

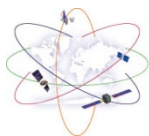


International Committee on
Global Navigation Satellite Systems

ICG Working Group A

ICG-10 Meeting
Boulder, Colorado, USA

November 5, 2015



ICG International Committee on
Global Navigation Satellite Systems

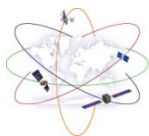


International Committee on
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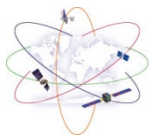
November 5, 2015



ICG International Committee on
Global Navigation Satellite Systems

2015 WG-A Schedule

- ✓ IGMA Task Force Meeting, Munich, March 26
- ✓ European Interoperability Workshop, Munich, March 27
- ✓ IGMA Workshop, Xi'an, China, Monday, May 12
- ✓ IDM Workshop & Task Force Meeting, Vienna, June 10-11
- ✓ WG-A Inter-sessional Meeting Part 1 – Vienna, June 11-12
- ✓ WG-A Inter-sessional Meeting Part 2 - iGNSS Conference, Gold Coast, Australia, July 13-16



Original Working Group A Work Plan

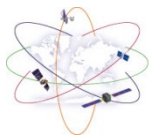
Action A1: Establish a Providers Forum to enhance compatibility and interoperability among current and future global and regional space-based systems.

Action A2: Organize a workshop(s) on measures being taken by Members, Associate Members and Observers to enhance interoperability and compatibility of 1) global and regional space-based systems and 2) regional ground-based DGNSS.

Action A3: Survey the level of interoperability and standardization among GNSS constellations and augmentations in order to identify concrete steps that can be taken at different levels (regulatory, system implementation, user algorithms) to improve interoperability and standardization.

Action A4: Consider guidelines for the broadcast of natural disaster alarms via GNSS.

Action A5: Develop a strategy for ICG support of mechanisms to detect and mitigate sources of electromagnetic interference, taking existing regulatory mechanisms into consideration.

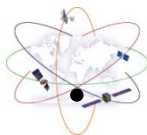


Working Group A Recommendations adopted at ICG-4, Saint Petersburg, 2009

✓ **Revised work plan**

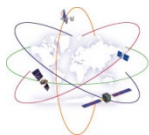
- **Compatibility**
- **Interoperability**
- **Open service information sharing**
- **Service Performance Monitoring**
- **Spectrum Protection**

- ✓ Continue seeking inputs on interoperability from industry and users - Conduct a workshop at iGNSS 2009
- ✓ Conduct a compatibility-focused meeting prior to ICG-5 – scheduled for June 2010 in Vienna
- ✓ Endorse the multi-GNSS demonstration campaign and encourage Provider participation
- ✓ 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

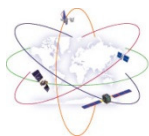
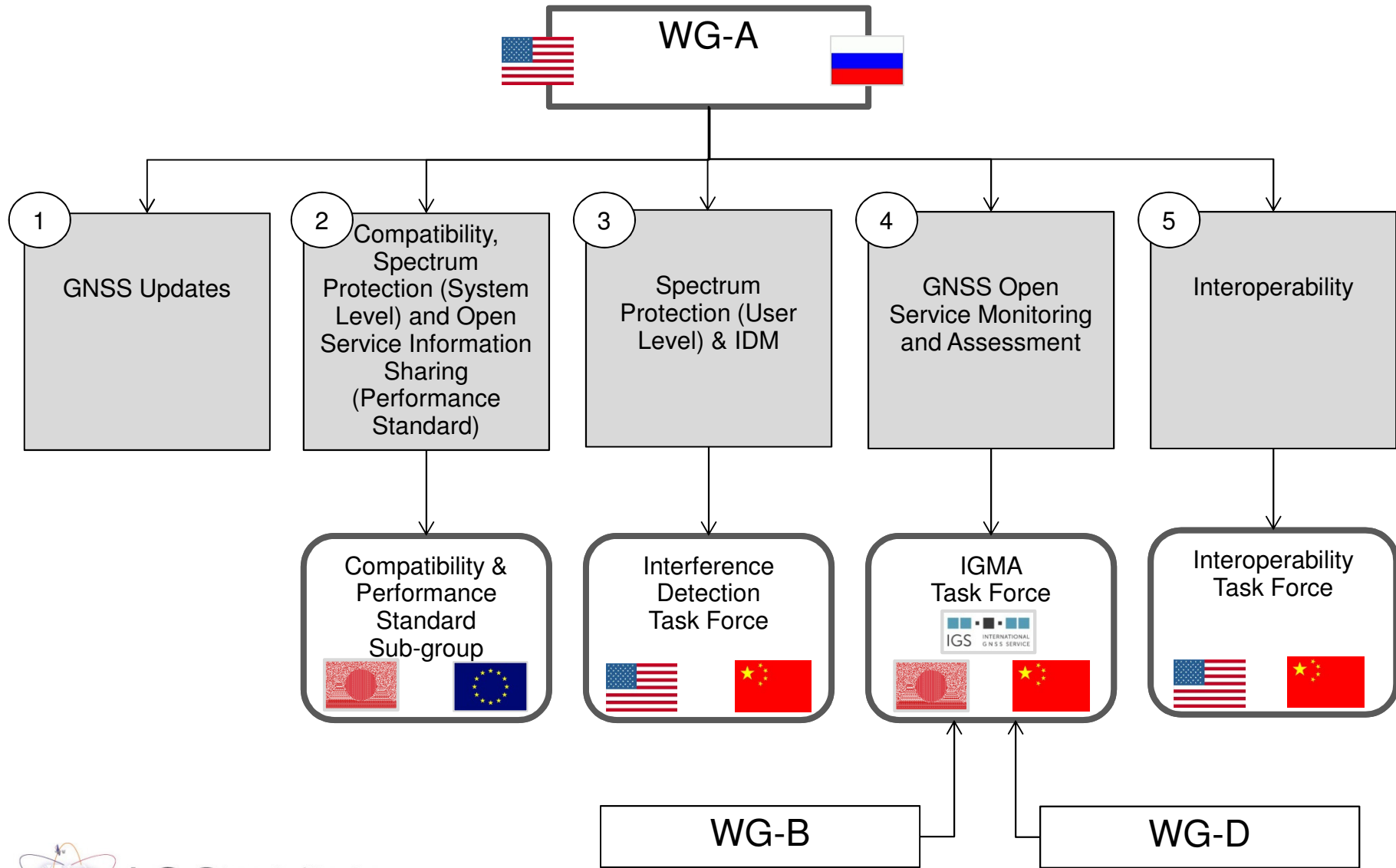


