

REPORT ON THE TWELFTH MEETING OF THE INTERNATIONAL COMMITTEE ON GLOBAL NAVIGATION SATELLITE SYSTEMS (ICG-12)

Kyoto, Japan, December, 2017
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INTRODUCTION

The twelfth meeting of the International Committee on Global Navigation Satellite Systems (ICG) was held in Kyoto, Japan from 2 to 7 December 2017. The ICG has been formed as a result of recommendations of the UN Committee on the Peaceful Use of Outer Space (COPUOS), as ratified by the General Assembly of the UN. The International Federation of Surveyors (FIG) is an Associate Member of the ICG. Mikael is the FIG representative to UNOOSA and Suelynn is the FIG co-chair to ICG Working Group D on Reference Frames, Timing and Applications. This meeting attracted more than 200 people with representatives from all of the GNSS/RNSS providers except India. There were also many representatives from other countries and non-government organisations.



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JOINT STATEMENT FROM ICG-12

At the end of each meeting, the ICG issues a Joint Statement outlining the highlights of the broad scope of work across the ICG. Various presentations were made at the plenary sessions and working group sessions of the meeting and they form a very useful snap shot of the state of the art with the various GNSS and also with issues across key user groups. The Joint Statement from ICG-12, Working Group Reports and all presentations are available on the ICG Information portal (<http://www.unoosa.org/oosa/en/ourwork/icg/icg.html>). The joint statement is also included as Appendix A.

MAJOR FINDINGS FROM THE MEETING

There were many other presentations, discussions and decisions at the meeting and the following is an outline of some that the authors found particularly interesting:

- Each provider presented on their status and their respective progress.
- The FIG/IAG/ICG Technical Seminars on Reference Frames are considered as successful and useful and was referenced by the ICG several times. It was decided that the ICG will continue with its support also during 2018 with the technical seminar to be held in Istanbul, Turkey in conjunction with the FIG Congress.
- FIG presented on the progress and establishment of the UN Global Geospatial Information Management Subcommittee on Geodesy, another UN entity where FIG is an associate member.
- User perspective and applications were described through several presentations. Suelynn raised questions concerning interoperability of the multi-GNSS precise point positioning services, which some of the GNSS Providers intend to provide. This is an important topic, which warrants further investigation, engagement and cooperation between GNSS Providers, the IGS, IGMA, iGMAS, RTCM and GNSS receiver manufacturers, as well as the broader end users community.

MEETINGS OF WORKING GROUP D AND ITS TASK FORCES ON GEODETIC AND TIMING REFERENCES

The Working Group D on Reference Frames, Timing and Applications had three meetings during the week. The number of participants varied between 20 and 40. The meetings were chaired by Chris Rizos (IAG) and the geodetic reference frames and timing task forces were chaired by Chris and Jerome Delporte (CNES), respectively. The minutes from Working Group D and other Working Groups will be available from the ICG web portal in due course as well as other official documents as e.g. recommendations and all presentations.

The Working Group noted significant progress on the geodetic and timing references by the ICG GNSS Providers including (1) the recent establishment of the United Nations Global Geospatial Information Management Subcommittee on Geodesy (UNGGIM SCoG); (2) the evaluation of quality of the new release of the International Terrestrial Reference Frame (ITRF2014) and the significant contribution of GNSS data; (3) the refinement of the

alignments of GNSS reference frames to the ITRF, and (4) the information on the GNSS timing references and the inter-comparisons of GNSS time offsets. There is the need to update some of the geodetic and timing templates.

The issue of sustainability of the geodetic infrastructure of the globally distributed laser ranging, DORIS, VLBI and GNSS tracking stations is central to the SCoG. In addition to preparing a work plan to address the sustainability challenge, the SCoG will encourage further education and capacity building in less developed countries. The Working Group members also participate in education and outreach projects, with WG-C, on “Reference Frames in Practice”.

The Working Group continues to contribute to the IGMA initiative, in particular through involvement in the IGMA-IGS Joint Trial Project. A related issue raised by the International Laser Ranging Service (ILRS) is the capacity constraint of the ILRS ground network to track all GNSS satellites fitted with laser retroreflectors. Laser tracking of GNSS satellites is an important means of independently determining the precise GNSS ephemerides, and hence evaluating the quality of GNSS satellite orbits computed by the Providers’ and third parties using GNSS measurements and models. Guidelines of selecting which GNSS satellites will be tracked by the ILRS, and for which periods and intervals, will need to be developed. WG-D acknowledges that there has been some progress in the provision of satellite metadata by some of the GNSS Providers. This satellite information has been shown to improve orbit modelling and accuracy.

