

**14th meeting of the International Committee on Global Navigation satellite Systems,
Bangalore, India, 9 – 13 December 2019**

Joint statement

1. The fourteenth meeting of the International Committee on Global Navigation Satellite Systems (ICG) was held in Bengaluru, India, from 9 to 13 December 2019 to continue reviewing and discussing developments in the field of global navigation satellite systems (GNSS) and to allow ICG members, associate members and observers to address recent developments in their countries, organizations and associations regarding GNSS services and applications.
2. On behalf of the Government of India, Dr. K. Sivan, Chairman of the Indian Space Research Organization (ISRO) and Secretary of the Department of Space (DOS) presided over the inaugural function of the ICG-14, also delivering a keynote address. Senior functionaries of ISRO, including the Scientific Secretary and the Directors of the UR Rao Satellite Centre and the Space Applications Centre; the key contributing ISRO Centres to the navigation programme also addressed the delegations. The representative of the Office for Outer Space Affairs also addressed the meeting. The inaugural event concluded with a vote of thanks offered by the Director, Satellite Navigation Programme Office, ISRO Headquarters.
3. The Meeting was attended by representatives of Australia, China, India, Japan, Nigeria, the Russian Federation, the United Arab Emirates, the United States of America and the European Union, as well as the following intergovernmental and non-governmental organizations: Asia-Pacific Space Cooperation Organization, Civil Global Positioning System Service Interface Committee, European Space Agency, Interagency Operations Advisory Group, International Aeronautical Federation, International Bureau of Weights and Measures, International Federation of Surveyors and International Global Navigation Satellite System Service. Representatives of the Office for Outer Space Affairs and the International Telecommunication Union (ITU) also participated. New Zealand and the Republic of Korea were invited to attend as observers. New Zealand was recognised by ICG as a new member.
4. ICG conducted a focussed seminar on the contributions of GNSS to societal and developmental purposes. Presentations were made on the use of satellite navigation in terrestrial and maritime transportation, timing applications, use of pseudolites for aircraft approach or unmanned aerial vehicle (UAV) guidance, environmental observations and introduction into mobile phones.
5. 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.

6. The Working Group on Systems, Signals and Services (Working Group S) through its subgroups and task forces advanced all aspects of its workplan in the intersessional period between ICG-13 and ICG-14. Under the leadership of the subgroup on compatibility and spectrum protection, an 8th GNSS Interference Detection and Mitigation (IDM) Workshop was conducted for the third time in conjunction with the annual Baska GNSS Conference in May 2019. At the workshop, a number of concepts and ideas were presented on IDM capabilities and methodologies. The Working Group continued its campaign to promote adequate protection of GNSS spectrum through education and outreach by conducting a fourth Spectrum Protection and Interference Detection and Mitigation Seminar in conjunction with a UN Regional GNSS Workshop held in Suva, Fiji, 24-28 June 2019. Based on positive feedback about the success of this outreach effort, the working group submitted a recommendation to the ICG to create a booklet addressing the importance of GNSS spectrum protection and IDM. This recommendation was adopted at the ICG plenary. The compatibility and spectrum protection subgroup also maintained a close watch on ITU activities including preparations for the WRC-19 meeting that took place in November 2019 in Egypt. The Working Group members received an update on the outcomes related to RNSS spectrum. As a result of the hard work before and during WRC-19, there were no radio regulatory impacts on RNSS.
7. The subgroup on interoperability and service standards held three workshops during the intersessional period, in June 2019 in Vienna, Austria. A workshop focused on defining guidelines for developing Open Service Performance Standards was held on 12 June 2019, led by a dedicated team of experts working under the auspices of the subgroup. The main emphasis was on defining and expanding the list of parameters beyond those in the initial performance standard guidelines adopted at ICG-13. On 12 and 13 June 2019, a workshop focused on international GNSS monitoring and assessment (IGMA) took place. The subgroup also organized a third workshop focused on GNSS system time interoperability held on 14 June 2019, in conjunction with ICG Working Group D. The working group agreed to continue these discussions by holding another workshop in conjunction with working groups B and D in 2020, with a focus on input from GNSS receiver manufacturers and users of different categories. Finally, the working group participated in a workshop chaired by working groups B and D, focused on Precise Point Positioning (PPP) Services, which took place in conjunction with the UN Regional GNSS Workshop in Suva, Fiji in June 2019. Based on the outcome of the workshop, Working Group S recommended the establishment of a Task Force on PPP interoperability, which was adopted by the ICG. The Task Force will be co-chaired by Australia, the EU and Japan, and will prepare a workshop in 2020 to continue the discussions and address the issues raised at the 2019 workshop.
8. The Working Group also highlighted the need for consultation with the Inter-Agency Space Debris Coordination Committee regarding implementation of the

recommendation from ICG-13 to study the issue of debris mitigation practices relevant to the MEO and IGSO orbital regimes used by GNSS.

