International Committee on Global Navigation Satellite Systems

EXTRACTS

from Reports of the International Committee on Global Navigation Satellite Systems and its Providers' Forum

Prepared by the United Nations Office for Outer Space Affairs as the Executive Secretariat of the International Committe on Global Navigation Satellite Systems and its Providers' Forum

20 January 2025

EXPLANATORY NOTE

The following informal compilation reproduces paragraphs from the United Nations General Assembly (UNGA) documentation in the A/AC.105/ series on the annual meetings of the International Committee on Global Navigation Satellite Systems (ICG), held since 2006, in which decisions and recommendations undertaken by ICG and its Providers' Forum are reflected. When necessary, the compilation is to be read with the UNGA annual reports. References are provided to the full text of the respective reports, including links to electronic copies thereof.

The Terms of reference of ICG and its Providers' Forum, the workplan of the Providers' Forum and the list of State Members of the United Nations and governmental, intergovernmental and non-governmental organizations participating in ICG are contained in annexes I through IV. A template for sharing information between service providers and the list of the meetings of ICG are contained in annexes V and VI. The list of publications is contained in annex VII. The statement of the Providers' Forum concerning ICG is contained in annex VIII. The summary of discussions concerning the "Future of ICG" is contained in annex IX, and the Mission Statement and Vision Statement of ICG are contained in annexes X and XI respectively.

Documents are available in all official languages of the United Nations and can be downloaded from the ICG information portal at www.unoosa.org or directly at: http://www.unoosa.org/oosa/en/ourwork/icg/icg.html

LIST OF ACRONYMS

AIN	Arab Institute of Navigation
APSCO	The Asia-Pacific Space Cooperation Organization
ARAIM	Advanced Receiver Autonomous Integrity Monitoring
BIPM	International Bureau of Weights and Measures
BDS	BeiDou Navigation Satellite System
CGS	China Geodetic Coordinate System
CGSIC	Civil Global Positioning System (GPS) Service Interface Committee
CNSS	Compass/BeiDou Navigation Satellite System
COSPAR	Committee on Space Research
COSPAS-SARSAT	International Satellite System for Search and Rescue
CSNC	China Satellite Navigation Conference
EGNOS	European Geostationary Navigation Overlay Service
EIAST	Emirates Institution for Advanced Science and Technology
ESA	European Space Agency
ESPI	European Space Policy Institute
EUPOS	European Position Determination System
EUREF	Reference Frame Sub-Commission for Europe
FAI	World Air Sports Federation
FCC	Federal Communications Commission
FIG	International Federation of Surveyors
GAGAN	GPS-aided GEO-augmented Navigation System
Galileo	European Global Navigation Satellite System
GEO	Geosynchronous orbit
GLONASS	Global Navigation Satellite System
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
ETRS	European Terrestrial Reference System
IADC	Inter-Agency Space Debris Coordination Committee
IAG	International Association of Geodesy
IAIN	International Association of Institutes of Navigation
ICA	International Cartographic Association
ICAO	International Civil Aviation Organization
ICG	International Committee on Global Navigation Satellite Systems
IDM	Interference detection and mitigation
IERS	International Earth Rotation and Reference Systems Service
IGMA	International GNSS Monitoring and Assessment
iGMAS	International GNSS Monitoring and Assessment Service
IGS	International GNSS Service

IMO	International Maritime Organization
IOAG	Interagency Operations Advisory Group
IRNSS	Indian Regional Navigation Satellite System
ISPRS	International Society for Photogrammetry and Remote Sensing
ISRO	Indian Space Research Organization
ITRF	International Terrestrial Reference System Frame
ITU	International Telecommunication Union
JAXA	Japan Aerospace Exploration Agency
JGS	Japan satellite navigation Geodetic System
LSQ	LightSquared
MEOSAR	Medium-Earth Orbit Search and Rescue
MGA	Multi-GNSS Asia
MSAS	The MTSAT Satellite Augmentation System
MTSAT MSAS	Multi-Function Transport Satellite (MTSAT) Satellite--based Augmentation System
M-GEX	Multi-GNSS Experiment
NASA	National Aeronautics and Space Administration
NavIC	Navigation with Indian Constellation
NigComsat-1 SBAS	Nigerian Communication Satellite Space Based Augmentation System
PPP	Precise Point Positioning
PZ	Parametry Zemli
QZSS	Quasi-Zenith Satellite System
RNSS	Radio Navigation Satellite Services
Roscosmos	Federal Space Agency
SDCM	System of Differential Correction and Monitoring
SSV	Space Service Volume
UNGA	United Nations General Assembly
UNOOSA	United Nations Office for Outer Space Affairs
URSI	International Union of Radio Science
UTC	Coordinated Universal Time
WAAS	Wide-Area Augmentation System
WGS	World Geodetic System