The Working Group D noted some Providers are providing GNSS data of their tracking stations to the IGS. Working Group D will continue to monitor progress (in conjunction with IGMA) and demonstrate the benefits of including some of their tracking stations data to encourage all Providers to contribute. Another issue identified by WG-D as requiring study is the planned provision of precise positioning services by some of the System Providers, and how interoperability can be ensured through rigorous definition of corrections and system biases, as well as message format.

The Working Group D noted progress on the recommendation #21 on the offsets between GNSS times but believes that a closer collaboration with WG-S (who held a workshop on this topic in June 2017) would be desirable. WG-D discussed several options that need further concrete evaluations and updated the recommendation #21.

NEXT MEETINGS OF THE ICG

China agreed to host ICG-13 in Xi’an in November, 2018.

APPENDIX A

Twelfth Meeting of the International Committee on Global Navigation Satellite Systems

3 – 7 December 2017

Kyoto, Japan

JOINT STATEMENT

1. The Twelfth Meeting of the International Committee on Global Navigation Satellite Systems (ICG) was held in Kyoto, Japan, from 3 to 7 December 2017 to continue reviewing and discussing developments in global navigation satellite systems (GNSS) and to allow ICG members, associate members and observers to address recent developments in their organizations and associations with regard to GNSS services and applications. ICG also addressed disaster risk reduction and management using GNSS.
2. The Director-General of the National Space Policy Secretariat of Cabinet Office, Ambassador in charge of Policy Planning, International Security Policy of the Ministry of Foreign Affairs, and Vice President of Kyoto University delivered opening speeches on behalf of Japan. The representative of the Office for Outer Space Affairs also addressed the Meeting.
3. The Meeting was hosted and organised by the Cabinet Office and the Ministry of Foreign Affairs of Japan. The Meeting was attended by representatives of China, Italy, Japan, the Russian Federation, the United Arab Emirates, the United States of America and the European Union, as well as the following intergovernmental and nongovernmental organizations: Arab Institute of Navigation, Asia-Pacific Space Cooperation Organization, Civil Global Positioning System Service Interface Committee, European Space Agency, Interagency Operations Advisory Group, International Aeronautical Federation, International Association of Geodesy, Reference Frame Sub-Commission for Europe, International Association of Institutes of Navigation, International Federation of Surveyors. Representatives of the Office for Outer Space Affairs also participated. Australia and Pakistan were invited to attend as observers.
4. ICG recalled that the General Assembly, in its draft resolution (A.72/446), had noted with satisfaction the continuous progress made by ICG towards achieving compatibility and interoperability among global and regional space based positioning, navigation and timing systems and in the promotion of the use of GNSS and their integration into national infrastructures, particularly in developing countries.
5. ICG emphasized the growing number of applications of GNSS not contemplated when the International Committee first met in 2006. Specifically, ICG noted that GNSS signals can be used for navigation and positioning of in-orbit space operations particularly from low-Earth orbit to cis-Lunar. ICG requested that the Government of Japan, as host of the 12th meeting of ICG, call to the attention of governments participating in the second International Space

Exploration Forum (ISEF2) that GNSS is an enabling capability that can make future space exploration more efficient and safe. ICG also noted that ISEF2 will be hosted by the Government of Japan on 3 March 2018.

6. ICG noted that the working groups had focused on the following issues: systems, signals, and services; enhancement of GNSS performance new services and capabilities; information dissemination and capacity-building; and reference frames, timing and applications.

7. The Working Group on Systems, Signals and Services (Working Group S) completed its 2016 - 2017 activities using its organizational structure and work plan that were adopted in 2015 at the tenth meeting of ICG. This structure includes a subgroup on Compatibility and Spectrum Protection and a subgroup on Interoperability and Service Standards. The Compatibility and Spectrum Protection subgroup decided to continue addressing the need for worldwide GNSS spectrum protection through a recommendation for ICG members to encourage national regulators to protect Radio Navigation Satellite Service spectrum from the unwanted emissions. The Working Group continued outreach and education efforts on spectrum protection by holding an Experts Seminar on GNSS spectrum, held in December 2016, in conjunction with a United Nations/Nepal Workshop on the applications of GNSS in Kathmandu. A third seminar is planned for 2018, to be held in conjunction with a United Nations/Argentina GNSS regional workshop. The interference detection and mitigation (IDM) Task Force, working under the subgroup, organized and completed a sixth IDM workshop in Baška, Croatia in May 2017. This resulted in a recommendation to work with the third Generation partnership Project (3GPP) process and organization on measures to implement crowd sourcing through mobile phones as a way to detect GNSS interference. The Task Force also agreed to hold a seventh IDM Workshop, to be held in May 2018, in conjunction with the Baška (Croatia) GNSS Conference.