WG-A

- Co-chairs:
 - **David TURNER, Department of State, U.S.A.**
 - **Sergey REVNIVYKH, ISS RESHETNEV Corp., Russia**
- Secretariat
 - **Jeff AUERBACH, Department of State, U.S.A**
 - **Tatyana MIRGORODSKAYA, PNT IAC, Russia**
 - **Tom STANSELL, Stansell Consulting, U.S.A.**



WG-A Architecture



Previous ICG WG-A recommendations implementation summary - 2009 (ICG-4)

No/Year	Brief description	Status
1 / 2009	Revised Work Plan for WG-A	Closed
2 / 2009	Continue seeking inputs on interoperability from industry and users - Conduct a workshop at iGNSS 2009	Closed – new effort initiated @ ICG-5
3 / 2009	Conduct a compatibility-focused meeting prior to ICG-5 – scheduled for June 2010 in Vienna	Closed – led to formation of sub-group
4 / 2009	Endorse the multi-GNSS demonstration campaign and encourage Provider participation	Closed – Some providers actively participate
5 / 2009	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	Closed – Principle adopted by Providers



Previous ICG WG-A recommendations implementation summary - 2010 (ICG-5)

No/Year	Brief description	Status
2.1 /2010	Continue the Work of the Sub-group Compatibility (Organizational Models and Procedures for Multilateral Discussions)	Specific focus abandoned – sub-group continues
2.2 /2010	Common Reference Assumptions for Compatibility Coordination	Specific focus abandoned by sub-group
3.1. /2010	IDM Study Plan and ICG Participation	Closed – evolved to IDM task force
5.1 / 2010	New approach to continued collection of user and industry views on interoperability	Open - Task Force evaluating workshop results
5.2 /2010	Continue to investigate system time and geodetic reference frame aspects of interoperability within the WG-D task forces on time and geodesy	Ongoing – templates completed by WG-D
5.3 / 2010	ICG participant participation in Asia-Oceania Multi-GNSS Demonstration Campaign and interaction with receiver manufacturers	Closed – effectiveness should be evaluated



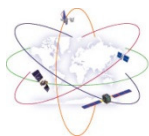
Previous ICG WG-A recommendations implementation summary 2011 (ICG-6)

No/Year	Brief description	Status
2.1 /2011	Continuation of WG-A compatibility subgroup	Closed. SG is Active
3.1 /2011	Workshop on GNSS Spectrum Protection and IDM	Closed. Became 1 st IDM workshop
4.1 /2011	Open Service GNSS performance parameters, including Definitions and Calculation Methods	Open
4.2 / 2011	International GNSS Monitoring and Assessment Sub-Group	Implemented - Became Task Force with WG-A and D Still Active



Previous ICG WG-A recommendations implementation summary 2012 (ICG-7)

No/Year	Brief description	Status
2.1 2012	RNSS spectrum protection from ITM. Joint efforts in ITU	Closed 8A.2.1 issued
3.2 2012	Conduct IDM workshops	Implemented - 4 workshops to date
4.1 2012	Extend tasks of IGMA Task Force to include the parameters definition elaboration	Implemented – work is incomplete
5.1 2012	Interoperability workshops based on the Questionnaire	Implemented – 5 of 6 Providers held workshops



Previous ICG WG-A recommendations implementation summary 2013 (ICG-8)

No/Year	Brief description	Status
8A.2.1 2013	ICG Members to joint efforts in ITU for GNSS spectrum protection from ITM	Closed 9A.2.1. issued
8A.2.2. 2013	Update brochure on GNSS with existing or expected performance for open service	Open
8A.3.1. 2013	Educational materials on GNSS features and why they are differ from communication	Open
8A.3.2. 2013	Establish an IDM Task Force	Implemented - Task Force still active
8A4.1	Rearrange the WG-A(B,D) IGMA Task Force to ICG IGMA Task Force	Open
8A5.1 2013	Establish an Interoperability Task Force to process data from workshops	Implemented - Task Force still active

Previous ICG WG-A recommendations implementation summary 2014 (ICG-9)

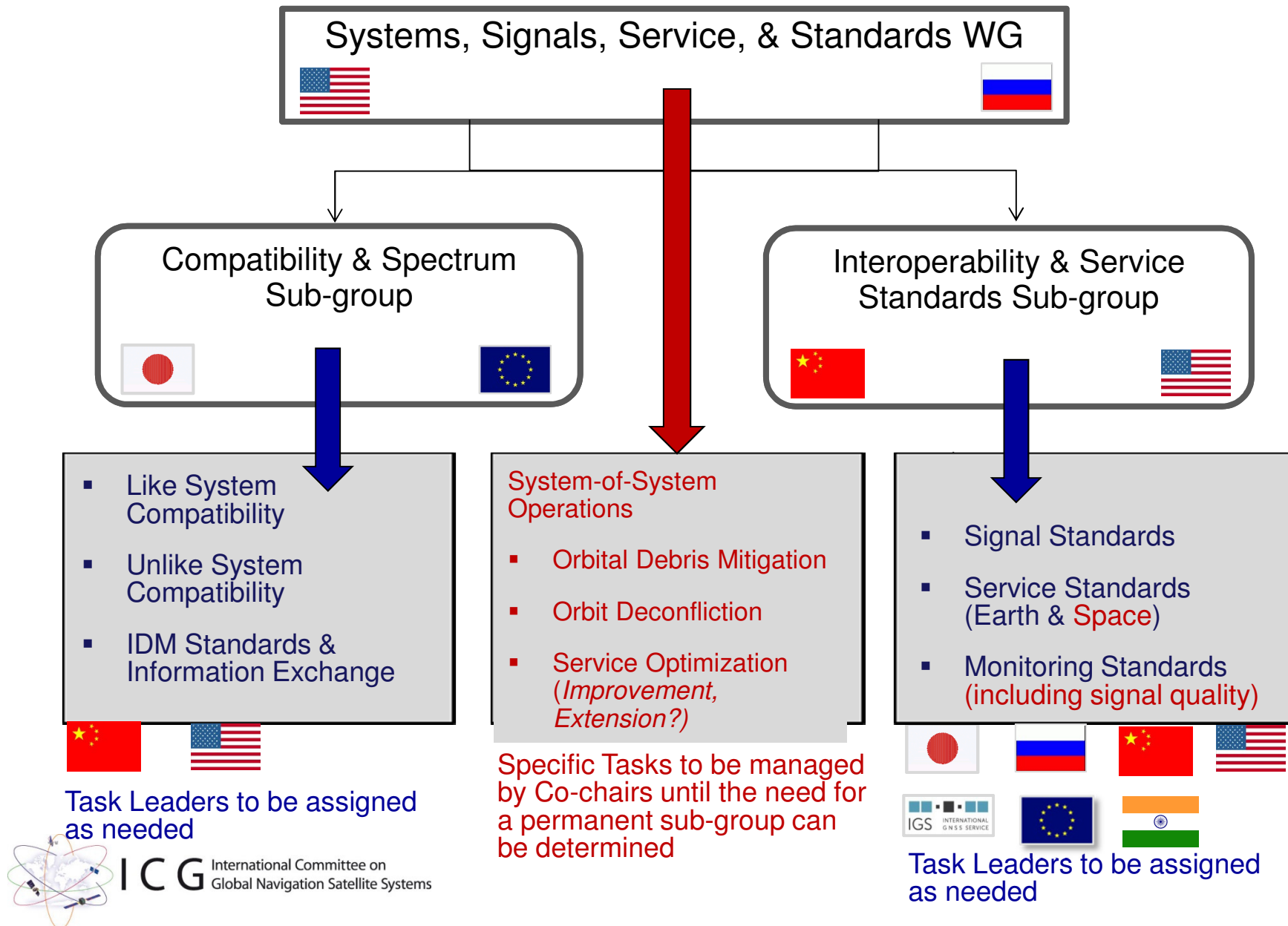
No/Year	Brief description	Status
9A.2.1. 2014	ICG Members to join efforts in ITU-R and WRC-2015 for GNSS spectrum protection from ITM	Uncertain
9A.3.1 2014	Evaluate existing and emerging IDM capabilities and consider developing, testing and implementing these or similar capabilities	Open
9A.3.2. 2014	Crowdsourcing capabilities analysis for IDM	Open
9A.3.3.	UN regional workshops on GNSS spectrum protection and IDM	Open. Moved to Comp. Subgroup
9A.4.1. 2014	National service monitoring center websites to connect to ICG internet portal	Open – to be updated at ICG-10
9A.4.2. 2014	IGMA Workshop in Xi'an in May, 2015	Completed, Closed

