Report of the Systems, Signals and Services Working Group (formerly Working Group A)

1. The International Committee on Global Navigation Satellite Systems (ICG) Working Group A (WG-A) on Compatibility and Interoperability met Tuesday, Wednesday and Thursday, 03-05 November 2015, in Boulder, Colorado, United States, under the co-chairmanship of Mr. Sergey Revnivykh, Russian Federation, and Mr. David Turner, United States of America (U.S.).

2. After brief welcoming remarks, the co-chairs reviewed the agenda noting the 6 sessions corresponding to the Work Plan of the Working Group, plus a 7th session on revisions to the work plan. The agenda was adopted, with a request from the European Union (EU) to add a presentation on spectrum protection under the session on GNSS Compatibility. Mr. Revnivykh on behalf of WG-A co-chairs, noted that this meeting's discussions will be based on ideas that were discussed during the intersessional meetings earlier in 2015.

3. The co-chairs then began **Session 1** of the agenda covering **System Provider Updates** by explaining that this session was designed to offer Providers the opportunity to present any new information that was not covered during the opening Plenary Session. The U.S. asked a question about whether the Beidou differential service will provide corrections to GPS. China responded that their system will augment all GNSS including GPS and BeiDou, noting that it will follow the RTCM format. The U.S. also announced that a GPS Public Interface Control Working Group and Public Forum will take place 9-10 December 2015 in El Segundo, CA to discuss Interface documents, and the meeting is open to public.

4. **Session 2, GNSS Compatibility,** was divided up into two parts. **Part 1, Spectrum Protection**, began with a presentation by Mr. Dominic Hayes from the European Union. Mr. Hayes provided a description of the role of the European Commission (EC) with regards to spectrum protection in Europe, and explained the EU policy on GNSS jamming. He noted that the EC is an active member of the International Telecommunications Union (ITU) Working Party 4C, which develops recommendations on GNSS spectrum protection. He also highlighted some of the work being done in Europe on jamming detection and mitigation, including Jamming Trials in Aachen, Germany. He explained that the EU DETECTOR System, completed in 2013 and developed into a commercial project, contains a monitoring network which is being expanded to include international partners.

5. The co-chair of the Compatibility Subgroup, Mr. Dominic Hayes, presented the report on the activities of the subgroup. He discussed the response to a previous action for the Compatibility Subgroup to review emissions limits from non-licensed transmitters, and explained that there are no common international guidelines for radiation limits, while domestic regulations vary. Draft ICG-10 Recommendation 1, *Campaign of protection of RNSS operations*, was also reviewed and consensus within the Working Group was reached on the draft text. Draft ICG-10 Recommendation 2, *UN COPUOS Agenda Item on Spectrum Protection and IDM*, was also reviewed. Mr. Turner explained that currently there is a lack of information from non-GNSS providers about spectrum protection and Interference

detection and mitigation (IDM), and the large COPUOS membership provides an excellent opportunity to expand beyond what can be achieved within the ICG. No comments to the draft text of the recommendation were raised.

6. **Session 3, Interference Detection and Mitigation**, continued with a presentation by Mr. Dana Goward from the U.S., titled "Almost Everything Depends…". The presentation discussed the concepts of protect, toughen and augment (PTA) for GNSS. Mr. Goward discussed the impacts of GNSS jammers, and expressed that he believes multiple systems are needed for robustness. He explained that Loran is currently available in the UK for navigation and timing, and the U.S. is currently looking into the feasibility of developing an enhanced-Loran system. A question from the EU was asked about the status of spoofing. Mr. Goward responded that the situation is similar to jamming, and it would be helpful to put out more information about the problem to get attention and raise awareness. The EU noted that politicians and legislators are not really aware of the problem and it is important to make them aware that jammers are more than personal privacy devices.

7. The Working Group co-chairs reviewed the section of the Working Group work plan covering IDM, as well as the list of current members of the IDM Task Force. Mr. Weimin Zhen and Mr. Jiemin Shen from China continued with a presentation "Review of IDM Technology". The presentation offered a review of the classifications of interference, to include intentional and unintentional. They also discussed detection and localization techniques and provided some feedback on the advantages and disadvantages of cellular phone crowd sourcing as a technique for detecting GNSS interference. They suggested that a "Cell Tower RFI Localization Method" might be easier to implement than crowd sourcing. Finally they reminded the Working Group about the next IDM Workshop, which China has agreed to host in conjunction with the China Satellite Navigation Conference in Changsha, China in May 2016.