8. The Subgroup on Interoperability and Service Standards held a meeting in Paris, France in July 2017, in conjunction with the 2017 International GNSS Service (IGS) Workshop, to discuss follow-up work on performance standards and interoperability. The Subgroup also organized a workshop held during the same week, focused on GNSS system time. The discussions at the workshop were productive, but there is a clear need for further discussions on this topic. The Working Group therefore recommended a second workshop on system time in 2018, to be coordinated with Working Group D. In 2017, the international GNSS monitoring and assessment (IGMA) Task Force conducted several meetings and an IGMA workshop, held in Shanghai, China in May. The work focused on carrying out the joint trial project activity with IGS to demonstrate a global GNSS Monitoring and Assessment capability for a limited set of GNSS parameters. A Performance Standards and IGMA workshop will be hosted by the European GNSS Agency in 2018 at the Galileo Reference Centre in Noordwijk, the Netherlands. Finally, the working group briefly discussed system-of-systems operations, with briefings on orbital debris mitigation for GNSS constellations. The Working Group agreed to continue these discussions, working with experts from each GNSS provider. All Working Group activities will be addressed at one or more intersessional meetings in advance of the thirteenth meeting of ICG.

9. Working Group on the Enhancement of GNSS Performance, New Services and Capabilities (Working Group B) is progressing significantly in establishing an interoperable GNSS Space

Service Volume (SSV). Joint simulations conducted by the group for multiple mission profiles provide clear evidence that for space users at high altitude no single constellation is able on its own to provide a sufficient level of GNSS

signal availability. By exploiting the interoperability between all systems allows to achieve GNSS signal availability very close to 100%.

10. The work of the Working Group related to the GNSS Space Service Volume (SSV) and its promising outcomes demonstrated the importance and relevance of the interoperability of GNSS. Further, the work of the working group also indicated very clearly the significant value of GNSS SSV for a much wider scope of future space exploration activities of various nations around the world. GNSS SSV and potential augmentations can be seen as an enabler for many ambitious missions and activities in the context of space exploration going beyond low Earth orbit to the Moon, Mars and other celestial bodies. The working group noted that new concepts such as the Deep Space Gateway, could use the SSV capability to serve humankind in its next phase of space exploration.

11. The excellent cooperation among all members of the SSV action team allowed it to prepare a final draft of the SSV booklet that will be submitted to ICG for provision to the GNSS Providers for review and endorsement of the SSV booklet for publication in time for the fiftieth anniversary of the first UNISPACE conference.

12. Beyond the publication of the ICG SSV booklet, Members of Working Group B will conduct outreach activities on the interoperable GNSS SSV, conference sessions and papers together with supporting illustrative video material will be prepared. Future areas of work to augment the interoperable GNSS SSV have been identified. All service providers are involved in the SSV activities.

13. Search and Rescue (SAR) services are implemented by Galileo and GLONASS and will be implemented by GPS and BDS according to COSPAS SARSAT standards. The Working Group will continue to assess the interoperability specifications at COSPASSARSAT level in line with the Working Group work plan. Signal level compatibility of the SAR downlink signals will be followed up by the Compatibility and Spectrum Sub-Working Group of the Working Group S.

14. A number of contributions on space weather highlighted the importance of exploiting the multitude of signals broadcast by GNSS enabling better monitoring of space weather phenomena and progressing the understanding of the ionosphere. The large number of GNSS signals also provide interesting features for scientific Earth observation utilising reflected GNSS signals-in-space. The presentations show synergies between GNSS and Science, this topic will be continued to be addressed by the Working Group. Furthermore, feedback has been provided on scientific experiments exploiting high precision on-board clocks that have significantly improved the measurement accuracy of the gravitational red-shift phenomena.