Draft Recommendation 10A.1 for ICG-10

- The Working Group on Compatibility and Interoperability (WG-A) recommends that the ICG endorse an updated work plan focused on GNSS civil service provision by a system-of-systems comprised of current and future global and regional systems
- The detailed work plan as attached will include the following areas of work:
 - Compatibility (signal compatibility, spectrum protection (space and user levels))
 - Interference detection, localization and mitigation [open service protection]
 - Interoperability [(signals, system times and system geodetic references)]
 - Open service performance (to include space and terrestrial service specifications and monitoring)
 - Future system provision issues and [constellation] coordination
- WG-A further recommends that its official name be changed to the Working Group on [GNSS Systems and Open Service Provision]
 - The working group will include a permanent subgroup on compatibility and a permanent subgroup on interoperability with ad hoc task forces as necessary

Objective: WG-A activity efficiency improvement and structure optimization

Draft S4 WG Architecture for Consideration



2

2a

**COMPATIBILITY, SPECTRUM
PROTECTION AND**

2b

PERFORMANCE STANDARDS



ICG International Committee on
Global Navigation Satellite Systems

2a

(Current) Work Plan - Compatibility

- Considering the principle of compatibility and its definition, the working group will:
 - In particular, review existing ITU regulations and recommendations related to the avoidance of harmful interference;
 - Seek common understanding on appropriate methods to determine compatibility among all GNSS; and,
 - If necessary, propose new questions or studies for ITU consideration, through appropriate mechanisms, to further protect the noise floor impacting all GNSS, and to define methodology used between GNSS providers to ensure compatibility.



2a

(Current) Work Plan

Spectrum Protection (system level) & IDM

- The Providers Forum has agreed to pursue the protection of radionavigation satellite service (RNSS) spectrum through appropriate domestic and international regulation.
 - When necessary and appropriate, the Working Group will facilitate Provider discussions on their individual views and actions related to RNSS spectrum issues and agenda items under consideration by the ITU and its Working Parties.
- The Working Group will develop a strategy for ICG support of mechanisms to detect and mitigate sources of electromagnetic interference, taking existing regulatory mechanisms into consideration. This could lead to concrete proposals for detecting interference.



2a

Compatibility & [Performance Standard Sub-group]

- Co-chairs:
 - **Takahiro MITOME, Japan**
 - **Dominic HAYES, EU**
- Members:
 - China: Jianwen LI, Zhou YI, Jiemin SHEN
 - European Union: Dominic HAYES
 - India: S. SAYEENATHAN
 - Japan: Yoshimi OHSHIMA
 - Russia: Dmitry ARONOV, Alexey BOLKUNOV
 - United States: Frank CLARK

to be updated



2a

Recommendation 9A.2.1

- ICG members are encouraged to actively participate in the ITU-R and regional WRC-15 preparatory work on new IMT spectrum allocations to ensure that proposals do not impact existing and future GNSS operations.
- The ICG members are recommended, when considering candidate bands for IMT below 3 GHz, to encourage their administrations to ensure the protection of RDSS/RNSS from the unwanted emissions from those candidate bands, including adjacent band interference, spurious interference and harmonic interference, as a result may require the implementation of more stringent limits for IMT unwanted emissions levels in RDSS/RNSS bands.
- Members may also consider forming links with other satellite groups already defending satellite spectrum.

STATUS: keep continued



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2a

Rec. 9A.2.1 implementation Summary of RNSS Spectrum Protection

- ITU-R studies and regional positions for WRC-15 agenda item 1.1, show little danger for interference into RNSS by new IMT spectrum identifications
 - WRC-15 should be watched to ensure the protection of RNSS allocations
- ITU-R studies for WRC-15 agenda item 1.2 show no danger for interference into RNSS by intermodulation from 700 MHz band
 - The 700 MHz band mobile service channel plans under WRC-15 agenda item 1.2 is also encouraged to be monitored at WRC-15.

2a

Rec. 9A.2.1 implementation Action Assigned to Compatibility Sub-Group

- Review existing electromagnetic emissions limits from all non-licensed transmitters (for example, hairdryers, escalators) in all RNSS bands and determine whether existing unwanted emissions limits are sufficient to protect GNSS reception.

2a

Rec. 9A.2.1 implementation Summary

Non-licensed emission limits in RNSS bands (L-band) are summarized as shown below;

Countries	Intentional radiation limits from radio sources other than allocated services (Domestic Regulations)	Electromagnetic emission limits from ISM equipment (IEC/CISPR Publication 11)
EU, Russia, China	Emissions from radio sources other than allocated services is not allowed.	e.i.r.p. levels of -33 to -55 dBW/MHz are applied.
US, Canada, Brazil	Emissions with e.i.r.p. of lower than -71.2 dBW/MHz is generally allowed.	In the band 1215-1300 MHz, the e.i.r.p. level of -77.8 dBW/MHz is applied
Japan, Korea	Emissions with e.i.r.p. of lower than -94.3 dBW/MHz is generally allowed.	