8. A presentation by Mr. Logan Scott, from the U.S., was given on "J911: The Case for Fast Jammer Detection and Location Using Crowd Sourcing Approaches". Mr. Scott discussed how crowd sourcing can be used to locate a source of interference down to a 40 meter area and can also identify the type of jammer being used. Getting a position does not require a large number of phones. However the accuracy is improved with more phones providing input. He believes that in the U.S., the concept could be adopted in 5-8 years once a decision was made to pursue this, and a real world validation should take place to confirm the analysis. China asked a question about software required for the phone and privacy concerns with implementing crowd sourcing. Mr. Scott explained that no special software is required for the phone, but an access point is needed to access the data. He also noted that individual users could have the ability to opt out of providing crowd sourced information. The EU asked about the impact to a phone's battery life. Mr. Scott indicated that the impact to a phone's battery life would be small and that the time to detect the interference is less than 1 millisecond.

9. The session on IDM continued with a report on the activities of the IDM Task Force from the co-chairs, Mr. Rick Hamilton and Mr. Weimin Zhen. They noted that Recommendation 8.A.3.1 from ICG-8, *develop educational material on GNSS*, is not yet complete. They also summarized the discussions that took place at the 4th IDM Workshop held on 10 June 2015 in Vienna, Austria. This included addressing Recommendation 9A.3.1, geolocation techniques, and Recommendation 9A.3.3, UN Workshop on IDM. It was noted that the UN will host an ICG Experts Meeting 14-18 December 2015 in Vienna, which will have a special session on Spectrum Protection and IDM. If successful, this could be could be an agenda item for future regional workshops and meetings. There was some discussion about a conclusion from the IDM Workshop that back-up systems to GNSS should be discussed at future workshops. The co-chair, Mr. Turner, noted that back-up systems are not addressed in the Working Group work plan and it might be more appropriate to use the term complimentary systems. This will require further deliberation from the Working Group and should be discussed at the next IDM Workshop. Finally, draft Recommendation 2, *UN COPUOS Agenda Item on Spectrum Protection and IDM,* was reviewed again and it was noted that 61 countries participated in the UN COPUOUS Scientific and Technical Subcommittee meeting in 2015.

10. The meeting continued with **Session 2, Compatibility**, **Part 2: Open Service Performance Standards.** Mr. Alexey Bolkunov, Russian Federation, began with a presentation "GLONASS and GNSS Performance Standards: Status and Plans". Mr. Bolkunov outlined a concern that currently there is no roadmap or tracking progress on a GNSS performance standard. He suggested that a document outlining the objectives is needed, and that a roadmap and scorecard for tracking progress be established. This led to a discussion on the way forward, and general consensus was reached that it is not beneficial to develop a single document at the current time. The Working Group co-chairs suggested that Providers share information about their plans for developing performance standards with the working group, and further discussions should be held about the value of working together to make individual performance standards common to the extent possible.

11. A joint session with Working Groups B, C and D was held on 04 November 2015. **Session 4, Open Service Information Sharing and Service Performance Monitoring,** was conducted during the joint session. Starting off the session, Mr. Alexey Bolkunov, Russian Federation, presented "International GNSS Monitoring and Assessment System: System-Level". Mr Bolkunov discussed his recommendations on the way forward, including: 1. Complete the list of monitored parameters; 2. Develop a short list of parameters for monitoring; 3. Agree on parameter calculation methods; 4. Develop a roadmap of actions to be completed.

12. Mr. Satoshi Kogure, Japan, provided the report of the International GNSS Monitoring and Assessment (IGMA) Task Force. He reviewed previous activities and recommendations for the Task Force, including Recommendation 8A.4.1, determining monitoring parameters. Mr. Kogure noted that this recommendation is still open, but this topic was discussed during the May 2015 IGMA Workshop held in Xi'an, China (Recommendation 9A.4.2). He also explained that Recommendation 9A.4.1, ICG portal designed by ICG, is being revised as new Recommendation 3, *ICG Open Service Monitoring Information Portal.*

13. The joint session with Working Groups B, C and D continued with a U.S. presentation and discussion on Space Service Volume Standards. For further details about this session, please see the Report of the Working Group on Enhancement of GNSS Performance, New Services and Capabilities (formerly Working Group B). The co-chair of the Working Group on Systems, Signals and Services, Mr. Turner, presented to the joint session the proposed changes to the work plan of the Working Group, including officially changing the name of the Working Group. The co-chair of the Working Group on Enhancement of GNSS Performance, New Services and Capabilities, Mr. Stefan Wallner from ESA, also presented proposed changes to the their work plan.

