



General Assembly

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Committee on the Peaceful Uses of Outer Space

Eleventh meeting of the International Committee on Global Navigation Satellite Systems

Note by the Secretariat

I. Introduction

A. Background

1. The establishment of the International Committee on Global Navigation Satellite Systems (ICG) in 2005 ushered in an unprecedented era of cooperation for the United Nations. ICG promotes coordination among leading satellite operators and strives to maximize the benefits of global navigation satellite systems (GNSS) in supporting sustainable development. One major challenge is to provide assistance and information to those countries seeking to integrate GNSS into their basic infrastructure, including at the governmental, scientific and commercial levels.
2. As a platform for open discussion and information exchange under the umbrella of the United Nations, ICG promotes the use of GNSS technology for environmental protection, disaster risk reduction, food security and making agriculture more sustainable and productive. GNSS technology also has a vital role to play in responding to emergencies, improving the efficiency of surveying and mapping, and enhancing the safety of transportation by land, sea and air.
3. The work of ICG is organized through four working groups involving both GNSS providers and international user groups. The working groups focus on systems, signals and services (co-led by the Russian Federation and the United States of America); enhancement of GNSS performance, new services and capabilities (co-led by China, India and the European Space Agency); information dissemination and capacity-building (led by the Office for Outer Space Affairs); and reference frames, timing and applications (co-led by the International Association of Geodesy, the International Federation of Surveyors and the International GNSS Service (IGS)).
4. In the Providers' Forum of ICG, the providers of space- and ground-based navigation systems work together to address key technical issues and operational concepts, including protection of the GNSS spectrum, orbital debris and orbit deconfliction.
5. The Office for Outer Space Affairs of the Secretariat, as the executive secretariat of ICG and its Providers' Forum, promotes the use of GNSS technology for national



development in a sustainable manner. The Office also implements a programme on GNSS applications, as mandated by ICG and the Forum (see [A/AC.105/1136](#)).

6. Previous meetings of ICG have been hosted by the United States (Boulder, 2016) (see [A/AC.105/1104](#)); the European Commission and the European GNSS Agency on behalf of the European Union (Prague, 2014) (see [A/AC.105/1083](#)); the government of Dubai (Dubai, United Arab Emirates, 2013) (see [A/AC.105/1059](#)); China (Beijing, 2012) (see [A/AC.105/1035](#)); Japan (Tokyo, 2011) (see [A/AC.105/1000](#)); Italy and the European Commission on behalf of the European Union (Turin, Italy, 2010) (see [A/AC.105/982](#)); the Russian Federation (Saint Petersburg, 2009) (see [A/AC.105/948](#)); the United States (Pasadena, 2008) (see [A/AC.105/928](#)); and India (Bangalore, 2007) (see [A/AC.105/901](#)). The First Meeting of ICG was organized and hosted by the Office for Outer Space Affairs in Vienna in 2006 (see [A/AC.105/879](#)).

7. The Eleventh Meeting of ICG was held in Sochi, Russian Federation, from 7 to 11 November 2016. The seventeenth meeting of the Providers' Forum was held, in conjunction with the meeting of ICG, on 6 and 10 November 2016. The Roscosmos State Corporation for Space Activities organized the meeting on behalf of the Government of the Russian Federation.

B. Structure and programme of the meeting

8. The programme of the Eleventh Meeting of ICG included three plenary sessions and a series of meetings of the four working groups. The first plenary session was held on 7 November 2016. That session provided an update on satellite-based navigation systems in operation and under development. A representative for each system provided a system overview, described current and planned characteristics and performance, presented updates to the schedule and plans and summarized ongoing interactions with other service providers. ICG members, associate members and observers, representing GNSS user groups, shared their views and ideas on matters of interest to ICG and its working groups.

9. In accordance with the ICG workplan, the four working groups met on 8 and 9 November 2016 to review progress made in implementing the recommendations made at previous meetings and ways and means of carrying them forward in 2017 and beyond.

10. A joint session of the working groups was held on 9 November 2016. The joint session considered each working group's workplan and recommendations status, including the actions to be taken on specific cross-cutting issues.