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2a

Possible Way Forward

Non-licensed emissions can be classified into the following two categories;

- i) **Intentional radiation limits from radio sources other than allocated services:** No common international guideline and various domestic regulations
- ii) **Electromagnetic emission limits:** Though international standards such as IEC/CISPR, domestic regulations may vary.

GNSS providers and users are encouraged to check the applicable domestic regulations (both i) and ii)) to protect GNSS receivers, since there are potentially other limits than checked here. (for example, see back-up slides)

Since there may be more appropriate interference models, further studies (including watching the activities of relevant international organization) are also encouraged.

2a

Draft Recommendation 10A.2 for ICG-10 **Campaign of Protection of RNSS operations**

- The ICG recommends that GNSS providers and GNSS user community member states promote the implementation of protection measures of GNSS operations in their nations and/or regions [of the world] as well as other parts of the world.

2a

Draft Recommendation 10A.2 for ICG-10 **Campaign of Protection of RNSS operations**

- The ICG recommends that GNSS providers and GNSS user community member states promote the implementation of protection measures of GNSS operations in their nations and/or regions [of the world] as well as other parts of the world.

Co-chairs believe that minor text revisions are needed

2a

Draft Recommendation 10A.3 for ICG-10 **UN COPUOS Agenda Item on Spectrum Protection and IDM**

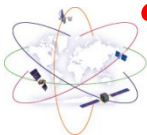
- UN COPUOS, based on a presentation to the Science & Technology Subcommittee (STSC), should establish a multi-year agenda item focused on National Efforts to protect RNSS Spectrum, and pursue GNSS Interference Detection and Mitigation in member states
- Under this agenda item, Member States will be asked to report:
 - National RNSS Spectrum Allocations and consistency with ITU Allocations
 - Regulations regarding Non-licensed emissions limits from RF emitters and non-emitters
 - Planned or existing Laws and Regulations related to the manufacture, sale, export, import, purchase, ownership, and use of GNSS jammers
 - Domestic efforts to detect and mitigate GNSS interference

WG-A should prepare a presentation on its spectrum protection and IDM activities for the February 2016 session of the UN COPUOS STSC

2b

(Current) Work Plan – Open Service Information Sharing

- 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 on a non-discriminatory basis. The Working Group will develop a template to promote common terminology and definitions in individual GNSS Open Service Signal Specifications.
- The Working Group 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.
- *As requested by a provider or providers, the working group will assist in exchanging information with ICG participants important to resolving GNSS open service anomalies that impact users.*

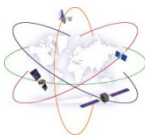


2b

Compatibility & [Performance Standard Sub-group]

- Co-chairs:
 - **Takahiro MITOME, Japan**
 - **Dominic HAYES, EU**
- Members:
 - China: Jianwen LI, Zhou YI, Jiemin SHEN
 - European Union: Dominic HAYES
 - India: S. SAYEENATHAN
 - Japan: Yoshimi OHSHIMA
 - Russia: Dmitry ARONOV, Alexey BOLKUNOV
 - United States: Frank CLARK

to be updated



2b

Status of Open Service Performance Standards

- **Action to WG-A:** Representatives from each system provider should review the draft template and prepare feedback for presentation and discussion at the ICG-7 meeting of WG-A
- **Status:** At WG-A in ICG-8, the status of each system provider's review was checked.
- **Major Activities to date:** It was agreed to develop a standard template for all open signals in all frequency bands. As the starting point, a specific band (e.g., the band 1164-1215 MHz) will be used for determining parameters and other frequency bands will be added as the template evolves.



2b

Proposed Way Forward

New target dates of completing this Action should be agreed soon.

The collaboration with International GNSS Monitoring and Assignment Task Force should also be continued.

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SPECTRUM PROTECTION & IDM



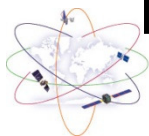
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3

(Current) Work Plan

Spectrum Protection (user level) & IDM

- The Providers Forum has agreed to pursue the protection of radionavigation satellite service (RNSS) spectrum through appropriate domestic and international regulation.
 - When necessary and appropriate, the Working Group will facilitate Provider discussions on their individual views and actions related to RNSS spectrum issues and agenda items under consideration by the ITU and its Working Parties.
- The Working Group will develop a strategy for ICG support of mechanisms to detect and mitigate sources of electromagnetic interference, taking existing regulatory mechanisms into consideration. This could lead to concrete proposals for detecting interference.



3

Interference Detection Task Force

(as of 12 June 2015)

- **Co-Chairs:**

- **Rick Hamilton, USCG, Co-lead** stephen.r.hamilton@uscg.mil
- **Weimin Zhen, China, Co-lead** crip_zwm@163.com

- **Members:**

- Attila Matas, ITU attila.matas@itu.int
- Matteo Paonni, EC JRC matteo.paonni@jrc.ec.europa.eu
- Stanislav Kizima, Vector, Russia kizima@vemail.ru
- Dmitry Buslov, Vector, Russia dmitry.aist@gmail.com
- Ivan Malay, Russia malay@vniiftri.ru
- TANG Jing, China blazingtangjing@163.com
- WEN Xiong, China crip_xw@163.com
- SHEN Jiemin, China shenjiemn@bsnc.com.cn
- Hidero Katayama, Japan hidero.katayam@cao.go.jp
- Takahiro Mitome, Japan takahiro.mitome.xp@hitachi.com
- Yoshimi Ohshima, Japan y-ohshima@cb.jp.nec.com
- Hiroaki Maeda, Japan Hiroaki.Maeda@LighthouseTC.jp



3

Interference Detection Task Force Preliminary Work Plan

Initially the task force will focus on developing a common set of information to be reported to GNSS civil service centers.

- The U.S., China and the ITU have presented existing interference reporting forms that are used to report interference
- The task force leaders will distribute the forms to the members of the task force and coordinate by e-mail. Findings and decisions will be reported to the next IDM workshop

Next the task force will focus on establishing routine communications among the (provider service) centers.

- Some center activities are more mature than other emerging providers organizations. Best practices will be shared by e-mail and the task force members agreed to share “after action reports” of interference activity on a regular basis.

Finally, the task force will develop guidelines for common capabilities to be considered in the development of future national IDM networks.

- The task force agreed that presentations could be made at future IDM workshops and that providers will come prepared to brief capabilities being considered.



