongoing spectrum seminars
2022	Incorporating Resilience into GNSS Interference Detection and Mitigation

GNSS Interoperability

- ***Interoperability definition adopted at the first Providers Forum meeting and updated at the third meeting***
- Consider the perspective of various user applications and equipment manufacturers by interacting ***with industry experts and user community representatives to solicit input*** on improving the overall open service provided by global and regional navigation satellite systems in a manner that allows for effective multi-GNSS use at the user level
- ***Focus on the open service signal development*** and broadcast plans of the system providers
- ***Consider the role of system time and geodetic reference frames in enabling interoperable*** multi-GNSS service



Interoperability Workshops Hosted by GNSS Providers

Interoperability and Service Standards Subgroup co-chaired by the U.S. and China

- Five Workshops held between 2013 & 2015:
 - **U.S.** hosted workshop – April 2013, Honolulu
 - **Russia** hosted workshop – April 2014, Moscow
 - **China** hosted workshop – May 2014, Nanjing
 - **Japan** hosted workshop – August 2014, Osaka
 - **EU** hosted workshop – March 2015, Munich
- Focused on receiving industry/user feedback on Interoperability and multi-GNSS use
- Led to in depth discussions within the Interoperability Subgroup and recommendations adopted by the full ICG



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Open Service Information

- From the current work plan of the ICG Working Group on Systems, Signals, and Services:
 - Consistent with the **principle of transparency** in the provision of open services, each individual Provider will strive to **publish and disseminate all signal and system information necessary** to allow manufacturers to design and develop GNSS receivers
 - The Interoperability and Service Standards Sub-Group will develop a template:
 - To **promote common terminology and definitions** in individual GNSS Open Service Signal Specifications
 - That each individual GNSS provider may consider using in their publication of signal and system information, the policies of provision, and the **minimum levels of performance offered for open services**



Service Performance Monitoring

- ***Discuss*** proposals ***to widely monitor the performance of GNSS open signals*** and provide timely updates to users regarding critical performance characteristics such as timing accuracy, positioning accuracy and service availability
- ***Translate open service performance standards into parameters for multi-GNSS monitoring***
- Adopt recommendations, as necessary, for ***monitoring infrastructure and organizational approaches***





Recommendations Related to Interoperability

Recent Recommendations Adopted by the ICG

2011/2012/2014 /2016/2018	Open Service GNSS performance parameters, including Definitions and Calculation Methods
2012/2013	Interoperability Workshops with industry
2014/2015	National service monitoring center websites to connect to ICG internet portal
2017	Develop guidelines on how to select and prioritize GNSS satellite laser tracking
2015	Joint trial project with IGS to demonstrate a global GNSS Monitoring and Assessment capability
2019	PPP Interoperability Task Force
2016/2017/2023	Workshop to discuss system time and offsets
2023	LEO PNT Workshop/Discussions