CONTENTS

1. BACKGROUND

At the fourth meeting of the Providers' Forum held in 2009 in conjunction with the fourth meeting of the International Committee on Global Navigation Satellite Systems (ICG) in Saint Petersburg, Russian Federation, it was agreed that the Providers' Forum would develop a document consolidating decisions and conclusions reflected in the reports of past meetings of the ICG and its Providers' Forum.

ICG, established under the umbrella of the United Nations in 2005, is meeting annually to promote the enhancement of and universal access to space-based positioning, navigation and timing systems and their compatibility and interoperability.

The ICG Providers' Forum, comprising the United States, the Russian Federation, the European Union, China, India and Japan, was established in the second meeting of ICG in 2007 in India. The Providers' Forum adopted its Terms of Reference and a work plan at the third meeting of ICG in 2008 in the United States.

In compliance with the work plan of ICG, as adopted in the first meeting of ICG organized by the Office for Outer Space Affairs in Vienna in 2006, ICG organizes its work through four working groups focusing on (a) systems, signals and services (formerly compatibility and interoperability) co-led by the Russian Federation and the United States of America; (b) enhancement of performance of GNSS services co-led by China, India and the European Space Agency (ESA); (c) information dissemination and capacity building led by the Office for Outer Space Affairs; and (d) reference frames, timing and applications co-led by the International Association of Geodesy (IAG), the International Federation of Surveyors (FIG) and the International GNSS Service (IGS).

To support the work of ICG, the United Nations Office for Outer Space Affairs was designated as the Executive Secretariat of ICG.

2. EXTRACTS FROM CONCLUSIONS OF THE PROVIDERS' FORUM MEETINGS

Service provision from current and planned global navigation satellite systems

2007: [A/AC.105/901, chapter IV, para. 38]

Information exchanged at the Providers' Forum revealed that all current and future providers were committed to their plans to deploy and/or modernize their respective global and regional satellite navigation systems having the following important characteristics:

a) Service to users was provided or would be provided from all systems in radiofrequency spectrum bands internationally allocated for radio-navigation satellite services (RNSS) in L-band (960-1300 MHz and 1559-1610 MHz). Two systems would also broadcast a navigation signal in S-band (2491.005 ± 8.25 MHz). The band 5000-5030 MHz could be used in the future by one or more systems;

b) All systems were broadcasting or would broadcast an open service using one or more signals provided to users free of direct user charges;

c) Many systems also broadcast authorized services specifically designed to meet the needs of authorized users in support of governmental functions.

2007: [A/AC.105/901, chapter IV, para. 39]

Participants in the Providers' Forum also agreed that:

a) Transparency in the provision of open services was desirable and required the open publication and dissemination of signal and system characteristics, in due time, required to allow manufacturers to design and develop global navigation satellite systems (GNSS) receivers on a non-discriminatory basis;

b) Discussions should emphasize that cooperation regarding global navigation satellite systems (GNSS) infrastructure (space and ground control/monitoring segments) for open services was desirable in order to permit open, free commercial competition in receiver and applications markets;

c) System providers should strive to monitor the performance of their open signals and provide timely updates to users regarding critical performance characteristics such as timing accuracy, positioning accuracy and service availability;

d) The protection of RNSS spectrum was vital to GNSS service provision. Therefore, adequate spectrum protection through domestic and international regulation should be pursued. In addition, steps to detect and mitigate interference to GNSS worldwide should be pursued;

e) Physical separation of operational satellite constellations and end-of-life disposal orbits should also be examined;

f) The concept of service guarantees should also be examined.