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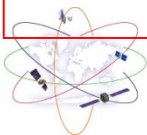
ICG-8 Recommendation 8A.3.1

Education & Outreach Regarding Sources of GNSS Interference

- The ICG should develop educational material such as a downloadable pamphlet or other web content on sources of interference to GNSS. The material should include an explanation why radio navigation satellite services (RNSS) are different than radio communications services and more vulnerable to interference, and will emphasize the importance of GNSS services to critical public and private sector functions, infrastructure, and economic activity

The WG-A Task Force on Interference Detection will lead the development of sample educational material on GNSS Interference for ICG consideration

Implementation of this recommendation has been moved from the IDM Task Force to the Compatibility Sub-Group



3

GNSS as Critical Infrastructure (as reported at ICG-9)

US	RU	China	EU
There is official Critical Infrastructure definition	There is no official Critical Infrastructure definition	There is no official Critical Infrastructure definition	There is official Critical Infrastructure definition
GPS is not a critical infrastructure	Navigation is a critical technology	BeiDou is Essential Space Infrastructure	Galileo will be designated as critical infrastructure
GPS integrated in most of all critical infrastructures	GLONASS is integrated in most of all priority development directions of science and technique	Beidou is integrated in most of all economy branches	Galileo service is critical to Energy and Transport critical infrastructure sectors



3 GNSS Jammers – National Legal Status (As Reported at ICG-9)

Jammers	US	RU	China	EU
manufacture	illegal	illegal	illegal	Nation-by-nation
sell	illegal	illegal	illegal	illegal
export	illegal	illegal	illegal	Nation-by-nation
purchase	Undefined (consumer import illegal)	illegal	illegal	illegal
own	legal	Undefined	Undefined	legal
use	illegal	illegal	illegal	illegal



3

4th IDM Workshop & Inter-sessional Task Force Meeting

Vienna, Austria

10-11 June 2015



3 Agenda of 4th Workshop – 10 June 2015, Vienna

- Introduction
- Discussion of recommendation/outcomes from previous Workshop:
 - Unintentional interference levels
 - Crowd Sourcing interference detection techniques
 - GNSS as International Critical Infrastructure
 - Adjacent Band Compatibility
 - Status update on the recommendations from ICG-9
- Interference Detection and Geo-Location Capabilities
- New Discussions
 - Back-up systems: Is a backup practical?
 - Spoofing
 - Workshop views and recommendations
- Adjourn

3

Recommendation 9A.3.1

The ICG recommends that GNSS providers and GNSS user community member states evaluate existing and emerging interference detection, localization, and characterization capabilities and consider developing, testing and implementing these or similar capabilities in their nations or regions of the world

STATUS: continue to implement



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3

Rec. 9A.3.1. implementation IDM Geolocation Systems

Discussed at June 2015 IDM Workshop

- Harris Corporation presented information about their Signal Sentry 1000 system, demonstrating a real-time geolocation system
- Consensus that all existing sensors should be tied into detection network, then add in other capabilities as they are developed
- IDM geolocation capabilities at ports in the U.S. are tied to Government intervention through regulation or legislation
 - Workshop attendees discussed a potential recommendation from the ICG to UN COPUOS that would suggest the same approach in other nations

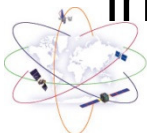


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Rec. 9A.3.1. implementation

EMI Spatial Distribution Analysis

- Design Bureau «Vektor», Russia presented General guidelines and a practical example of the analysis of the spatial distribution of emissions in the frequency bands of GNSS from a ground monitor station
- The spatial distribution of emissions in the frequency bands of GNSS:
 - provides meaningful characterization of the detailed electromagnetic environment;
 - helps to detect the interference impact on GNSS
- The proposed approach to obtain data from practical measurement and assessment techniques is aimed at a comprehensive analysis of the electromagnetic interference situation in the GNSS radio frequency bands
- The results could be used as a basis for guidance on needed measurements and data processing and operational recommendations to develop special GNSS interference monitoring equipment



3

Recommendation 9A.3.2

System providers and user community member states are encouraged to work with industry groups to determine if standards for crowd sourcing interference detection and localization techniques should be developed and cost-effectively implemented by mobile telecom service providers.

STATUS: keep continued



3

Rec 9A.3.2 Implementation

Crowd Sourcing for Interference Detection

- Discussed at June 2015 IDM Workshop
 - Suggestion that it might be better for detection networks to begin with cell-towers instead of mobile phones
 - Volume of data from nation-wide system may not be practical; regional monitoring centers might be more realistic.
 - Consensus that efforts aimed at initiating crowd-sourcing should begin with discussions between Task Force and individual companies before approaching user industry organizations such as 3GPP
 - Industry may be reluctant to act without market demand or government intervention through laws or regulations

Way Forward

- **WG-A requested Task Force** to invite industry representatives to WG-A Meeting at ICG-10 to show how crowd-sourcing would work and discuss the feasibility
- Crowd Sourcing may also be discussed further at the next IDM Workshop

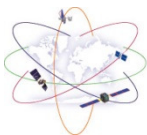


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Recommendation 9A.3.3

The ICG Executive Secretariat, in coordination with the IDM taskforce, should organize United Nations workshops on RNSS spectrum protection and IDM for governments of user community member nations in order to protect the worldwide utility and benefits of GNSS.

- A proposal focused on educating UN member state administrations regarding RNSS spectrum management approaches and IDM capabilities will be developed for consideration by the ICG
- Participating member state administration representatives will be encouraged to Provide information as to whether it is legal within their country to: manufacture, sell domestically, export, import, purchase, own, or use GNSS jammers



3

Rec 9A.3.2 Implementation

Planned UN Experts Workshop: 14-18 December 2015

- Will include session (1-2 days) devoted to Spectrum Protection and IDM
- Task Force agreed to help organize this session
- Task Force will assist in developing agenda and encourage appropriate experts to participate
- Will include presentations from WG-A participants focused on the IDM work taking place in the ICG

Based on the success of the Spectrum/IDM session in December, WG-A and the ICG Secretariat will pursue additional sessions at upcoming UN Space Applications Program GNSS Workshops and/or events held by UN GNSS Regional Centers



ICG International Committee on
Global Navigation Satellite Systems

Draft Recommendation for ICG-10

- UN COPUOS, based on a presentation to the Science & Technology Subcommittee (STSC), should establish a multi-year agenda item focused on National Efforts to protect RNSS Spectrum, and pursue GNSS Interference Detection and Mitigation in member states
- Under this agenda item, Member States will be asked to report on:
 - [National RNSS Spectrum Allocations and consistency with ITU Allocations]
 - Planned or existing Laws and Regulations related to the manufacture, sale, export, import, purchase, ownership, and use of GNSS jammers
 - Domestic efforts to detect and mitigate GNSS interference

WG-A should prepare a presentation on its spectrum protection and IDM activities for the February 2016 session of the UN COPUOS STSC

3

Additional Workshop/Task Force Agenda Items

Unintentional Interference

- China presented their regulatory limits and pointed out that they are more strict than FCC Part 15 regulations.
- Co-Chairs of WG-A informed the workshop that this work had been moved to the Compatibility subgroup.