14. **Session 5, GNSS Interoperability**, began with a joint presentation by the Russian Federation, Mr. Igor Silvestrov, titled "System Time Scales Interoperability Approach". Mr. Silvestrov explained that GNSS timescales are generated based on UTC, and offsets for GPS and GLONASS are being published by BIPM and available online. Therefore a recommendation to create another time offset is not needed. This led to a discussion about a draft recommendation proposed by the Interoperability Task Force at the intersessional meeting in July 2015, recommending cross referencing system time offsets. Mr. Jeffrey Auerbach and Mr. Tom Stansell, from the Interoperability Task Force, briefly explained how the recommendation was developed based on the industry feedback received from the Interoperability Workshops. Russia noted that this would be complicated. The U.S. commented that receivers can already calculate the offsets, and GNSS Providers' provide an offset in their Interface Control Document relative to GPS. GNSS biases are removed and this does not put the U.S. in a special position. The EU suggested that it is much simpler to continue using GPS as the baseline, the way it is currently being done by. Finally, China explained that BDS time is tied to UTC and a multi-constellation receiver is used to calculate an offset relative to UTC. Based on all of the comments, the Task Force co-chairs concluded that the recommendation should not go forward, but that additional timing discussions take place within Working Group D.

15. The Session on Interoperability continued with Mr. Dominic Hayes from the EU briefly reviewing the Galileo reference documents, including: the Galileo Nequick Ionospheric Model, Galileo Signal in Space Interface Control Document, Galileo Signal in Space Operational Status Definition, and Service Definition Document. He noted that this information will be discussed within the Compatibility Subgroup. Dr. Xiaochun LU from China continued with a presentation on the "China GNSS Haoping Radio Observatory and Monitoring Results". She explained that China's 40m antenna in Haoping, China can receive all GNSS signals for monitoring, and due to its isolated location, it is a controlled radio frequency environment with remote monitoring. She presented the results of recent monitoring for both BDS and other GNSS signals, and suggested that the ICG members consider working together on methods for monitoring. The Working Group co-chair, Mr. Turner, commented that this could be addressed during the IGMA Task Force meeting.

16. Mr. Grigory Stupak, Russian Federation, continued with a presentation on "Compatibility and Interoperability of GNSS: Further Discussions". The presentation discussed the definition of GNSS Interoperability and Orbital GNSS Compatibility, including some information about GLONASS graveyard orbits. Mr. Stupak suggested that we should think

about GNSS Interoperability in two parts: 1. Orbital interoperability (geometrical) and; 2. Signal interoperability (spectral, informational, etc.). The U.S. commented that we have passed the point where receivers are making a selection of which constellations to use. The EU noted that moving a few satellites will not result in significant improvements to the constellations from an interoperability perspective.

17. The co-chairs of the Interoperability Task Force, Dr. Xiaochun LU from China and Mr. Jeffrey Auerbach from the U.S., wrapped up the session with a review of the Task Force activities over the past year, including proposed recommendations and conclusions. The Task Force addressed the question of whether the international community should strive to protect all GNSS signal bands from terrestrial signal interference, and concluded that the issue should continue to be addressed by the Compatibility Subgroup. Recommendation 1, *Campaign of protection of RNSS operations*, addresses this issue. A comment was made that there might be benefit to discussing receiver design as part of the topic of spectrum protection. The Working Group co-chair, Mr. Turner, responded that this has not been discussed in the working group before, but the topic could be considered in a future workshop if there is agreement among the working group members.

18. Another conclusion from the Task Force was to continue pursuing an earlier effort to standardize performance parameters and clearly define the meaning of each performance parameter. This is in line with previous discussions, and there were no further comments about this conclusion from the Working Group members. The Task Force brought up a draft recommendation that Providers' should employ a center frequency identical to the center frequency employed in that same frequency band by another Provider. However, the Working Group members did not agree that this recommendation should be adopted, and concluded that the topic should be further discussed within the Task Force.