11. After considering the various items on its agenda, ICG adopted a joint statement (see sect. III below).

12. In conjunction with the Eleventh Meeting of ICG, the Providers' Forum held its seventeenth meeting on 6 and 10 November 2016 under the co-chairmanship of the Russian Federation and the United States (see sect. IV below).

C. Attendance

13. Representatives of the following States participated in the Eleventh Meeting of ICG: China, India, Italy, Japan, Russian Federation, United Arab Emirates and United States. The European Union was also represented.

14. The following intergovernmental and non-governmental organizations dealing with GNSS services and applications were also represented at the meeting: Arab

Institute of Navigation, Asia-Pacific Space Cooperation Organization, Civil Global Positioning System Service Interface Committee, European Space Agency, European Space Policy Institute, Interagency Operations Advisory Group, International Aeronautical Federation, International Association of Geodesy Reference Frame Sub-Commission for Europe, International Association of Institutes of Navigation, International Bureau of Weights and Measures, International Earth Rotation and Reference Systems Service, International Federation of Surveyors, International Steering Committee of the European Position Determination System and International Union of Radio Science. Representatives of the Office for Outer Space Affairs and the International Telecommunication Union also attended the meeting.

15. ICG decided to invite, at their request, observers for the Republic of Korea to attend the Eleventh Meeting and to address it, as appropriate, on the understanding that it would be without prejudice to further requests of that nature and that doing so would not involve any decision of ICG concerning their status.

16. A list of the States Members of the United Nations, United Nations entities and governmental, intergovernmental and non-governmental organizations participating in ICG is contained in annex I.

D. Expert seminar on global navigation satellite systems applications

17. An expert seminar entitled “High precision GNSS applications in various fields of the world economy” was held on 7 November 2016 to raise awareness of issues and opportunities in user applications and GNSS technology for consideration by ICG and its working groups.

18. Presentations given at the seminar included the following: “United States Position, Navigation and Timing Advisory Board (PNTAB): current activities and focus” and “Real-time GNSS for earthquake and tsunami early warning”, by the representatives of the United States; “Qianxun BeiDou Navigation Satellite Systems (BDS) high precision positioning services and applications”, by the representative of China; “High precision GNSS land applications in the economy” and “Prospects of application of high-precision navigation in the integrated agriculture”, by the representatives of the Russian Federation.

E. Documentation

19. A list of the documents of the Eleventh Meeting is contained in annex II. Those documents and further information on the meeting agenda, background materials and presentations are available on the ICG information portal (www.unoosa.org/oosa/en/ourwork/icg/icg.html).

II. Observations, recommendations and decisions

20. After considering the various items before it, at its Eleventh Meeting, ICG made the observations, recommendations and decisions set out below.

21. ICG noted that the joint working group session, held on 9 November 2016, was organized in the form of presentations and discussions on the following topics: (a) open service information-sharing; (b) service performance monitoring; and (c) international GNSS monitoring and assessment (IGMA).

22. The presentations given at the joint session included the following: “Future plans and international GNSS monitoring and assessment further development” by the

representative of the Russian Federation; “Monitoring and assessment algorithms on GNSS” and “GNSS signal in space quality evaluation and monitoring” by the representatives of China. A report on the IGMA task force was also presented.

23. ICG noted that the IGMA-IGS joint trial project was aimed at creating an authoritative IGMA system to benchmark the performance of available GNSS. It was noted that the Project would be implemented in phases. In the initial phase, a limited set of service parameters, such as post-processing, system-level performance monitoring for each single constellation would be monitored. Subsequent phases would strive for real-time processing, user-level performance monitoring and a combined product and assessment function.

24. ICG noted that the Working Group on Systems, Signals and Services had been discussing spectrum protection and interference detection and mitigation for over 10 years and collected a large amount of information about this subject. However, the discussions and information collected had been limited to ICG participants, especially spectrum experts and industry representatives from GNSS providers. It was therefore recommended that a call for participation in the ICG spectrum protection and interference detection and mitigation activities be presented to the Scientific and Technical Subcommittee on the Committee on the Peaceful Uses of Outer Space in 2017.