9. The Working Group on Enhancement of GNSS Performance, New Services and Capabilities (Working Group B) has progressed in its activities.
10. The Space User Subgroup (SUSG) informed WG-B on the progress since ICG-13 when the Subgroup has been established. The SUSG made major progress related to the updates for the next envisaged release of the GNSS Space Service Volume (SSV) booklet, in line with their work plan for 2019/2020. The finalization of a video, produced to explain the basic concept of the GNSS SSV to the general public, is expected during the 1st quarter 2020. In the same time frame the finalization of the name of this subgroup is envisaged. New activities have also been identified, including discussions on the need for user guidelines or standards for space usage of GNSS and the identification of space user needs related to timing aspects. The Subgroup also proposes a recommendation related to the release of the GNSS transmit antenna patterns or equivalent representative modelling information, including the side lobes, by all GNSS service providers, in order to fully exploit the potential of GNSS for space users, including Moon missions and beyond.
11. The WG-B recognizes the efforts made by its Application Subgroup (AppSG) on setting up a user questionnaire and a GNSS catalogue, with a draft questionnaire and a draft structure of the application catalogue being distributed to the WG-B co-chairs and the AppSG members. Having reviewed the current status of the project, it is recommended by WG-B that the project should focus on specific areas. The focus areas are still to be identified, but user needs on emerging scientific GNSS applications such as space weather, reflectometry, PPP and unmanned vehicles have been suggested. All WG-B members are encouraged to take a more proactive role on the project.
12. The AppSG co-chairs request every PoC to report the topics of interest to the co-chairs and to identify additional AppSG members by end of January 2020 as input to a SG meeting planned in March 2020. The AppSG will select the focus topics and develop a work plan to be submitted to the WG-B for the intersessional meeting in June 2020, in preparation of ICG-15.
13. The WG-B as part of its agenda addressed additional aspects on GNSS usage in space, based on presentations provided by NASA, India and China. WG-B was informed about updates on space missions using GNSS receivers based on the information recorded by IOAG. NASA shared new Magnetospheric Multiscale (MMS) Mission navigation performance results and discussed plans and analyses related to the use of GNSS for its lunar exploration missions. NASA reported on the recent successful first operational use of the NASA Autonomous Flight Termination System using GPS during a launch on December 6, 2019. China reported a signal improvement method for Cislunar space missions. India informed WG-B about activities on orbit determination for NavIC including extended Kalman filter based

onboard orbit determination using GNSS and investigations on NavIC extended ephemerides, India's efforts for SSV and lunar missions as well as on PRN code design for future NavIC L1 band. China introduced a LEO Satellite-Based Augmentation System using 120 Low-Earth Orbit satellites to provide global fast convergence high-accuracy PPP, GNSS monitoring and Integrity Augmentation services. Russia presented RTK navigation module developments for multi-GNSS and integration with inertial sensors.

14. As part of the scientific presentations, India provided details on many scientific investigations and research for future applications such as: a NeQuick model based ionospheric corrections and solar flux estimation for NavIC, Ionospheric TEC perturbation modelling for space weather studies, atmospheric water vapor detection by GNSS and its impact on weather prediction, the detection of seismic activities utilising NavIC signals by identifying anomalies in the Ionosphere and the benefits of GNSS signals for weather monitoring employing GNSS reflectometry techniques.
15. China informed the WG-B on the BDS-3 on-board space weather payloads and the recent release of data on the BDS web-page (<http://beidou.gov.cn>). Since most GNSS satellites have space weather payloads, China suggests that GNSS providers share space weather data. Furthermore, China suggests that a correspondence group on this topic be established within WG-B. This point will be addressed as part of the WG-B activities leading to ICG-15.
16. Japan informed the WG-B on the progress of the QZSS Emergency Warning Services and updated on the EWS correspondence group activities. A draft message definition has been shared with the points of contact of the correspondence group. Future work will be focusing on EWS message definition. More active response from each POC is encouraged. China updated the WG-B on the progress of the BDS SAR and the BDS return link service. India also presented the results of a project on monitoring of rip currents and its application to improve safety on beaches on the Indian coastline.
17. The WG-B appreciated the variety of the contributions and noted the growing importance of the scientific use of GNSS. In addition, WG-B supported the joint session with WG-S and D on the topics of PPP and Timing interoperability.
18. The Working Group on Information Dissemination and Capacity-building (Working Group C) considered, through extensive deliberations, the outreach programmes and the capacity building activities carried out by the European Space Agency, The University of Tokyo, Tokyo University of Marine Science and Technology of Japan, Beihang University of China, the United Nations affiliated Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), Indian Space Research Organisation of India, the Moscow State University Geodesy and Cartography of the Russian Federation and the European Union. It was emphasized that these institutions could collaborate on future training curricula and opportunities.