19. Finally, the Task Force introduced a draft recommendation on signal structure patents, declaring that demanding payment for such patents is contrary to the spirit of international GNSS cooperation. Both the EU and China suggested that although the intent of the recommendation is good, further discussion is required to rework the language before it can be adopted as an ICG recommendation. The Task Force agreed to continue discussing this over the next year, with the possibility of developing a revised recommendation for ICG-11.

20. **Session 7, Proposed Revisions to the Working Group Work Plan**, was led by the Working Group co-chairs, Mr. Revnivykh and Mr. Turner. They reviewed draft Recommendation 5, *Updated Work Plan Nomenclature for Working Group A*, and the draft changes to the work plan. Consensus was reached on the title of the Working Group being changed to: *The Working Group on Systems, Signals and Services.* The other proposed changes to the work plan were agreed to by the Working Group.

21. **Session 6, Conclusion**, was held on 05 November 2015. The Working Group co-chairs began by reviewing the recommendations, noting that the objective was to reach consensus for presentation to the full ICG at the Plenary session. Mr. Satoshi Kogure presented the revised language in draft Recommendation 4, *IGMA - IGS Joint Trial Project.* China suggested that signal quality monitoring should be added to the recommendation. There were no objections to this suggestion, and the recommendation was adopted by the Working

Group. Recommendation 1, *Campaign of protection of RNSS operations,* Recommendation 2, *UN COPUOS Agenda Item on Spectrum Protection and IDM*, Recommendation 3, *ICG Open Service Monitoring Information Portal,* and Recommendation 5, *Updated Work Plan Nomenclature for Working Group A*, were also reviewed and adopted by the Working Group without further comments.

22. The meeting concluded with a brief discussion about intersessional meetings of the Working Group and future subgroup/task force meetings and workshops. The co-chairs noted that June-July time frame works best for holding the intersessional meetings because it allows for enough time for work to take place between the meetings. The Working Group also agreed that they will make an attempt to combine meetings where possible and to hold the meetings in conjunction with other widely attended GNSS events to maximize participation. No dates or venue were identified for the intersessional meeting, but the co-chairs agreed to make a decision early enough to allow participants time to make their travel arrangements.

The full set of WG-A recommendations as adopted by the Committee at ICG-10 are enclosed.

Recommendation 1 (formerly 10A.2.1)

Prepared by: **Working Group on Systems Signals and Services**

Date of Submission: **05 November 2015**

Issue Title: **Campaign of Protection of RNSS Operations**

Background/Brief Description of the Issue:

By investigating the interference detection and monitoring for the protection GNSS, it was found that the accrual implementation of the protection measures of GNSS is becoming more important. For this purpose, it is essential to recognize the international regulations or guidelines such as ITU Radio Regulations and ITU-R Recommendations. However, it would be necessary to reflect these international Regulations/guidelines to each nation's domestic regulations/guideline, in order to enforce them in effective ways.

Discussion/Analyses:

In order to implement the measures for the protection of RNSS, it would be essential to completely understand both a regulatory and operational status of RNSS.

For this purpose, the followings knowledge would be required at least;

- Relevant provisions of the ITU Radio Regulations
- Relevant ITU-R Recommendations
- User's domestic/regional regulations concerning non-licensed emission limits including intentional radio emission limits and electromagnetic emission limits

Recommendation of ICG WG-A:

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

Recommendation 2 (formerly 10A.2)

Prepared by:	**Working Group on Systems Signals and Services**
Date of Submission:	**05 November 2015**
Issue Title:	**UN COPUOS Agenda Item on Spectrum Protection and IDM**

Background/Brief Description of the Issue:

The ICG Working Group A has been discussing spectrum protection and interference detection and mitigation (IDM) for several years, and has collected information about this subject. However, the discussions and information collected have been limited to ICG members and participants. At the 2014 meeting of the United Committee on the Peaceful Uses of Outer Space (UN COPUOS) Science & Technology Subcommittee (STSC), the subject of GNSS interference detection and mitigation was raised as a topic of interest, specifically with regard to the prevalence of GNSS jammer devices. UN COPUOS has broad reach across UN countries, with [82] member states. In order to expand the discussion on this topic beyond the members of the ICG, and to further expand on what was previously discussed within the STSC, the ICG should reach out to UN COPUOS through the STSC on this topic

Discussion/Analyses:

The long term goal of this recommendation will be for the Science & Technology Subcommittee (STSC) or UN COPUOS to establish a multi-year agenda item focused on National Efforts to protect RNSS Spectrum, and pursue GNSS interference detection and mitigation in member states.

