International Committee on
Global Navigation Satellite Systems

ICG Workshop on GNSS Interoperability

In Association with ION Pacific PNT 2013, Honolulu, Hawaii

25 – 27 April, 2013

AGENDA (1)

DAY 1: Thursday, 25 April

1800 Introduction

- Opening Remarks

1815 Discussion of Workshop Purpose and Objectives

- Based on previous work and recommendations of ICG WG-A

1900 Approval of the Agenda

1915 Updates from System Providers

- GROUP DISCUSSION

AGENDA (2)

DAY 2 Friday, April 26

Participants: Open to all ION Pacific PNT Conference attendees, ICG participants (members, associate members, observers), and other invited guests from industry and the user community

0900 Welcome and Introductory Remarks

Working Group A Co-chairs

Xiaochun LU, National Time Service Center, Chinese Academy of Science

Tom STANSELL, Stansell Consulting, Workshop Facilitator

AGENDA (3)

0950 Session 1: **Certified Avionics**

1040 Break

1055 Session 2: **High Precision**

1235 Lunch

1335 Session 3: **High/Medium Precision**

1425 Session 4: **Consumer Applications**

1515 Break

1530 Session 4: **Consumer Applications** (Continued)

1645 **Recap & Summary**

AGENDA (4)

DAY 3: Saturday, 27 April

Participants: All interested participants from the previous two days

0930 Workshop Conclusions

- Conclusions
- Discussion of Potential Recommendations
- Drafting of Workshop Summary
- Next Steps
  - Future Workshops
  - Other mechanisms for Continued dialogue with industry and users

1230 Adjourn

REVIEW OF PREVIOUS RECOMMENDATIONS AND ACTIONS

Work Plan - Interoperability

- Consistent with the principle of interoperability and its definition, the working group will consider the perspective of various user applications and equipment manufacturers, and will:
  - continue efforts to survey industry and user community experts and may require sponsoring and participating in workshops and meetings designed to solicit GNSS user input. It may also require elaboration of an approach for quantitative interoperability evaluation.
  - support measures to promote the interoperability of regional ground-based DGNSS in cooperation with Working Group D.
- The Working Group will assist Providers in drafting individual reports on their respective planned or operating systems and the policies and procedures that govern their service provision, consistent with the Providers Forum template for information sharing.
  - The reports will be consolidated and maintained by the ICG Secretariat on behalf of the Providers, and updates will be provided at least annually in preparation for each major meeting of the ICG.
  - The reports will emphasize each Providers current and planned efforts to ensure compatibility and interoperability among the global, regional, and augmentation system components of the global system of navigation satellite systems.

ICG-5
Torino, Italy - October 2010

ICG International Committee on Global Navigation Satellite Systems

Interoperability Tasks

- Original ICG WG-A work plan:
  - 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)
  - **Survey** the level of interoperability and standardization among GNSS constellations and augmentations
- Revised work plan (adopted at ICG-4):
  - 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

Timeline (1)

- DEC 08 - ICG-3 concurred with WG-A recommendation to solicit user and industry inputs on interoperability
- JAN 09 – Questionnaire drafted by WG-A co-chairs
- FEB 09 - Circulated in preparation for Munich workshop
- MAR 09 – Munich workshop
- JUL 09 - Results of workshop and responses presented to WG-A in Vienna - revisions to questionnaire recommended

Timeline (2)

- AUG 09 – revised questionnaire circulated
- **SEP 09 – ICG-4 concurred with WG-A recommendation to continue activity**
- DEC 09 – Workshop in Queensland, Australia
- APR 10 – Questionnaire posted online by GPS World Magazine
- OCT 10 – ICG-5

Munich Workshop Summary

- Opportunity for industry and user representatives to express views on interoperability based on system provider plansd as described at ICG-3
  - Updates presented by 4 system providers
- Presentations were made by user/industry experts from mass market, transportation, timing, and high precision sectors
  - Findings were varied, but all sectors expressed interest in use of multiple constellations with varying views on the benefits of interoperability
  - Cost and common frequencies were important to some while accuracy and availability were mentioned by others

Queensland Workshop Summary

- 2nd Opportunity for industry and user representatives to express views on interoperability
- System updates provided by 4 system providers
- User presentations were heavily focused on high precision applications and time and geodesy aspects of interoperability
- One WG-D Co-chair attended meeting
- Value of multi-system reference stations and common monitoring sites was a major topic of discussion

