



Achieving Multi-GNSS Interoperability through the ICG



China Satellite Navigation Conference 2017

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ION PANEL

*Office of Space and Advanced Technology
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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 Provider Forum

- Members include the U.S., EU, Russia, China, India, and Japan
 - Focused discussions on compatibility and **interoperability**, encouraging development of complimentary systems
 - Exchange detailed information on systems and service provision plans
- Consensus reached on Principles of compatibility, **interoperability** and transparency in civil service provision
- Providers are leading efforts to promote GNSS *radio-frequency interference detection and mitigation*

Providers participate in, and are supported by, the ICG Working Group on Systems, Signals and Services



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
 - *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*



WG-S Work Plan - Interoperability

- As with the ***principle of compatibility, the principle of interoperability and its definition was adopted at the first Providers Forum meeting and updated at the third meeting.*** Consistent with this principle and its definition, the working group, through a subgroup on interoperability, considers the perspective of various user applications and equipment manufacturers, and:
 - ***Continues efforts to interact with industry experts and user community representatives in order 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;
 - ***Maintains a focus on the open service signal development*** and broadcast plans of the system providers; and,
 - In cooperation with Working Group D, ***consider the role of system time and geodetic reference frames in enabling interoperable*** multi-GNSS service



Interoperability Subgroup

- Created, initially as a Task Force, in 2013 (ICG-8)
- Co-chaired by China and the United States
- Initial focus was on obtaining user community and industry views on interoperability, and identifying how Providers can best use that information to improve interoperability among the GNSS
- Task Force became permanent subgroup in 2015 (ICG-10) with the expanded role of focusing on all aspects of GNSS interoperability



Interoperability Workshops Hosted by GNSS Providers

- 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



WG-S Work Plan - Open Service Performance Standards

- 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 Subgroup will ***develop a template to promote common terminology and definitions in individual GNSS Open Service Signal Specifications*** as published in Interface Standards and Interface Control Documents.
- The Subgroup will ***also develop a template 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 used on the Earth and in outer space (Open Service Performance Standards).



System-of-System Operations

- As requested by the Providers Forum, the Working Group will investigate methods to ensure orbital de-confliction among constellations in medium Earth orbit (MEO) and appropriate application of United Nations Orbital Debris Mitigation guidelines to this regime implemented through national practices. In this regard, the working group will coordinate with the Inter-Agency Space Debris Coordination Committee.
- Overall open service performance provided by the system of global and regional navigation satellite systems may also be improved through coordination of constellation configurations and replenishment of satellites in specific orbital locations. The Working Group will assist providers in this area as desired and appropriate.
- The Working Group will investigate the overall GNSS open service volume in order to consider improvement in terms of accuracy, integrity, availability, reliability and service coverage.



11th Meeting of the International Committee on GNSS (ICG-11)



- More than 100 participants
 - Representatives from 21 countries/organizations
 - Representation from all 6 GNSS Providers
- Agenda included:
 - Meeting of the Providers' Forum
 - System Provider Updates
 - Applications and Experts Session
 - Meeting of all four Working Groups





ICG-11: Significant Accomplishments and Recommendations

- Interference Detection and Mitigation (IDM) & Spectrum Protection
 - Recommendation for Providers to promote the implementation of protection measures of GNSS operations around the world
 - Proposal for ICG Secretariat to deliver a communication to select members of the UN Committee on the Peaceful Uses of Outer Space (COPUOS) - Focused on National Efforts to protect RNSS Spectrum, with a request for member states to report their regulations and report on efforts to mitigate interference
 - 6th IDM workshop was conducted in Baska, Croatia, May 2017
- International Multi-GNSS monitoring (IGMA)
 - Recommendation for an ICG workshop to be held in May 2017 to discuss the multi-GNSS monitoring trial project established in 2016 between the ICG and IGS, and discuss the need for GNSS signal quality monitoring
- Interoperability – Timing
 - Recommendation for ICG expert level workshop to be held in 2017 to further discuss GNSS system time offsets among the systems



ICG-11: Significant Accomplishments and Recommendations (continued)

- **Signal Patents**
 - Recommendation for nations to ensure that open signal structure patents are discouraged and not used for the collection of royalties
- **Search and Rescue (SAR)**
 - Presentations from 3 GNSS providers on SAR implementation status – recognition by providers of the importance of having interoperable SAR services
- **Space Weather**
- **Discussion about ionospheric models – will be further discussed at future ICG meetings**
- **Space Service Volume (SSV)**
 - SSV Booklet to be released in early 2017 – results of completed simulations used to develop definitions and assumptions for an interoperable SSV
 - Outreach activities scheduled in 2017 to highlight the importance of the ICG work taking place and the benefits of an interoperable SSV



Workshop on Performance Monitoring

WG-S Recommendation from November 2016:

Building upon the work of the trial project between ICG and IGS for international performance monitoring, additional discussion is needed to examine further aspects of monitoring

This can include examining additional parameters to monitor in the future, and the need/feasibility for GNSS signal quality monitoring.

ICG Recommendation:

The IGMA Task Force should organize a workshop on Performance Monitoring, to take place in Shanghai in conjunction with the China Satellite Navigation Conference in May 2017

The Workshop will address the following:

- IGMA Activities and the status of the IGMA-IGS trial project
- Need/benefit for GNSS signal quality monitoring, and the feasibility of establishing this within the ICG in the future

***Completed: China Successfully hosted the Workshop on
22 May 2017***



Timing Workshop

WG-S Recommendation from November 2016:

Recognizing that GNSS time offsets can affect interoperability, some Providers are broadcasting time offsets relative to other systems. In order to better assess the advantages of this type of offset, it is necessary to have further discussion among timing experts.

ICG Recommendation:

The ICG WG-S should work with WG-D, to include BIPM and the IGS, to organize an experts workshop on timing to discuss GNSS time offsets among the systems. The workshop will take place in conjunction with the IGS Workshop, to be held in or near Paris, in early July 2017.



Space Service Volume Cooperation

- GNSS Providers working through the ICG to create an interoperable Space Service Volume (SSV) that can be used for real-time navigation
 - Significantly improves real-time navigation performance
 - GNSS timing reduces need for expensive on-board clocks
 - Supports increased satellite autonomy
- Recommendations adopted by the ICG include:
 - Development of an SSV booklet by GNSS Providers
 - Outreach effort on SSV initiative



Progress at ICG in GNSS Civil 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*



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THANK YOU!