Recommendation:

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

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*

Recommendation 3 (Update to Joint Recommendation 9A.4.1)

Prepared by:	**Working Group on Systems Signals and Services, Working Group on Enhancement of GNSS Performance, New Services and Capabilities, and Working Group D**
Date of Submission:	**05 November 2015**
Issue Title:	**ICG Open Service Monitoring Information Portal**

Background/Brief Description of the Issue:

1. Currently GNSS monitoring activities are conducted by each Provider through its own service/analysis center with different information services
   - These centers may be associated under the ICG umbrella
   - Information about each center may be available on the ICG portal
2. Both existing and prospective system's centers may provide raw data, products, and information about the service of GNSS OS monitoring, free of charge
3. [To archive the goal of international recognition of monitoring and assessment results, these centers should use a unified list of characteristics to be monitored: with unified definitions; unified calculation methods; the technical capability to assure international recognition of the accuracy and other characteristics based on national standards.]

Discussion/Analyses:

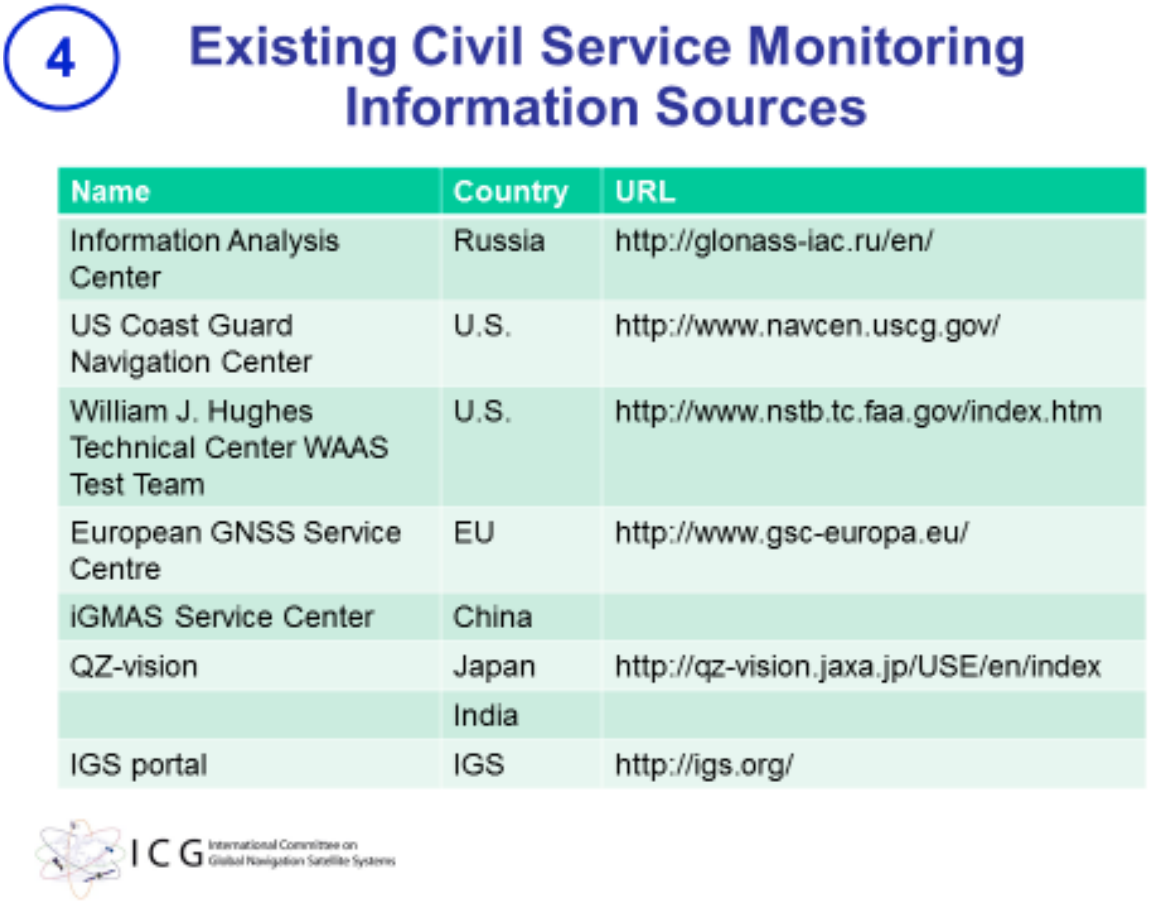
At the present time, GNSS Providers do their own service monitoring through service/analysis centers. As the Providers work to make their systems more interoperable, the users gravitate toward solutions that use signals from multiple GNSS constellations. As a result, there is an increased need to be able to access standardized data produced by the service/analysis centers, for all GNSS signals. Additionally, having this information available at a single location makes it much easier and quicker to access the information that is needed. Multilateral cooperation by all GNSS Providers can enable this kind of service to be offered through the creation of an ICG portal.

