

15th meeting of the International Committee on Global Navigation Satellite Systems, Vienna, 27 September – 1 October 2021

Joint Statement

1. The fifteenth meeting of the International Committee on Global Navigation Satellite Systems (ICG) was held in Vienna, from 27 September to 1 October 2021 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. The ICG intersessional meetings were held on 19 October 2021, 22 February 2022 and 14 April 2022.
2. On behalf of the United Nations, Simonetta Di Pippo, Director of the Office for Outer Space Affairs delivered an opening statement. Sharafat Gadimova, the Executive Secretariat of ICG, also addressed the meeting.
3. The meeting was attended from 27 September to 1 October 2021 in-person and/or virtually by representatives of Australia, China, India, Italy, Japan, Malaysia, New Zealand, 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 (APSCO), Civil Global Positioning System Service Interface Committee (CGSIC), Committee on Space Research (COSPAR), European Space Agency (ESA), European Position Determination System (EUPOS), Interagency Operations Advisory Group (IOAG), International Bureau of Weights and Measures (BIPM), International Association of Geodesy Reference Frame Subcommittee for Europe (EUREF), Federation Aeronautique Internationale (FAI), International Federation of Surveyors (FIG), International Association of Geodesy (IAG), International Association of Institutes of Navigation (IAIN), International GNSS Service (IGS) and the International Telecommunication Union (ITU). Representatives of the Office for Outer Space Affairs also participated.
4. Representatives of Islamic Republic of Pakistan, Republic of Korea, United Kingdom of Great Britain and Northern Ireland, Abdus Salam International Centre for Theoretical Physics (ICTP), Boston College, Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP, India), Goddard Space Flight Center (GSFC), Inter-Agency Space Debris Coordination Committee (IADC), International Civil Aviation Organization (ICAO), International Maritime Organization (IMO), L3Harris Technologies, Laboratoire de Physique des Plasmas of Sorbonne Université, Qascom, Radio Technical Commission for Maritime Services (RTCM), Regional Centre for Space Science and Technology Education for Latin America and the Caribbean (RECTEALC, Mexico), Regional Centre for Space Science and Technology Education for Western Asia (RCSSTEWA, Jordan), Royal Observatory of Belgium, Space Generation Advisory Council (SGAC), University of Rijeka were invited to attend as observers.
5. The intersessional meetings, held virtually on 19 October 2021, 22 February 2022 and 14 April 2022, were attended by representatives of Australia, China, India, Italy, Japan, Malaysia, New Zealand, Nigeria, Russian Federation, United Arab Emirates and United States. The European Union was also represented. Representatives of Islamic Republic of Pakistan and Republic of Korea also attended the meeting as invited observers.
6. Consensus was reached on accepting the request for membership of the Republic of Korea received in December 2019.
7. Regarding the membership of Pakistan, ICG received no objections from members, however, one member asked for further time to consider the technical merits of the application. The ICG Working Group S co-chairs and its subgroups co-chairs reviewed the government of Pakistan's request for membership in ICG, including the presentation from the June 2021 planning meeting and statements made during the ICG Plenary Meeting. Based on the characteristics described in the ICG Terms of Reference for membership, the Working Group co-chairs and its subgroups co-chairs have concluded that Pakistan satisfies the technical requirements for membership in ICG.