Questionnaire

- **Purpose:** Obtain worldwide input from industry, academic institutions, and other representatives of the GNSS user community with technical expertise regarding characteristics of GNSS signals which, from their perspective, aid or hinder the combined use of these signals in multiple applications
- Total number of respondents: 34
  - Industry:
  - Government-sponsored organizations:
  - Academia:
  - Non-profit organizations:

Summary of Questionnaire Results

- ICG Principle of Interoperability and its definition seems valid
  - No substantial changes to definition required
- Benefits of interoperability include better availability, accuracy, and ability to support RAIM
- Priorities include common carrier frequencies, common time scale & reference systems, common modulation, and collocation of reference stations
- Service-related assurances viewed as important by almost all respondents
- It is difficult to draw more detailed conclusions
  - Many respondents did not appear to understand the underlying issues
  - Interviews probably were needed

Can the Results Make a Difference?

- Each Provider should indicate if questionnaire results could now affect your:
  - Existing or new signal designs
  - System documentation
    - Interface and Performance Standards
  - System commitments
    - Constellation health, sustainment policy, notifications to users, treatment of unhealthy satellites, etc.
- If not, the effort should be ended
- If so, the interested Providers should re-shape the survey and its process for maximum benefit
- Questionnaire responses will be made available to Providers

ICG-5 Recommendation - 2

- Interested members of WG-A will develop a new approach to continued collection of user and industry views on interoperability
  - Potential specific topics to include in new questionnaire:
    - Value of a common third open service signal
    - Importance of DOP improvement with the addition of 2nd, 3rd, 4th, Nth global constellation
  - Plan for conducting interviews in association with the questionnaires
  - Consider organizing a large user/industry summit to be attended by key technical experts

ICG-5 Recommendation - 3

- Continue to investigate system time and geodetic reference frame aspects of interoperability within the WG-D task forces on time and geodesy
  - First task is the completion of time and geodetic reference frame templates by all system providers
  - Other specific methods to potentially improve interoperability could be addressed afterwards
    - Inclusion of multi-constellation, multi-frequency tracking in the IGS network
    - Monitor and disseminate offsets between each system time

ICG-5 Recommendation - 4

- Interested ICG participants are encouraged to interact with receiver manufacturers and encourage participation in the Asia-Oceania Multi-GNSS Demonstration Campaign
  - An opportunity to test and experiment with multi-system receivers and demonstrate the benefits of interoperability
  - Also an opportunity to develop potential new GNSS applications enabled by multiple systems
  - Industry, users, and system providers should all benefit

ICG-6
Tokyo, Japan - September 2011

ICG International Committee on Global Navigation Satellite Systems

SESSION 5 - INTEROPERABILITY

- Relationship between Visible Satellite Number and receiver Noise Floor

  Ms. Xiachun LU (China)

- Status of implementing ICG-5 recommendations
  - Recommendation 2: User Community Views on Interoperability
  - Recommendation 3: Time and Geodesy Aspects of Interoperability
  - Recommendation 4: Participation in the Multi-GNSS Demonstration Campaign
- Group Discussion on WG-B and/or WG-D on recommendations related to Interoperability

WG-B ICG-6 Recommendation: Optimizing navigation message content in new signals to achieve the highest possible level of multi-GNSS interoperability

- **Background/Brief Description of the Issue:** Most system providers have "locked-in" many of their signal structures. However individual systems plans for L5, i.e. definition of the navigation data message are less fixed. Therefore there is potential for the ICG to identify characteristics of L5 message that can optimize the level of interoperability. One example presented by the FAA is to include ARAIM Integrity Support Message parameters in SBAS L5.
- **Discussion/Analyses:** The above consideration could be also extended to the definition of the navigation data messages (i.e. spare capacity) of the other new signals coming from GPS, Galileo, COMPASS, GLONASS, QZSS, IRNSS.
- **Recommendation of ICG WG-B Action:** That the ICG consider a cross working group workshop involving system providers and key user groups to identify opportunities in existing or planned spare capacity of the navigation messages that will achieve the most benefit for users from a truly interoperable system of systems.

WG-B ICG-6 Recommendation: ARAIM Parameter Development in response to Work plan action B3

- **Background/Brief Description of the Issue:** As presented at the meeting by L. Eldredge (FAA), ARAIM based on multiple GNSS constellations is dependent on a number of parameters which need to be broadcast to the users.
- **Discussion/Analyses:**
  - The parameters reported in the presentation are: Probability of Satellite Failure Psat, Probability of Constellation Failure Pconst, User Range Accuracy (URA), Bias (b).
  - Standards for ARAIM use by aviation worldwide will eventually need to be adopted by ICAO. Prior consensus on the definition of these parameters among the GNSS providers would facilitate the ICAO standard-setting process.
- **Recommendation of ICG WG-B Action:** To encourage to research a consensus on the definition of broadcast parameters necessary to enable multi-constellation ARAIM.