Recommendation:

WG-A recommends that existing monitoring service centers for GNSS open services establish a link to the new ICG portal designed by the ICG Secretariat.

- *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.



Recommendation 4 (formerly 10A-D4.1)

Prepared by:	**Working Group on Systems Signals and Services, Working Group on Enhancement of GNSS Performance, New Services and Capabilities, and Working Group D**
Date of Submission:	**05 November 2015**
Issue Title:	**IGMA - IGS Joint Trial Project**

Background/Brief Description of the Issue:

IGMA was established as a joint ICG sub-group by recommendation of WG-A (ICG-6, 4.2 an later became a Task Force of WG-A, B, and D, ICG-7 4.1, which includes the IGMA work plan and charter).

Recognizing the on-going activities of Providers to expand their monitoring capability to track and monitor multiple constellations.

The Subgroup/Task Force has conducted a number of meetings and collected proposals on the parameters set to be monitored by IGMA.

Discussion/Analyses:

Recognizing:

- 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
- Utilizing existing resources such as IGS and providers monitoring and assessment systems (which may include signal quality monitoring) could maximize benefits in the early stage of the IGMA roadmap

Recommendation:

The ICG recommends that the IGMA TF and IGS initiate a joint trial project that will demonstrate a global GNSS Monitoring and Assessment capability

In advance of launching the joint trial project, the following items are to be determined:

- ToR for the Trial project
- Status of Trial Project and list of participating organizations (existing monitoring systems and/or providers), operation modes

- Short list of stations to be used in Trial Project, providing 1X coverage (to provide collecting all measurement data from all satellites of all GNSS)
- Requirements for receivers and related equipment
- Short list of monitored parameters for Trial Project and calculation methods for them
- Organizational procedures (reference data validation for parameters calculations, measurement data exchange, monitoring results exchange, etc.)

An example of IGMA - IGS joint Trial project as a reference for making further definition:

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

Recommendation 5

Prepared by: **Working Group on Systems Signals and Services**

Date of Submission: **05 November 2015**

Issue Title: **Updated Work Plan Nomenclature for Working Group A**

Background/Brief Description of the Issue:

The original ICG work plan from UN General Assembly Document A/AC.105/879 - 29 December 2006 - *Meeting of the International Committee on Global Navigation Satellite Systems, Vienna, 1 and 2 November 2006* assigned five actions to the Working Group on Compatibility and Interoperability (WG-A)

Discussion/Analyses:

One of the five original WG-A actions has been completed, two are being actively pursued, one remains critically important as an area of future work, and one is no longer considered essential to pursuing compatibility and interoperability among all GNSS.

The revised work plan for WG-A maintains a focus on compatibility and interoperability and adds additional areas of work consistent with the work plan of the Providers Forum.

Recommendation:

The ICG should adopt the attached work plan for WG-A

05 November 2015

Updated Work Plan of the International Committee on Global Navigation Satellite Systems

WORKING GROUP ON SYSTEMS, SIGNALS, AND SERVICES

Leads: United States, Russia

PREAMBLE

1. Global and regional system providers agree that GNSS has become an essential international positioning, navigation, and timing infrastructure operating in a manner that benefits users worldwide.

2. GNSS has become a key component of critical infrastructure in many countries and the world's economy relies more and more on the services that it enables.

3. To provide reliable global navigation service and meet the user needs, the Committee, Providers Forum, and Working Group seek ways to generate recommendations for how to coordinate system development and provide reliability, compatibility, and interoperability of their systems and services , for peaceful purposes, for users worldwide.