19. The Working Group delved into certain points, pertinent to offering superior quality of education on GNSS and building up sustainable cooperation. These points included exchange of faculties across different regional centres; approaches and methods for dissemination of GNSS data and information about GNSS related events, and encouraging the working group participating institutions listed above to consider making available online GNSS courses.
20. The Working Group noted that a communication framework for the sharing of the short-term training opportunities should be developed, enabling efficient use of programmes provided by the United Nations- affiliated regional centres for space science and technology education and other institutions. By virtue of the experience in conducting short-term training courses, the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) in India could take a leading role in organizing such courses.
21. 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. Specific progress was noted: (1) the refinement of the alignments of GNSS reference frames to the ITRF, and (2) the information on the GNSS timing references and the inter-comparisons of GNSS time offsets. WG-D noted that the templates on geodetic and timing references currently provided on the ICG website should be updated by the GNSS Providers to contain the most current information.
22. It was noted that the work of ICG and WG-D has made significant progress in the realization of GNSS reference frames, and especially with their alignment to ITRF. This progress includes deformation of the terrestrial scale. As this work progresses into a high-accuracy positioning community service, participants are encouraged to consider how to address potential reference frame interoperability issues.
23. Knowledge of satellite physical and geometrical properties related to the shape, mass, optical properties, dimensions and locations of radiating antennas permits improved orbit modelling, which in turn increases the accuracy of satellite ephemerides and clock correction determination. WG-D acknowledges that there has been some progress made in the provision of satellite properties by the GNSS Providers based on the ICG Recommendation #23, and in accordance with the IGS whitepaper titled “Satellite and Operations Information for Generation of Precise GNSS Orbit and Clock Products”. The IGS collects and makes available GNSS satellite properties to the user community. Access to satellite metadata is essential for enabling scientific applications and for high accuracy precise positioning. WG-D also noted that provision of GNSS satellite phase center offset enables determination of the ITRF scale by GNSS. WG-D acknowledges the release of additional satellite metadata for QZSS, Galileo and BDS.
24. WG-D noted little progress on the ICG Recommendation #12. Some Providers are providing GNSS data from their tracking stations to the IGS. WG-D will continue

to monitor progress. WG-D continues to contribute to the IGMA initiative, in particular through involvement in the IGMA-IGS Joint Trial Project.

25. WG-D noted progress on the ICG Recommendation #21 on monitoring the offsets between GNSS times. Studies have been conducted by some Providers and the timing community identifying several methods to improve their time offset determination and impact on positioning. Additional work is necessary for the Providers to assess the accuracy goals in the determination of the GNSS time offsets and impact on positioning, so as to specify a recommended method to determine and monitor them. The common session between WGs S and D concluded that a further focused workshop should address these questions in 2020 by inviting receiver manufacturers to discuss multi-GNSS positioning and interoperability.
26. The Task Force on Timing References of WG-D has noted significant progress related to the ICG Recommendation #20 as BIPM is on the verge of extending the provision of UTC – UTC(k)_GNSS to Galileo and BDS. WG-D also noted the excellent performance of UTCr in particular since July 2017. It is recalled that the creation of UTCr by the BIPM was initiated by the ICG Recommendation #19.
27. WG-D acknowledges contributions from India and presentations of NavIC time scale, time transfer and space-based clock. WG-D notes interest by NavIC to propose an update regarding the ICG Recommendation #20 in the next ICG.
28. With respect to education and capacity building in developing countries, WG-D members also participated in education, outreach, and community engagement projects, in partnership with WG-C. Linkages between ICG capacity building initiatives and the Sendai Framework for Disaster Risk Reduction were also introduced.
29. WGs D and C chairs recognize synergies between the two WGs activities in GNSS, Geodesy and Reference Frames. It is suggested and agreed by both WGs to continue to work together and contribute to capacity building on GNSS and utilisation of GNSS in Geodesy and Reference Frames.
30. WG-D held a joint meeting with WGs B and S to discuss “Interoperability of GNSS Precise Point Positioning (PPP) Services”. The joint meeting discussions highlighted the importance to harmonize key aspects of System Provided PPP services, which subsequently led to a recommendation to establish a Task Force under WG-S Interoperability Sub-group.