25. ICG took note with appreciation of the reports of its four working groups, which set out the results of their deliberations in accordance with their respective workplans.

26. ICG endorsed the decisions and recommendations of the working groups with regard to the implementation of the actions set forth in their workplans.

27. ICG noted the working groups’ schedule of intersessional meetings and workshops for 2017, which would be held in conjunction with the international conferences and symposiums.

28. ICG accepted the invitation of Japan to host the Twelfth Meeting of ICG in 2017 and noted the offer of China to host the Thirteenth Meeting in 2018. ICG also noted the expressions of interest by India and the Office for Outer Space Affairs in hosting the annual meetings of ICG in 2019 and 2020, respectively.

29. ICG agreed on a tentative schedule for the preparatory meetings for its Twelfth Meeting, to be held during the fifty-fourth session of the Scientific and Technical Subcommittee and the sixtieth session of the Committee on the Peaceful Uses of Outer Space, both in 2017. It was noted that the Office for Outer Space Affairs, as the executive secretariat of ICG and its Providers’ Forum, would assist in preparations for those meetings and the activities of the working groups.

30. At a closing ceremony, participants expressed their appreciation to the Roscosmos State Corporation for Space Activities for organizing the meeting and to the Office for Outer Space Affairs for its work in support of ICG and its Providers’ Forum, including carrying out planned activities.

III. Joint statement

31. ICG adopted by consensus the following joint statement:

1. The Eleventh Meeting of the International Committee on Global Navigation Satellite Systems (ICG) was held in Sochi, Russian Federation, from 7 to 11 November 2016 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 high-precision GNSS applications in various fields of the world economy.

2. The Designer General and Deputy Director of the State Space Corporation Roscosmos, the Mayor of the City of Sochi delivered opening speeches on behalf of the Russian Federation. The Director of the Office for Outer Space Affairs also addressed the Meeting.

3. The Meeting was hosted by the Russian Federation and organized by Roscosmos. The Meeting was attended by representatives of China, India, Italy, Japan, the Russian Federation, the United Arab Emirates, the United States and the European Union, as well as the following intergovernmental and non-governmental organizations: Arab Institute of Navigation, Asia-Pacific Space Cooperation Organization, Civil Global Positioning System Service Interface Committee, European Space Agency, European Space Policy Institute, Interagency Operations Advisory Group, International Aeronautical Federation, International Association of Geodesy Reference Frame Sub-Commission for Europe, International Association of Institutes of Navigation, International Bureau of Weights and Measures, International Earth Rotation and Reference Systems, International Federation of Surveyors, International Steering Committee of the European Position Determination System and International Union of Radio Science. Representatives of the Office for Outer Space Affairs and the International Telecommunication Union also participated. The Republic of Korea was invited to attend as observer.

4. ICG recalled that the General Assembly, in its resolution 70/82, 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 infrastructure, particularly in developing countries.

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) completed its first year of activities using its updated organizational structure approved by ICG at its Tenth Meeting. That structure included 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 an updated recommendation for ICG member administrations to encourage the protection of radio navigation satellite service (RNSS) spectrum from unwanted emissions. Efforts to encourage reporting on domestic RNSS spectrum protection through the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space will also continue, and an experts seminar on GNSS spectrum will be held on 13 and 14 December 2016, in conjunction with a United Nations regional workshop on GNSS, which will be held from 12 to 16 December 2016, in Kathmandu. The interference detection and mitigation (IDM) task force working under the subgroup organized and completed the fifth ICG-IDM workshop in Changsha, China, in May 2016. The sixth workshop focusing on both network-based and sensor-based (crowdsourcing) IDM capabilities will be held in May 2017, in conjunction with the Baška GNSS Conference in Baška, Croatia.