4. Activity of WG-A follows the principles of compatibility and interoperability and the definitions were adopted at the first Providers Forum meeting held in Bangalore, India, September 2007. The Third Providers Forum meeting, held in Pasadena, CA, USA, December, 2008, updated these principles and their definition, as attached.

5. Global and regional system providers agree that at a minimum, all GNSS signals must be compatible. To the maximum extent possible, open signals and services should also be interoperable, in order to maximize benefit to all GNSS users. Each individual Provider has also agreed that they 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.

6. Since compatibility and interoperability are highly dependent on the establishment of standards for service provision and user equipment, the Committee and associated Providers Forum will consider guidelines and standards developed by existing standard-setting bodies applicable to GNSS service provision and use, such as the International Civil Aviation Organization (ICAO), the International Maritime Organization (IMO), the International Telecommunication Union (ITU) and potentially, the International Organization for Standardization (ISO).

TASKS AND SCOPE OF WORK

7. In order to assist the Providers Forum in accomplishing its objectives, as described in the Terms of Reference, and in order to further the work of the committee focused on compatibility, interoperability, and provision of open service through a system of global, and regional navigation satellite systems, the Systems, Signals, and Services Working Group, co-led by the United States of America and the Russian Federation, will pursue the activities described below.

Compatibility and Spectrum Protection

8. The principle of compatibility and its definition was adopted at the first Providers Forum meeting held in Bangalore, India, in September 2007. . The Third Providers Forum meeting, held in Pasadena, CA, USA, in December, 2008, updated this principle and its definition.

9. The Providers Forum has also agreed to pursue the protection of radionavigation satellite service (RNSS) spectrum through appropriate domestic and international regulation.

10. Considering the principle of compatibility and its definition, and the importance of RNSS spectrum protection, the working group, through a subgroup co-chaired by Japan and the European Union will:

    a. Seek common understanding on appropriate methods to determine compatibility among all GNSS;

    b. In particular, review existing ITU regulations and recommendations related to the avoidance of harmful interference to GNSS; and,

    c. If necessary, propose new questions or studies for ITU consideration, through appropriate mechanisms, to further protect all GNSS from harmful interference, and to define methodology used between GNSS providers to ensure compatibility;

    d. Develop educational material on sources of interference to GNSS as recommended by the Committee at its 8th meeting, and assist the working group and ICG Secretariat in training and educating governments of user community member nations on RNSS spectrum protection and management, consistent with ITU regulations and recommendations.

11. The Sub-group will develop a strategy for ICG to support mechanisms to detect and mitigate sources of electromagnetic interference, taking features of GNSS signals and existing regulatory mechanisms into consideration. This should lead to increased efforts worldwide to implement coordinated interference detection and mitigation capabilities at the national level. Specifically, the Sub-group will:

    a. Develop standards for interference reports submitted to GNSS Civil Service National Centers and establish routine communications among the centers;

    b. Recommend standards for IDM capabilities to be implemented by national governments and industry;

c. Facilitate information exchange among system providers on positioning, navigation, and timing capabilities to complement GNSS.

12. If necessary, the sub-group will establish ad hoc task forces to implement concrete tasks and reach objectives in schedule.

Interoperability and Service Standards

13. 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 co-chaired by the United States and China, will consider the perspective of various user applications and equipment manufacturers, and will:

    a. Continue 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;

    b. Maintain a focus on the open service signal development and broadcast plans of the system providers; and,

    c. In cooperation with [Working Group D], consider the role of system time and geodetic reference frames in enabling interoperable multi-GNSS service

14. 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).

15. 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.

16. The Working Group, through the Interoperability and Service Standards Subgroup, will support this activity by translating open service performance standards into parameters for multi-GNSS monitoring. Recommendations on the necessary monitoring infrastructure and organizational approaches may be made to Providers and international organizations in coordination with other ICG working groups as necessary and appropriate.

17. When requested by a provider or providers, the Subgroup will assist in exchanging information with ICG participants to help resolve GNSS open service anomalies that impact

users. The Subgroup will also facilitate cooperation and information exchanges between providers and scientific organizations that engage in open service signal quality monitoring.

18. If necessary, the sub-group will establish ad hoc task forces to implement concrete tasks and reach objectives in schedule.

System-of-System Operations

19. 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.

20. 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.