8. ICG agreed to invite Pakistan to continue its participation as an invited observer in the work of ICG, pending a formal decision on Pakistan's full membership at the sixteenth meeting of ICG in 2022.
9. ICG conducted an expert seminar entitled "Space weather and GNSS". At the seminar, the challenging aspects of space weather phenomena, their impact on GNSS users, the variability of those impacts and the actions that might mitigate their effects were described.
10. 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.
11. The Working Group on Systems, Signals and Services (Working Group S), through its subgroups and task forces, made good progress in advancing its workplan during the intersessional period between the fourteenth meeting of ICG and the fifteenth meeting of ICG. Under the leadership of the subgroup on Compatibility and Spectrum Protection, a ninth GNSS Interference Detection and Mitigation (IDM) workshop was conducted online in August 2021. At the workshop, a number of concepts and ideas were presented on IDM capabilities and methodologies, as well as GNSS resilience. The Working Group continued its campaign to promote adequate protection of GNSS spectrum by agreeing on a plan for completing a booklet on the importance of spectrum protection and IDM, which was a recommendation from the fourteenth meeting of ICG. The compatibility and spectrum protection subgroup also maintained awareness of GNSS/RNSS-related ITU activities. The Working Group tasked the subgroup to conduct workshops in 2022 focused on utilizing Automatic Dependent Surveillance Broadcast (ADS-B) and Automatic Identification System (AIS) for interference detection, and to further investigate national processes for notification of interference testing. The subgroup will also continue to discuss policy and technical measures regarding the resilient use of GNSS.
12. The subgroup on Interoperability and Service Provision held three virtual meetings during the intersessional period focused on continuing to make progress on recommended activities consistent with its workplan. An updated version 2.0 of the Performance Standard Guidelines document was adopted by the Working Group and will be made available for posting on the ICG information portal. The International GNSS Monitoring and Assessment (IGMA) task force continued to make progress on calculation methodologies and data formats for the joint ICG-IGS trial project, as well as an update to the project's Terms of Reference. The Performance Standard Subgroup and the IGMA task force plan to hold combined workshops in 2022, as well as continue to hold combined virtual meetings on a monthly basis. During a joint working group session on timing interoperability, a new recommendation for calculating GNSS offsets was presented from BIPM. The working group agreed on the need to hold an in-person workshop in 2022 in conjunction with Working Groups B and D, in order to further discuss techniques to ensure multi-GNSS time interoperability and determine if consensus can be reached on a recommendation. Finally, the Precise Point Positioning (PPP) Interoperability task force held two meetings and established its membership. In addition, the task force began putting together a template for collecting information from service providers on the characteristics of their PPP services. The task force agreed to hold a workshop later in 2022 to continue this effort.
13. Under the Working Group's focus on System of System Operations, a report was received from the Inter-Agency Space Debris Coordination Committee (IADC) in November 2020, following a recommendation from the thirteenth meeting of ICG to study the issue of debris mitigation practices relevant to the medium earth orbit (MEO) and inclined geosynchronous satellite orbit (IGSO) orbital regimes used by GNSS. The Working Group intends to complete its review of the report with input from system providers in time to submit feedback to the IADC before its planned meeting in June 2022.
14. The Working Group on Enhancement of GNSS Performance, New Services and Capabilities (Working Group B) has progressed in its activities.
15. The Working Group B Space Users Subgroup (SUSG) informed the Working Group on the progress since the fourteenth meeting of ICG. SUSG was pleased to announce the second

edition of the GNSS Space Service Volume (SSV) booklet, which represents a thorough review and update of all content, including the latest constellation data from all providers and adding real-world GNSS space user flight experiences. In addition, SUSG announced the release of the companion SSV video (available on the website of the Office for Outer Space Affairs). Both efforts were developed to convey the significant improvements afforded by the use of a multi-GNSS SSV and its benefits to science and humanity.

16. All ICG participants are encouraged to broadly disseminate both the booklet and the video within their respective regions and organizations. Furthermore, SUSG is interested in gathering feedback from booklet and video users and taking steps to further promote their use, including publication of translations and tailored versions.
17. SUSG also announced its new work plan for 2021–2022, which outlines five major areas of future work: (1) Availability of Provider Antenna Data, (2) GNSS Space User Mission Data, (3) GNSS Space User Timing Requirements, (4) Lunar GNSS SSV and (5) GNSS Space User Standards. SUSG requests and encourages collaboration with the other ICG working groups in each of these areas. Further coordination with international bodies like IOAG, the International Space Exploration Coordination Group (ISECG), the Space Frequency Coordination Group (SFCG) and others is planned.
18. Working Group recognizes the efforts made by its Application Subgroup (AppSG). Based on the joint statement of the fourteenth meeting of ICG, AppSG proposes to start a new initiative – “GNSS Applications – for Present and Future” – to survey GNSS applications that identifies challenges and facilitates the development of solutions that serve society. These actions are intended to provide assistance, lessons-learned and guidance to GNSS users. This initiative will lead to a research report entitled “GNSS Applications for Sustainable Development – Case Studies”.
19. Further enhancements are identified to create opportunities for greater participation and to attract new contributions to AppSG. All Working Groups members are encouraged to take a proactive role in support of this new initiative of AppSG.
20. AppSG intends to participate in important GNSS conferences and events to promote GNSS application development and to obtain information about trends in GNSS applications in line with the new initiative. AppSG also intends to support the GNSS Application Workshop of the Office for Outer Space Affairs.
21. Working Group appreciates the variety of the contributions such as the Galileo Emergency Warning Service (EWS), Vavigation with Indian Constellation (NavIC) NavCom (an electronic navigation and communication systems) and Science Applications, Beidou Satellite Navigation Systems (BDS) Search and Rescue (SAR) and LunaSAR, illustrating the convergence of science, positioning, navigation and timing (PNT) and communication systems. The growing importance of the scientific use of GNSS is noted by the Working Group.
22. Working Group recognised the potential impact of the rising solar activities of 25th solar cycle could have on GNSS services and satellites. Further discussions among experts through workshops should be conducted to understand the possible impact of space weather events and the need for alert systems. This will be subject to further discussion in Working Group 2022 intersessional meeting.
23. The Working Group on Information Dissemination and Capacity-building (Working Group C) addressed all areas of its workplan. Representatives of China, India, Japan, the Russian Federation, European Union and ESA gave presentations on their GNSS education programmes. The Working Group received an update on the activities undertaken or supported by UNOOSA during 2021 and the main results achieved.
24. The Working Group acknowledged the work of the United Nations-affiliated regional centres for Space Science and Technology Education, also acting as information centres for ICG. The Working Group would continue to collaborate with the regional centres to further develop the GNSS curriculum, including scientific applications, and provide support in carrying out seminars and training courses on space weather and GNSS.