15. The application subgroup of Working Group B continued its work and presented an update on the Application Catalogue together with an initial version of an online questionnaire to collect future user needs. The application subgroup will continue its work

with the final objective to issue a report based on the feedback collected through the online questionnaire.

16. The Working Group on Information Dissemination and Capacity-building (Working Group C) considered educational programmes and activities carried out by the Russian Space Systems company, the Moscow State University of Geodesy and Cartography, the Moscow Timiryazev Agricultural Academy, the BeiDou Belt and Road School of Beihang University, Tokyo University of Marine Science and Technology, The University of Tokyo and the Regional Centre for Space Science and Technology Education in Asia and the Pacific (RCSSTEAP - China) affiliated to the United Nations in promoting the use of GNSS capabilities, particularly in developing countries.

17. The working group therefore emphasized that ICG should join forces with educational institutions to strengthen and deliver targeted capacity-building and technical advisory activities with the goals of sharing ideas and expertise regarding GNSS technology and its applications, particularly encouraging participation of women and young professionals. Additionally, further research on the definition of a capacity-building and workforce index should be undertaken. In order to avoid duplication of efforts in sharing available educational materials, support for open data-sharing policy and realtime data accessibility should be taken into account.

18. The working group took note of the educational resources of the European Space Agency (ESA) on GNSS technologies and applications available on the wiki-based information source “Navipedia” (www.navipedia.net). Cooperation with the United Nations Global Geospatial Information Management Subcommittee on Geodesy and its focus group on Education, Training and Capacity Building, presented by the International Federation of Surveyors (FIG), aiming at assessing the current availability of education, training, and capacity building resources on global geodetic infrastructure, was considered. The working group also took note of the GPS interference test approval process, training activities, and authorized test exercises announced by the United States Coast Guard Navigation Center.

19. The Working Group on Reference Frames, Timing and Applications (Working Group D) noted significant progress on the geodetic and timing references by the GNSS providers, including: (1) the recent establishment of the United Nations Subcommittee on Geodesy (SCoG) as part of the work of the United Nations Global Geospatial Information Management (UN-GGIM) initiative; (2) the evaluation of the quality of the new release of the International Terrestrial Reference Frame (ITRF2014) and the significant contribution of GNSS data; (3) the refinement of the alignments of GNSS reference frames to the ITRF, and (4) the information on the GNSS timing references and the inter-comparisons of GNSS time offsets. There is the need to update some of the geodetic and timing templates.

20. The Working Group noted that the issue of sustainability of the geodetic infrastructure of the globally distributed laser ranging, Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS), Very Long Baseline Interferometry (VLBI) and GNSS tracking stations is central to the SCoG. In addition to preparing a work plan to address the sustainability challenge, the SCoG will encourage further education and capacity building in developing

countries. Working Group members also participate in education and outreach projects, with the Working Group C, on “Reference Frames in Practice”.

21. The Working Group continues to contribute to the IGMA initiative, in particular through involvement in the IGMA-IGS Joint Trial Project. A related issue raised by the International Laser Ranging Service (ILRS) is the capacity constraint of the ILRS ground network to track all GNSS satellites fitted with laser retroreflectors. Laser tracking of GNSS satellites is an important means of independently determining the precise GNSS ephemerides, and hence evaluating the quality of GNSS satellite orbits computed by the Providers’ and third parties using GNSS measurements and models. Guidelines of selecting which GNSS satellites will be tracked by the ILRS, and for which periods and intervals, will need to be developed. The Working Group acknowledges that there has been some progress in the provision of satellite metadata by some of the GNSS providers. This satellite information has been shown to improve orbit modeling and accuracy.

22. The Working Group noted some providers are providing GNSS data of their tracking stations to the IGS. The Working Group will continue to monitor progress (in conjunction with IGMA) in order to demonstrate the benefits of providing GNSS data from a subset of the tracking stations and encourage all providers to contribute. Another issue identified by the Working Group as requiring study is the planned provision of precise positioning services by some of the System providers, and how interoperability can be ensured through rigorous definition of corrections and system biases, as well as message format.

23. The Working Group noted progress on the recommendation #21 on the offsets between GNSS times but believes that a closer collaboration with Working Group S would be desirable. The Working Group held a workshop on this topic in Paris in July 2017, in conjunction with the annual IGS Workshop. The Working Group discussed several options that need further concrete evaluations and updated the recommendation #21.