7. The subgroup on interoperability and service standards held a meeting in Vienna in June 2016 to discuss follow-up work on performance standards and interoperability. The discussions on interoperability based on previous system provider workshops resulted in two recommendations, one related to open service signal patents and the second related to system time aspects of interoperability among multiple GNSS. The IGMA task force conducted several meetings in 2016 and initiated a joint trial project with IGS to demonstrate a global GNSS monitoring and assessment capability, by monitoring a limited set of GNSS parameters. A related recommendation to conduct an IGMA workshop in conjunction with the 2017 China Satellite Navigation Conference (CSNC) in Shanghai, China, was adopted by ICG. Finally, the working group briefly discussed a new area of possible future work included in its workplan focused on system-of-systems operations such as orbital debris mitigation and orbit deconfliction, taking note of a presentation made in the Providers' Forum by the Russian Federation.

8. The 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 provided clear evidence that for space users at an altitude close to the geostationary orbit or higher, no single constellation can provide a sufficient level of GNSS signal availability. Exploiting the interoperability between all systems allows achievement of GNSS signal availability very close to 100 per cent. Members of the Working Group will conduct outreach activities on the interoperable GNSS SSV, including the publication of an ICG SSV booklet, conference sessions and papers, together with supporting illustrative video material. Future areas of work in relation to the interoperable GNSS SSV are identified. All service providers are involved in the SSV activities.

9. Search and rescue services will be implemented by Galileo, the Global Navigation Satellite Systems (GLONASS) and the Global Positioning System, according to the International Satellite System for Search and Rescue standards. Assessments are ongoing regarding the future evolution of BeiDou search and rescue functions.

10. In relation to new services and capabilities, feedback is provided on scientific experiments exploiting high-precision on-board clocks that show the potential to significantly improve the measurement accuracy of the gravitational red-shift. Future integrity concepts based on advanced receiver autonomous integrity monitoring will continue to be studied with the objective of exploiting the interoperability between the different systems for safety-of-life applications.

11. Space weather aspects will continue to be addressed, showing improvements that are achievable by advanced ionospheric modelling and receiver technologies.

12. The application subgroup of Working Group B continued its work and presented an application catalogue together with an initial version of an online questionnaire to collect future user needs. The application subgroup will work with the final objective to issue a report based on the feedback collected through the online questionnaire.

13. The Working Group on Information Dissemination and Capacity-Building (Working Group C) reviewed the implementation status and follow-up to its recommendations and noted the continuous progress made in 2016 by the Working Group with the support of the Office for Outer Space Affairs in the

promotion of the use of GNSS. Additional work carried out by the Office in support of ICG activities, including regional GNSS workshops, have been carried out satisfactorily.

14. Working Group C emphasized that regional centres for space science and technology education, which are affiliated to the United Nations and also serve as information centres for ICG and its Providers' Forum, have been working towards the establishment of a network of institutions involved or interested in GNSS. With the support of GNSS providers, they have also identified new applications that could be developed in the regions on the basis of GNSS services.

15. The Working Group on Reference Frames, Timing and Applications (Working Group D) noted significant continued progress on geodetic and timing references by GNSS providers. Specific progress was noted in (a) the availability of the new release of the International Terrestrial Reference Frame (ITRF2014) and the significant contribution of GNSS data; (b) the refinement of the alignments of GNSS-associated reference frames to the ITRF; and (c) the information on the GNSS timing references, the publications of the International Bureau of Weights and Measures and the intercomparisons of GNSS time offsets.

16. Working Group D has contributed and will continue to contribute to the IGMA initiative, in particular through the IGMA trial project and the joint IGS-IGMA call for participation.

17. Working Group D noted a lack of progress on two specific recommendations, number 12 and 23: one in relation to the provision to IGS of GNSS data of tracking stations of providers, and one on the possible provision by GNSS providers of satellite data that would help improve orbit modelling and accuracy. GNSS providers, represented in the Working Group, are solicited to follow up the implementation of the recommendations.

18. ICG accepted the invitation of Japan to host the Twelfth Meeting of ICG from 3 to 8 December 2017. The Office for Outer Space Affairs, in its capacity as the executive secretariat of ICG and its Providers' Forum, will assist in the preparations for the meeting and for interim planning meetings and working group activities to be held in 2017. ICG noted expressions of interest by China in hosting the Thirteenth Meeting of ICG in 2018, by India in hosting the Fourteenth Meeting in 2019 and by the Office for Outer Space Affairs in hosting the Fifteenth Meeting in 2020 in Vienna.