Promotion of compatibility and interoperability[1]

2010: [A/AC.105/982, chapter IV, para. 32, section A.1, item 2]

The current definition of interoperability appears not to need any further modification based on a survey conducted by Working Group A. Based on the results of a compatibility workshop held on 7 June 2010, it was also noted that the current definition of compatibility does not require modification either.

Open service information dissemination

2010: [A/AC.105/982, chapter IV, para. 32, section A.2, item 5]

In the framework of the US-funded GNSS Evolutionary Architecture Study the use of dual frequency and advanced receiver autonomous integrity monitoring was recommended in order to get benefits for aviation. Some important performance parameters were being investigated for possible inclusion in future performance standards. It was also recommended that other service providers consider including those parameters in developing their performance standards, once the definitions had been finalized.

It was proposed that other system providers should consider using the GPS Standard Positioning Service Performance Standard as a template for developing their own performance standard.

2012: [A/AC.105/1035, chapter IV, para. 33, section A.2, item 1]

The representatives of the European Union and the United States of America made a presentation on their joint efforts in the area of using multiple GNSS constellations for advanced receiver autonomous integrity monitoring (ARAIM) and requested from the Providers service commitments to expand the use of multiple constellations.

The United States requested that the Providers' Forum members complete the templates developed to document the space service volume characteristics of the Provider systems.

2013: [A/AC.105/1059, chapter IV, para. 38, section A.2, items 2 - 3]

The United States presented an update to the GNSS space service volume concept. The United States continued to encourage the development of an interoperable space service volume to enable improved capabilities. The presentation highlighted some of the advantages of creating an interoperable global space service volume, including improvements to space weather predictions and lunar navigation. A template had already been distributed through Working Group B for assistance in that effort.

The European Union provided an update on the Galileo in-orbit validation, which is the validation before system deployment. It reported two successful in-orbit validation satellite launches and highlighted that they were well on their way to achieving full operational

[1] The definitions of compatibility and interoperability are listed under Appendix of Annex III

capability. The in-orbit validation campaign had been initiated in May 2013 and completed in November 2013, with very good performance results.

2014: [A/AC.105/1083, chapter IV, para. 38, section A.1, item 1]

The United States encouraged GNSS and radio-navigation satellite services partners to complete the space service volume templates, develop specifications and publish constellation data.

2014: [A/AC.105/1083, chapter IV, para. 38, section A.1, item 2]

The United States presented background information on Medium-Earth Orbit Search and Rescue (MEOSAR) as an application for the International Satellite System for Search and Rescue (COSPAS-SARSAT).

2014: [A/AC.105/1083, chapter IV, para. 38, section A.1, item 5]

The European Union intends to publish the Galileo characteristics related to the interoperable GNSS space service volume in early 2015.

2014: [A/AC.105/1083, chapter IV, para. 38, section A.1, item 6]

It was noted that the United States national space policy encouraged market access, and that bilateral discussions had been held with Japan and the European Union on that topic. The United States would prefer to see technology-neutral performance-based standards, which would allow manufacturers and users to identify the optimal means for meeting requirements.

2016: [A/AC.105/1134, chapter IV, para. 33, section A.1, items 2 - 7]

Space Service Volume (SSV): 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.

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.

Global positioning system time offset issue: 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: 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: 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: 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.

2017: [A/AC.105/1158, chapter IV, section A.1 (a), para. 32]

Adjacent-band compatibility: The United States presented an update on the adjacent-band compatibility study that resulted from a proposal by a United States private company made in 2011 to broadcast, in the United States, terrestrial mobile telecommunication signals adjacent to the radio-navigation satellite services (RNSS) L1 frequency band. The goal of the study was to determine the power levels that can be tolerated in the adjacent radiofrequency bands. The presentation focused on the GNSS protection criteria recommended by the United States National Space-Based Positioning, Navigation and Timing Advisory Board, including the 1 dB carrier-to-noise degradation as a GNSS receiver interference protection criterion. In order to determine appropriate interference tolerance masks at the GNSS receiver antenna

input, radiated testing in an anechoic chamber was completed in 2016 using 80 civil GPS/GNSS receivers that included the following six categories: general aviation (non-certified), general location/navigation, high-precision and networks, timing, space-based, and cellular. The impact regions of a 1 dB or greater carrier-to-noise degradation that would be caused by the potential deployment of terrestrial mobile and base stations was computed for different network deployment scenarios. The results demonstrated that high-precision receivers could experience a degradation of 1 dB beyond 10 km based on macro-urban deployment with loss of lock on all GNSS satellites within 1 km of the interfering transmitter. The results highlighted that the distance from the GNSS receiver to the transmitter was a key factor, as were the transmitter density and inter-site distance associated with the network deployment.