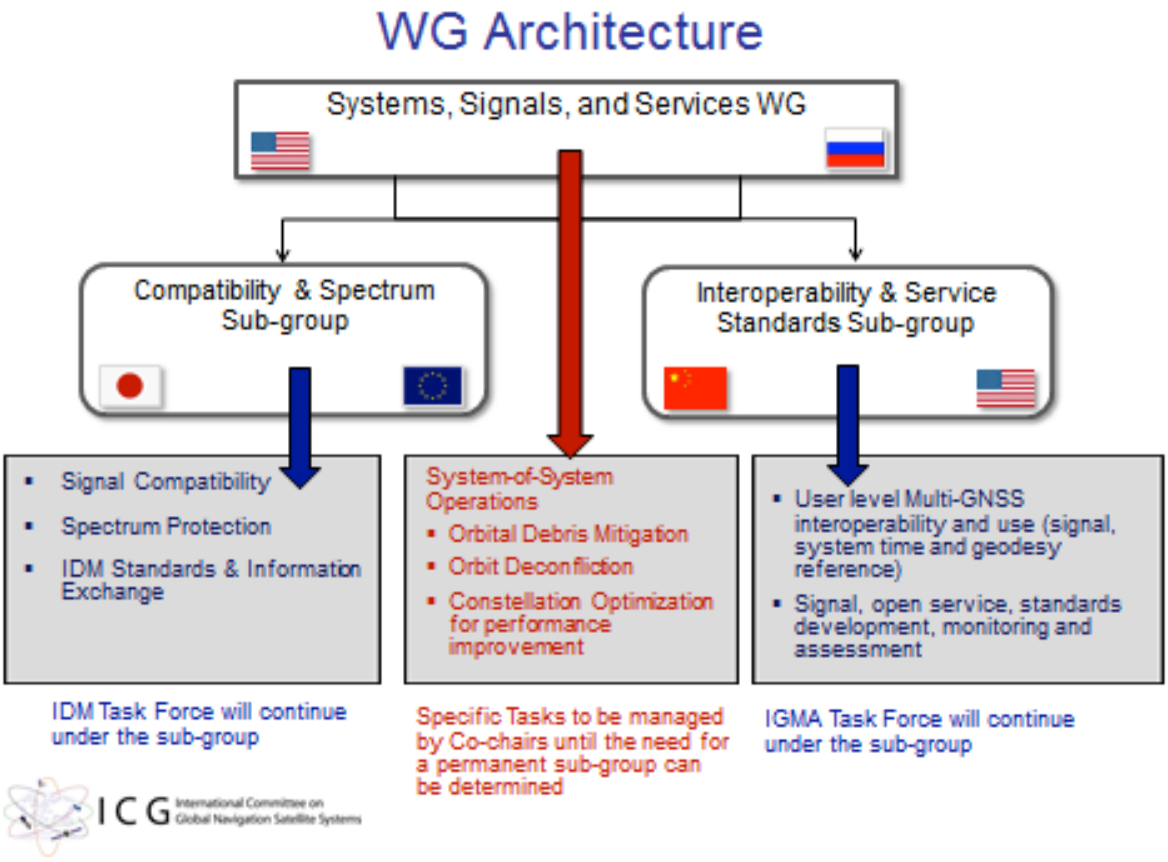
21. The Working Group will investigate the overall GNSS open service volume in order to consider improvement in terms of accuracy, integrity, availability, reliability and service coverage.

METHOD OF WORK

22. If necessary, the working group will establish ad hoc task forces to implement concrete tasks and reach objectives in schedule.

23. The working group will conduct at least one meeting each year between the previous and next meeting of the ICG in order to develop draft conclusions and recommendations for Committee consideration.

24. This work plan will be reviewed on an annual basis and revised as necessary in order to address important issues that require the attention and focus of the system providers.


WG Architecture
Systems, Signals, and Services WG
Compatibility & Spectrum Sub-group
Interoperability & Service Standards Sub-group
Signal Compatibility
Spectrum Protection
IDM Standards & Information Exchange
System-of-System Operations
Orbital Debris Mitigation
Orbit Deconfliction
Constellation Optimization for performance improvement
User level Multi-GNSS interoperability and use (signal, system time and geodesy reference)
Signal, open service, standards development, monitoring and assessment
IDM Task Force will continue under the sub-group
Specific Tasks to be managed by Co-chairs until the need for a permanent sub-group can be determined
IGMA Task Force will continue under the sub-group
ICG International Committee on Global Navigation Satellite Systems