IV. Providers' Forum

32. The seventeenth meeting of the Providers' Forum, co-chaired by the Russian Federation and the United States, was held in conjunction with the Eleventh Meeting of ICG, on 6 and 10 November 2016, in Sochi, Russian Federation. China, India, Japan, the Russian Federation, the United States and the European Union were represented at the meeting.

33. After considering the items on its agenda, the Providers' Forum adopted the report on its seventeenth meeting, containing the recommendations set out below.

A. Summary of discussions and recommendations

1. Open service information dissemination

1. The following presentations were provided:

Space service volume

2. The Russian Federation gave a presentation on SSV and the practical results of using GNSS for positioning, navigation and timing of Russian geosynchronous orbit (GEO) satellites for 10 years. The presentation discussed the benefits of using GNSS for high-orbiting satellites and signal geometry. It also reviewed results on visibility, geometry and positioning accuracy. The knowledge and experience gained so far has revealed prospects for on-board autonomous GNSS navigation technology for GEO and highly elliptical orbit satellites, and identified new benefits for many high-orbit missions.

3. The United States presented an update on the progress in developing and utilizing the GNSS SSV. It was noted that the GPS and GNSS systems, in general, are being utilized for three purposes: real-time on-board navigation; earth science, including atmospheric and ionospheric science and geodesy; and attitude determination, in particular for the International Space Station. The presentation discussed the significant benefits of SSV cooperation and specifications for high-altitude space user performance when moving from GPS-only usage to multi-GNSS usage, which increases the signal visibility of a main-lobe-only system from sporadic to nearly continuous. The United States expressed appreciation for the significant contributions presented by the Russian Federation on SSV progress and to the ICG Working Group B for the substantial work they have accomplished over the past year. The Providers' Forum noted that Japan will host the second International Space Exploration Forum in 2017. In addition to the Twelfth Meeting of ICG, there may be a natural synergy between these events with respect to discussion on SSV.

Global positioning system time offset issue

4. The United States presented an update on the January 2016 Coordinated Universal Time (UTC) time offset anomaly to GPS. It was noted that software updates were implemented to resolve the core upload issue, with future software updates planned to further reduce the risk of a reoccurrence. The Institute of Navigation paper (available at www.gps.gov/systems/gps/performance) discusses the impacts to receivers. It was explained that this software issue is not unique to GPS. Monitoring systems can reduce the impact on users.

Space debris

5. The Russian Federation gave a presentation on space debris in GNSS operational orbits. The presentation discussed the population and density of catalogued objects in GNSS orbits and the results of an analysis of long-term orbital evolution of GNSS satellites, specifically looking at the intersection of orbits of different GNSS satellites. GLONASS mitigation measures were described and compliance with the Committee on the Peaceful Uses of Outer Space and Inter-agency Space Debris Coordination Committee Space Debris Mitigation Guidelines was noted. A recommendation was made for providers to monitor discussions related to debris mitigation in medium Earth orbit by linking with experts working in those international organizations.

International GNSS Monitoring and Assessment System update

6. China presented an update on the International GNSS Monitoring and Assessment System (iGMAS), and explained that the objectives are to establish a global tracking network and to monitor operational status and key indicators for all GNSS. The system has an open architecture and other international monitoring centres and GNSS tracking stations are invited to participate. Most of the system construction has been completed, with 18 tracking stations around the world, and routine service is now underway. Information distribution of the system is now available in Chinese and English through a website (<http://124.205.50.178>) and an application that can be downloaded for mobile use.

Adjacent band compatibility

7. The United States presented an update on the adjacent band compatibility study that resulted from a proposal by a private company in 2011 to broadcast terrestrial mobile telecommunication signals adjacent to the GNSS L1 frequency band in the United States. The testing in 2011 showed impact to virtually all GPS receivers. The goal of the study is to determine the power levels that can be tolerated in the adjacent radiofrequency bands. Radiated testing in an anechoic chamber was completed in 2016, as were lab testing and antenna characterization. Eighty GPS and GNSS receivers were tested, which included the following six categories: general aviation (non-certified), general location/navigation, “high precision and networks”, timing, space-based and cellular. An overview of the preliminary results was presented.