Critical Infrastructure

- The representative from China explained that the GNSS signals in China are treated as National Essential Space Infrastructure.
- It was consensus that the Task Force/WG-A has exhausted the work on this item for now

Back-Up Systems

- It was suggested that back-up systems would not be used without a government mandate
- There is some indication of discussion at IMO of mandating carriage requirements for terrestrial signals
- It was the consensus of the workshop that this topic is currently outside the scope of the ICG

3

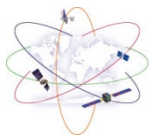
Next Proposed Workshop – May 2016

- China expressed interest in hosting the next IDM Workshop
- To be held in conjunction with the 2016 China Satellite Navigation Conference (CSNC)



4

INTERNATIONAL OPEN SERVICE MONITORING AND ASSESSMENT



ICG International Committee on
Global Navigation Satellite Systems

4

(Current) Work Plan - Service Performance Monitoring

- The Providers Forum has agreed to consider the development and discussion of proposals to widely monitor the performance of their open signals and provide timely updates to users regarding critical performance characteristics such as timing accuracy, positioning accuracy and service availability.
- Working Group A will support this activity by focusing on potential cooperation in the development of the necessary ground infrastructure to monitor signal and service performance for open services, recognizing that the actual implementation of this infrastructure is subject to the budgetary limitations of each system provider, and the completion of provider-to-provider agreements as necessary and appropriate.

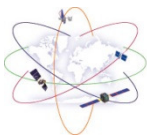


4

IGMA Task Force

- Co-Chairs:
 - Satoshi Kogure, JAXA, Japan
 - Xurong Dong, CSNO, China
 - Ruth Neilan/Urs Hugentobler, IGS
- Members:
 - Oleg Denisenko, Russia
 - Igor Silvestrov, Russia
 - LI Jianwen, China
 - Hiroaki Tateshita, Japan
 - Karen Van Dyke, United States
 - Hillar Tork, European Union
 - Werner Enderle, ESA

to be updated



4

Origin of IGMA Task Force

- International GNSS Monitoring and Assessment (IGMA) Task Force was established at ICG-6 meeting in Tokyo, 2011. (At that moment, it was called IGMAS Sub Group)
- Discussion through several meetings, tasks were defined and re-named as IGMA TF at ICG-8 in Dubai. (see Rec. 8A.4.1)



4

ICG-8 Recommendation 8A.4.1

- The task of the joint IGMA sub-group of WG-A, B & D will be to:
 - Determine Service Parameters to Monitor – definition and methodology to be coordinated with WG-A Compatibility sub group study
 - Determine what gaps exist in current and planned monitoring and assessment
 - Consider organizing workshop on IGMA parameters, services and methodologies
 - Recommend what should be monitored by:
 - Individual GNSS monitoring/control segments
 - Shared sites of 2 or more GNSS through bilateral agreements
 - Global monitoring of Multi-GNSS parameters
 - Propose an Organizational Approach that:
 - Avoids Duplication
 - Coordinates and integrates the related activities for identifying parameters
 - Considers the role of the current/planned IGS and
 - Defines the Relationship of the proposed organization to ICG
 - Explore methods to disseminate monitoring and assessment results, considering specific proposals from system providers



4

Status of Tasks from Recommendation 8A.4.1 (1/2)

- The task of the joint IGMA sub-group of WG-A, B & D will be to:
 - Determine Service Parameters to Monitor – definition and methodology to be coordinated with WG-A Compatibility sub group study

Open: Action is required. Create new recommendation 10A(D).4

- Determine what gaps exist in current and planned monitoring and assessment

Open: Action is required. Create new recommendation 10A(D).4

- Consider organizing workshop on IGMA parameters, services and methodologies

Closed: Two workshops were held;

- June 2014, Pasadena in conjunction with IGS Workshop 2014
- May 2015, Xian in conjunction with CSNC 2015



4 Status of Tasks from Recommendation 8A.4.1 (2/2)

- Recommend what should be monitored by:
 - Individual GNSS monitoring/control segments
 - Shared sites of 2 or more GNSS through bilateral agreements
 - Global monitoring of Multi-GNSS parameters

Open: Action is required. Create new recommendation 10A(D).4

- Propose an Organizational Approach that:
 - Avoids Duplication
 - Coordinates and integrates the related activities for identifying parameters
 - Considers the role of the current/planned IGS and
 - Defines the Relationship of the proposed organization to ICG

Open: Action is required. Create new recommendation?

- Explore methods to disseminate monitoring and assessment results, considering specific proposals from system providers

Closed: Refer to recommendation 9A.4.1 as revised



4

REVISED Joint WG-A, B, D Recommendation 9.4.1

- *WG-A recommends that existing monitoring service centers for GNSS open services establish a link to [the a] new ICG portal designed by the [ICG Secretariat ~~IGMA Task Force~~].*
 - *This portal will allow GNSS users worldwide to easily find GNSS monitoring information and products by just looking for the ICG webpage.*
 - *Eventually, open service monitoring and analysis centers linked to the ICG portal will use an ICG-recommended list of open service parameters to be monitored that are defined and calculated using accepted techniques and procedures based on a consensus among GNSS service providers.*



4

Existing Civil Service Monitoring Information Sources

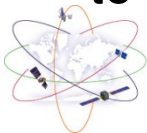
Name	Country	URL
Information Analysis Center	Russia	http://glonass-iac.ru/en/
US Coast Guard Navigation Center	U.S.	http://www.navcen.uscg.gov/
William J. Hughes Technical Center WAAS Test Team	U.S.	http://www.nstb.tc.faa.gov/index.htm
European GNSS Service Centre	EU	http://www.gsc-europa.eu/
iGMAS Service Center	China	
QZ-vision	Japan	http://qz-vision.jaxa.jp/USE/en/index
	India	
IGS portal	IGS	http://igs.org/



4

Joint WG-A, B, D Recommendation 9.4.2

- An IGMA Workshop should be held in 2015 for potential users and service providers in order to discuss the following:
 - Goal and purpose
 - Parameters to be monitored using the “Matrices” prepared by the TF
 - Organizational approach
 - Sharing portal
- The workshop will be held in Xi’an China, May 12, 2015 immediately preceding CSNC 2015
- Participation from the following organizations is expected:
 - Existing monitoring network operators, service providers
 - GNSS Providers
 - SBAS Operators
 - International network operators
 - Commercial service operators
 - User community representatives
- TF members should prepare the “Matrices”, categorizing the parameters to be monitored by the IGMA



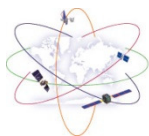
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Rec. 9.4.2 Implementation

Summary of IGMA Workshop

- The Workshop was held on May 12 in Xian in conjunction with China Satellite Navigation Conference (CSNC) 2015.
- 26 participants from US, Russia, China, Japan and IGS
- Goal and purpose, How to create the “Matrix” were discussed.
- Proposed matrix was simplified and set timeline to be submitted to co-chairs after filling out.