25. Experience from the International Space Weather Initiative (ISWI) instrument network, that was developing space weather science, showed that the instrument network requires further enhancement. The Working Group proposed to establish a project team on “Space weather monitoring using low-cost GNSS receiver systems” that would develop prototype systems to explore the possibilities of using low-cost receiver systems for space weather monitoring.
26. 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 International Terrestrial Reference Frame (ITRF), and (2) the information on the GNSS timing references and the inter-comparisons of GNSS time offsets.
27. Working Group noted that the templates on geodetic and timing references currently provided on the ICG information portal should be updated by the GNSS providers to contain the most current information. Moreover, the tracking of updates on the web repository should be improved.
28. Working Group reiterates that 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. Working Group acknowledges that there has been some progress made in the provision of satellite properties by the GNSS providers based on Recommendation #23 in accordance with the whitepaper titled “Satellite and Operations Information for Generation of Precise GNSS Orbit and Clock Products” released by the IGS. 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. Working Group also noted that provision of GNSS satellite Phase Center Offsets (PCOs) significantly contributes to the determination of the scale of the GNSS/IGS reference frame and allows intercomparing with Satellite Laser Ranging (SLR) and Very Long Baseline Interferometry (VLBI) scales used to determine ITRF scale. Working Group acknowledges significant progress in the release of additional satellite metadata by Quazi-Zenith Satellite System (QZSS), Galileo and BeiDou-2.
29. Working Group noted little progress on Recommendation #12. Some Providers are providing GNSS data from their tracking stations to the IGS. Working Group will continue to monitor progress (in conjunction with IGMA); demonstrate the benefits and encourage all GNSS Providers to contribute. Working Group continues to contribute to the IGMA initiative, in particular through involvement in the IGMA-IGS Joint Trial Project.
30. Working Group noted the progress by the BIPM towards implementation of Rec #20 «BIPM publication of [UTC – GNSS times] and [UTC – UTC(k)_GNSS] ». Details on the procedure leading to the publication for all four Global navigation systems have been presented. Working Group acknowledged the great progress in the development of the NavIC infrastructure by India and encourages experimentation on the NavIC system time, also in collaboration with other metrological laboratories. It noted the proposal by India for NavIC to be included in the BIPM publication of [UTC – GNSS times] and [UTC – Brdc_UTC_{GNSS}] as first mentioned at the 14th meeting of ICG..
31. Working Group recognized that the extension of the BIPM publication to regional and national systems is not foreseen at the moment and must be discussed by BIPM international committees based on the needs of international users, so that updating Rec #20 in this direction is not mature at this stage. Working Group examined developments on Rec 21-B “On the monitoring of offsets of GNSS times”. It acknowledged the work carried out by the Consultative Committee for Time and Frequency (CCTF) and its working groups and task groups, emphasizing that the current broadcast predictions of (UTC-GNSStime) provide a ready-to-use and robust method to determine GNSS to GNSS timing offsets (GGTO). Working Group discussed a Recommendation of the CCTF (2021) “On the use of existing time scales to generate GNSS inter-system information”. This Recommendation solicits GNSS Providers to evaluate the possible use of the broadcast predictions of (UTC-GNSStime) for interoperability and to continue improvement of these predictions in collaboration with time laboratories. The Recommendation also invites receiver manufacturers to consider this

possibility for interoperability. Working Group D concluded that collaboration with Working Group S and Working Group will continue to further assess the user needs in view of considering support of Recommendation CCTF (2021) at the sixteens meeting of ICG.

32. Working Groups D and C chairs recognize synergies between the two Working Groups activities in GNSS, Geodesy and Reference Frames. Working Group -D will continue to work together with WG-C to contribute to capacity building on GNSS and utilization of GNSS in Geodesy and Reference Frames.
33. Working Group noted the recent efforts of the United Nations Committee of Experts on Global Geospatial Information Management (UN GGIM) and its Subcommittee on Geodesy (SCoG), namely the ongoing work of building and maintaining a Global Geodetic Reference Frame (GGRF), as well as the plans for establishment of a UN Global Geodetic Centre of Excellence (GGCE) in early 2022 at the United Nations campus in Bonn, Germany.
34. Working Group D, together with Working Groups B and S, highlighted the importance of harmonized key aspects of System Provided PPP services, which led to the successful establishment of the Task Force under Working Group-S Interoperability and Service Provision Subgroup.