2. Service performance monitoring

8. The United States gave a presentation on the GPS service performance standard assessment. The 2013 GPS performance standard report has been published and is available online (see www.gps.gov/systems/gps/performance). The 2014 and 2015 reports are being finalized and will be available in 2017. These reports measure GPS performance against the GPS standard positioning service performance standard parameters. Other GNSS providers are encouraged to make available similar reports for their systems.

3. Multi-GNSS demonstration project in the Asia/Oceania region

9. Japan provided an update on the multi-GNSS demonstration project in the Asia/Oceania region. There are three components to the project: the establishment of monitoring networks, application demonstrations and regional workshops. Currently there are 99 multi-GNSS monitoring network stations in operation. Multi-GNSS Asia (MGA) is an organization that promotes the project with 53 participating organizations. The 8th MGA Conference was held from 14 to 16 November 2016 in Manila. MGA discussed possible updates to its workplan enhancing the linkage with ICG.

4. Information centres of the International Committee on Global Navigation Satellite Systems: regional centres for space science and technology education (affiliated to the United Nations)

10. The ICG executive secretariat reported that the regional centre in Rabat will host a training course on GPS data processing for studies of the ionosphere from 16 to 21 January 2017. Experts from the United States and other GNSS providers are invited to participate in this training.

B. Other matters**1. Terms of reference of the Providers' Forum**

11. The providers agreed to the schedule through 2019, and it was noted that co-chairs will be provided by the following members: China and Japan will co-chair the 2018 Providers' Forum meeting, and China and India will co-chair the 2019 meeting. The terms of reference will be modified accordingly.

2. Membership and participation in the International Committee on Global Navigation Satellite Systems

12. The request received in January 2016 for observer status from the Resilient Navigation and Timing Foundation was noted. It was suggested that the Foundation be invited to present their purpose and reason for interest in becoming an observer to ICG. It was further noted that a participant from the Foundation was not available to attend the ICG-11 meeting.

13. The providers noted the expression of interest from the Korean Aerospace Research Institute (KARI), on behalf of the Government of the Republic of Korea, to participate in the ICG-11 meeting as an invited observer and concurred with the request.

14. The Providers' Forum reviewed the recommendations from the four working groups and agreed that they should be adopted by ICG at its last plenary session. The Providers' Forum also adopted the summary of its seventeenth meeting.

Annex I

List of States Members of the United Nations, United Nations entities and governmental, intergovernmental and non-governmental organizations participating in the International Committee on Global Navigation Satellite Systems

China
India
Italy
Japan
Malaysia
Nigeria
Russian Federation
United Arab Emirates
United States of America
European Union
Arab Institute of Navigation
Asia-Pacific Space Cooperation Organization
Civil Global Positioning System Service Interface Committee
Committee on Space Research
European Space Agency
European Space Policy Institute
Interagency Operations Advisory Group
International Aeronautical Federation
International Association of Geodesy
International Association of Geodesy Reference Frame Sub-Commission for Europe
International Association of Institutes of Navigation
International Bureau of Weights and Measures
International Cartographic Association
International Earth Rotation and Reference Systems Service
International Federation of Surveyors
International Global Navigation Satellite System Service
International Society for Photogrammetry and Remote Sensing
International Steering Committee of the European Position Determination System
International Telecommunication Union
International Union of Radio Science
Office for Outer Space Affairs of the Secretariat

Annex II**Documents of the Eleventh Meeting of the International
Committee on Global Navigation Satellite Systems**

<i>Symbol</i>	<i>Title or description</i>
ICG/WGS/2016	Report of the Working Group on Systems, Signals and Services
ICG/WGB/2016	Report of the Working Group on Enhancement of GNSS Performance, New Services and Capabilities
ICG/WGC/2016	Report of the Working Group on Information Dissemination and Capacity-Building
ICG/WGD/2016	Report of the Working Group on Reference Frames, Timing and Applications
ICG/PF/TOR/2016	Terms of Reference of the Providers' Forum