A more detailed summary report of the workshop can be presented by China at ICG-10



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WG-A Action to the IGMA Task Force

IGMA TF is requested to complete establishing Matrix until ICG-10 in the following ways;

1. TF co-chairs update the Matrix based on inputs provided by IGS and China.
 - Add to four columns inquiring if provider would like to monitor or not, and would like to ask other organization to monitor the parameter in order to distinct which parameters would be monitored in the proposed IGS pilot project. (ref. draft Rec 10A.7)
2. [Consult with the Compatibility subgroup regarding the inclusion of monitoring parameters derived from the current open service performance standards template]
3. Distribute the above updated matrix to TF members requesting to fill it out by the one Month before ICG-10.
4. If No feedback from providers, the updated matrix by co-chairs is decided as final draft to be presented at ICG-10.

4

Draft Recommendation 10A(D).4 for ICG-10 IGS Multi-GNSS Monitoring and Assessment Pilot Project

- Recognising:
 - The need for a global GNSS monitoring and assessment capability to assist with public confidence in GNSS service provision and interoperability
 - The role the International GNSS Service (IGS) has played in producing precise GNSS products since its inception in 1994, noting the evolution of products and services over time to meet user segment requirements
- The ICG recommends that the IGS initiate a Pilot project that will demonstrate a global GNSS Monitoring and Assessment capability
 - The results to date of the IGMA Task Force, such as the completed matrix of monitoring parameters, should be utilized by the IGS to design their multi-GNSS Monitoring and Assessment pilot project

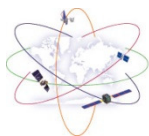
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IGS – IGMA Pilot project

- IGS is well placed to establish a Pilot Project for IGMA
- Invite participation from existing non-IGS analysis groups, networks and data centres
- Develop benchmarking between Groups and generate combined IGS products
- Cross sharing between existing IGS functional streams and IGMA activities benefit both

5

INTEROPERABILITY



ICG International Committee on
Global Navigation Satellite Systems

5

Interoperability Task Force

to be updated

- **Jeff Auerbach, USA - Co-lead** Auerbach@state.gov
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5

Interoperability Tasks from (Current) Work Plan

- Consistent with the principle of interoperability and its definition, **consider the perspective of various user applications and equipment manufacturers**
- **Continue efforts to survey** industry and user community experts
- **Sponsor and participate in workshops and meetings** designed to solicit GNSS user input



5

WG-A Request to Providers

- Determine interest in specific interoperability questions and answers
 - Provide all relevant future system and service plans to the task force related to signals, time, and geodesy
- Decide whether further interactions with industry will be pursued on issues of interest
- Provide this information to the Interoperability Task Force



5 Interoperability Workshops Hosted by GNSS Providers

- **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



5

Workshop Results and Analysis

- Providers presented their own view of the results and analysis of the workshops to the ICG
 - Differences due to variances in the way the workshops were conducted
- Questions and answers grouped together based on type of question
- Inconsistent results have made it difficult to analyze and develop recommendations based solely on the data from the workshops



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WG-A Guidance to Task Force (ICG-9)

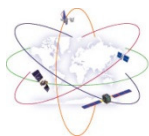
- Reach a consensus on the need for additional analysis
- Identify issues (Q's and A's) that should continue to be addressed collectively and issues that appear relevant only to specific providers
- Work with the EU/ESA to conduct a workshop in 2015
- Begin development of recommendations to Providers for WG-A consideration



5

Interoperability Task Force Meetings (2015)

- 27 January 2015: Dana Point, CA, U.S.
- 08 April 2015: Remote Participation
- 21 April 2015: Honolulu, HI, U.S.
- 11 June 2015: Vienna, Austria
- 13 July 2015: Gold Coast, Australia



5

Workshop Questions

Questions from ICG Interoperability Workshops		
No.	Question	Original Question No.
1	Do you prefer all new CDMA signals at “L1” to be centered at 1575.42 MHz or have some of them elsewhere, e.g., at 1602 MHz?	3
	Do you see a threat to GNSS receivers due to many more GNSS signals centered at 1575.42 MHz?	2
	Do you prefer signals in different “L1” frequency bands for interference mitigation rather than at one center frequency for interoperability? Why?	6
	Assuming signal quality is acceptable from every provider, would you limit the number of signals used by the provider or by other criteria? What criteria?	12
	Will the marketplace “force” you to make use of signals from every available constellation (i.e. GPS, GLONASS, Galileo, BeiDou, QZSS, IRNSS)?	14
2	To assure only “good” signals, should GNSS providers agree on minimum international signal quality standards and agree to provide only signals meeting the standard?	8
	If a satellite’s signals do not meet quality standards, what should happen: a. Be set unhealthy? b. Transmit with a nonstandard code? c. Transmit with reduced signal power (reduce interference)? d. Be switched off? e. Other method f. Other	7
3	For best interoperability, how important is a common center frequency? How important is a common signal spectrum (PSD)?	15
	Will you provide “tri-lane” capability in the future? Why?	16
	If so, do you prefer a common middle frequency or the combined use of L2 (1227.6), B3 (1268.52), and E6 (1278.75) if B3 and E6 open access is available	17
	Would you prefer a common open signal in S Band? In C Band? Why?	18
4	Should the international community strive to protect all GNSS signal bands from terrestrial signal interference?	25
5	If you are faced with having to pay royalties to use a particular signal due to a patent on the signal design, what would you be most likely to do: a. Pay the royalty? b. Use different signals that are not patented? c. Other? d. Not sure	34



5 Task Force Agreement on Method for Developing Recommendations

- Agreement/disagreement in answers could be useful information for Providers
- Relevance of questions may be more important than the detailed answers
- Only if a Provider considers making changes would further investigation be beneficial
- Focus on questions posed to industry as part of Interoperability Workshops

5

Conclusion: Protection of All GNSS Signals

The Interoperability Task Force [workshops] addressed the question of whether the international community should strive to protect all GNSS signal bands from terrestrial signal interference

[Based on the feedback received] the Interoperability Task Force [concludes] [~~recommends~~] that this issue continue to be addressed by the Compatibility Subgroup.



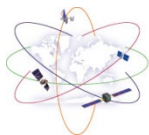
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Conclusion: Open Service Performance Standards

The Interoperability Task Force considered the wisdom and practicality of formulating a consensus-based Open Service Performance Standard representing the minimum level of performance to be expected from any GNSS signal from any GNSS Provider.

[The conclusion was that the benefit to users would not be sufficient to justify the time and effort required to create and approve a consensus standard.]

Interoperability Task Force recommends that WG-A continue pursuing an earlier effort to standardize performance parameters and clearly define the meaning of each performance parameter.