ICG-7
Beijing, China – November 2013

ICG International Committee on Global Navigation Satellite Systems

AGENDA: Session 5 - Interoperability

- PRESENTATION: Research on GNSS Interoperability Parameters

  Xiaochun LU (China) National Time Service Center, Chinese Academy of Science

- Actions, and Recommendation from the Intersessional Meeting

  Sergey REVNIVYKH, David TURNER

Proposed Agenda for Workshop on interoperability

ICG-7 Planning Meeting
Beijing, China
7th November 2012

Joint U.S./China input

Proposed Recommendation

Consistent with the principle of interoperability and its definition, and the implementation of previous ICG recommendation related to interoperability, the ICG should host a user/industry workshop in conjunction with the ION Pacific PNT meeting, meeting, April 22-24 2013.

——ICG WG-A Intersession Meeting, Olsztyn, Poland

ION-PNT provides a platform for interoperability discussion!

The "user/industry workshop" in ION-PNT 2013 should be named as "GNSS Interoperability Workshop", with the following draft agenda.

Proposed Agenda

1. Interoperable signals
2. Interoperable parameters
3. Interoperability at the user level
4. Methods to enhance interoperability
5. Benefits of Increased Interoperability

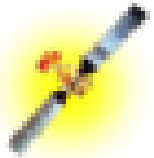
Interoperable signals

Interoperable signals

—— *Consider GNSS interoperability in navigation signal level.*

Potential for a common third open service signal

—Focus on the frequency, modulation of a third signal to increase GNSS interoperability



Frequency diversity vs. frequency commonality

—Discuss the advantages and disadvantages of diversity and commonality respectively

Interoperable parameters

- **Definition, model and calculation method of interoperable parameters;**
  - Complement the content of interoperable parameters in interoperable parameter set
  - Realize the definition and meaning of parameters in the set
  - Research on calculation method and model of interoperable parameters
- **Monitoring method of interoperable parameters (including system time differences monitoring)**
  - interoperable parameters acquisition methods
  - Monitoring channels of interoperable parameter
- **Broadcasting method of interoperable parameters**
  - Broadcasting channels of interoperable parameters

Interoperability at the user level

- **Views on intellectual property policy for GNSS;**
- **Interoperability for hardware and algorithm efficiency;**
  - Manufacture multi-GNSS receiver
  - Multi-GNSS signal receive technology research
- **Algorithm and models of interoperability parameters for users;**
  - After user get these GNSS interoperability parameters, user can put these parameters to a positioning algorithm;

Methods to enhance interoperability

Utilize existing or planned open service to increase multi-GNSS interoperability

Utilize SBAS navigation messages to increase multi-GNSS interoperability

Other methods to increase multi-GNSS interoperability

Benefits of Increased Interoperability

- System provider time and geodetic reference frame implementation as described by the ICG WG-D templates;
- DOP improvement by multi-system interoperability;
  - Research the improvement of DOP caused by multi-constellation;
  - DOP improvement with the addition of 2nd, 3rd, 4th, Nth global constellation;
- Trade-offs between DOP and other performance parameters.

ICG-7 Recommendation 7A.5.1

- Consistent with the principle of interoperability and its definition, and the implementation of previous ICG recommendations related to interoperability, the ICG should host an interoperability workshop in conjunction with the ION Pacific PNT meeting, April 22-25 2013.
- The ICG will request inputs from potential participants prior to the workshop through existing web sites related to GNSS information dissemination, conferences, major PNT organizations and events.
- The following interoperability subjects may be addressed:
  1. **Potential for a common third open service signal**
  2. **Frequency diversity vs. frequency commonality**
  3. DOP improvement with the addition of 2nd, 3rd, 4th, Nth global constellation
  4. System provider time and geodetic reference frame implementation as described by the ICG WG-D templates
  5. Potential opportunities to utilize existing or planned spare capacity in civil/open service or SBAS navigation messages in order to increase multi-GNSS interoperability

Related Working Group Action

Interoperability Workshop

Actions to WG-A:

• Each participating system provider will provide the WG-A Co-Chairs with a point of contact for developing the agenda and web site material for the proposed Interoperability workshop to be held in conjunction with ION Pacific PNT 2013

• The identified team will begin developing a draft agenda and other web-based material for consideration by the Committee