5

Draft Recommendation 10A.5 for ICG-10 Center Frequency of New CDMA Signals

For optimum interoperability it is preferable for all new CDMA signals in the “L1” band to be centered at 1575.42 MHz. However, (a) there is concern that with three global constellations (GPS, BeiDou, and Galileo) and one regional constellation (QZSS) having Open Signals centered at 1575.42 MHz, that adding more could undesirably increase the noise floor, (b) recognizing that new GLONASS L1 CDMA signals will be centered at 1600.995 MHz, (c) understanding that modern user equipment, from consumer products to high precision receivers, successfully use CDMA signals centered at 1575.42 MHz as well as multiple FDMA signals at higher frequencies, including 1600.995 MHz, and (d) realizing there is potential benefit with frequency diversity to enable continued operation even if significant interference is present at one of the center frequencies:

Recommendation:

For any new open GNSS CDMA signal, the ICG should request the Provider to employ a center frequency which is identical to the center frequency employed in that band by another Provider, but only after successful ITU Compatibility coordination with the incumbent provider(s).



Draft Recommendation 10A.4 for ICG-10

Center Frequency of New CDMA Signals

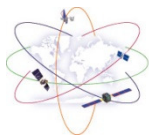
For optimum interoperability it is preferable for all new CDMA signals in the “L1” band to be centered at 1575.42 MHz. However, (a) there is concern that with three global constellations (GPS, BeiDou, and Galileo) and one regional constellation (QZSS) having Open Signals centered at 1575.42 MHz, that adding more could undesirably increase the noise floor, (b) recognizing that new GLONASS L1 CDMA signals will be centered at 1600.995 MHz, (c) understanding that modern user equipment, from consumer products to high precision receivers, successfully use CDMA signals centered at 1575.42 MHz as well as multiple FDMA signals at higher frequencies, including 1600.995 MHz, and (d) realizing there is potential benefit with frequency diversity to enable continued operation even if significant interference is present at one of the center frequencies:

Potential ICG Recommendation:

[For most applications, f] For any new open GNSS CDMA signal, the ICG should request the Provider to employ a center frequency which is identical to the center frequency employed in that band by another Provider, but only after successful ITU Compatibility coordination with the incumbent provider(s).

Russia – believes this needs additional study before forwarding to the Committee

Alternate Text from China



5

Draft Recommendation 10A.6 for ICG-10

Protection from Provider Signal Patents

Recognizing that at least one [GNSS Provider nation] filed patents on signal structures and demanded payment of royalties by users of such signals and/or from manufacturers of receivers using such signals.

Recommendation:

ICG members and participants should declare open service signal structure patents contrary to the spirit of international GNSS cooperation and GNSS Providers should consider modifying their signals, either temporarily or permanently, so use of such signals will not be subject to patent claims. In addition, the ICG should call on nations which have issued or may issue such patents to invalidate these patents. Further, the ICG should call on all nations, individually and/or collectively, to oppose the application of any such patents by diplomatic or by other means.



5

Draft Recommendation 10A.6 for ICG-10

Protection from Provider Signal Patents

Recognizing that at least one [GNSS Provider nation] filed patents on signal structures and demanded payment of royalties by users of such signals and/or from manufacturers of receivers using such signals.

Alternate Text from the Co-chairs

Recommendation:

ICG members and participants should declare open service signal structure patents contrary to the spirit of international GNSS cooperation and GNSS Providers should consider modifying their signals, either temporarily or permanently, so use of such signals will not be subject to patent [infringement]claims. In addition, the ICG should call on nations which have issued or may issue such patents to [abandon these patents or applications or dedicate them to the public domain] ~~invalidate these patents~~. Further, the ICG should call on all nations, individually and/or collectively, to oppose the application of any such patents by diplomatic or by other means.



Draft Recommendation 10A.5 for ICG-10

Protection from Provider Signal Patents

Recognizing that at least one [GNSS Provider nation] filed patents on signal structures and demanded payment of royalties by users of such signals and/or from manufacturers of receivers using such signals:

Alternate Text from China

Potential ICG Recommendation:

ICG members, participants [and international GNSS industries] should consider that demanding payment of any kind for [open] signal structure patents is] contrary to the spirit of international GNSS cooperation and GNSS providers should ~~consider modifying their signals, either temporarily or permanently, so use of such~~ [fully consider whether current and future] signals will ~~not~~ be subject to patent claims. In addition, the ICG should call on nations [and industries] which have issued or may issue such patents to [make publically available these patents at suitable time.] ~~invalidate these patents. Further, the ICG should call on all nations, individually and/or collectively, to oppose the application of any such patents by diplomatic or by other means.~~



5

Draft Recommendation 10A.7 for ICG-10 Cross-Referencing System Times

Given that: (a) with visibility of signals from multiple satellites from two or more Provider systems a GNSS receiver can autonomously determine system time differences with greater accuracy than can be provided by messaging, (b) the main purpose of time difference messages (e.g., GGTO) is to permit rapid navigation when only a few signals from two or more systems are first available, i.e., primarily for urban users who demand a very rapid time to first fix, (c) the time required to acquire signals and demodulate messages is at least 20 seconds and often much longer, (d) system time differences are slowly changing and thus can be “remembered” from a previous determination, and (e) other communication systems, e.g., WiFi and cell phone messaging, can deliver system time differences not only quicker but prior to need.

Recommendation

- Providers should agree on an organization which can monitor system time differences on a global basis and supply each Provider with its system time offset relative to the [ensemble time (defined?)] so each provider can transmit that offset information in its GNSS message. It is envisioned that all system offsets also would be provided via the Internet or other means of communication
- [The concept of monitoring individual system times to develop a GNSS **ensemble** time should be discussed at a focused workshop to be held in conjunction with the IGS Workshop to be held in Sydney, February 2016]



5

Draft Recommendation 10A.7 for ICG-10 Cross-Referencing System Times

Given that (c) with visibility of signals from multiple satellites from two or more Provider systems, Russia – does not support a time monitoring organization.

great Workshop is acceptable

difference messages (e.g., GGTO) is to permit rapid navigation when only a few signals

from Japan – has concerns about implementing "ensemble" time in receivers

changing and thus can be "remembered" from a previous determination, and (e) other

com USA – not prepared to support a time monitoring organization or a workshop.

Rec – Providers already plan to provide bilateral system time offsets

- Providers should agree on an organization which can monitor system time differences on a global basis and supply each Provider with its system time offset relative to the [ensemble time (defined?)] so each provider can transmit that offset information in its GNSS message. It is envisioned that all system offsets also would be provided via the Internet or other means of communication
- [The concept of monitoring individual system times to develop a GNSS **ensemble** time should be discussed at a focused workshop to be held in conjunction with the IGS Workshop to be held in Sydney, February 2016]