2017: [A/AC.105/1158, chapter IV, section A.1 (b), paras. 35 – 37 and 39]

Medium Earth Orbit Search and Rescue system update: The United States presented an update on the progress made with the implementation of the Medium Earth Orbit Search and Rescue (MEOSAR) system. MEOSAR implementation was currently at its initial operating capability, with 20 experimental S-band payloads and 7 operational L-band payloads. MEOSAR offered near-instantaneous beacon detection, while satellite systems in low-Earth and geosynchronous orbits could experience a delay in signal acquisition, processing, and transmission to the ground.

Currently there were three space-segment MEOSAR providers: GPS, Galileo, and GLONASS. The future inclusion of the BDS search-and-rescue payload into COSPAS-SARSAT was acknowledged. The next step would be to amend the terms of reference of the correspondence working group on the space segment of MEOSAR to encourage China to participate.

COSPAS-SARSAT acknowledged that discussions about downlinks needed to continue within the programme to ensure that beam collision was mitigated, as all four providers would need to share two downlink bands (1,544.0–1,544.2 MHz and 1,544.8–1,545.0 MHz).

The European Union expressed its concerns about potential interference between MEOSAR downlinks in the 1,544–1,545 MHz band. The European Union recognized that the substantive discussion was conducted in COSPAS-SARSAT groups, but given the urgency, it encouraged the GNSS providers, as a matter of priority, to fully engage in those technical discussions, consider all options to prevent interference, and then, in due course, report back to ICG on the progress made.

2017: [A/AC.105/1158, chapter IV, section A.1 (c), paras. 40 – 42]

Update on space service volume: The United States presented an update on the progress made in developing and utilizing a GNSS SSV and on the benefits of SSV to the domains of real-time on-board navigation, Earth sciences, launch vehicle range operations, attitude determination and time synchronization.

The benefits of using GNSS for real-time navigation in SSV are improved real-time navigation performance, quicker trajectory manoeuvre recovery, a reduced need for expensive on-board clocks, increased satellite autonomy and better performance for missions in highly elliptical orbit, geosynchronous orbit and beyond.

The speaker gave examples of GNSS being used for the positioning, navigation and timing of satellites, including meteorological satellites of Japan, the United States and the European Union, in geosynchronous and highly elliptical orbits.

2017: [A/AC.105/1158, chapter IV, section A.1 (e), para. 51]

Application activities relating to global navigation satellite systems under the Belt and Road Initiative: BDS provided regional services and covered 30 countries included in the Belt and Road Initiative. Between 2015 and 2016, five BDS-3 testing satellites had been launched, while new technologies and concepts for BDS-3 had been validated and tested. BDS-3 would include a nominal 30-satellite constellation. The first pair of BDS-3 satellites had successfully been launched on 5 November 2017.

2018: [A/AC.105/1191, chapter IV, section A.1 (a), paras. 42-44]

BeiDou Navigation Satellite System featured service: China presented BDS-3 featured service. BDS-3 will provide two basic services, regional navigation satellite systems and SBAS. In addition, BDS-3 will provide three featured services, international search and rescue service, short message communication (SMC) service (regional and global), and precise point positioning (PPP) service.

The BeiDou search and rescue service meets the international standard, and has a return link function, which provides a useful enhancement to that rescue service. The B2b signal is used to broadcast confirmation messages and other messages associated with search and rescue to users. The three inclined geosynchronous orbit satellites and the 24 medium Earth orbit satellites have the return link function.

BDS-3 regional SMC service has a two-way link, including an uplink on L band, and a downlink on S band. It plays an important role in safety-of-life applications. BDS-3 also deploys SMC service globally through crosslinks.

2018: [A/AC.105/1191, chapter IV, section A.1 (b), paras. 48, 50 and 51]

Update on the space service volume: The United States presented updates to the space service volume (SSV) effort by NASA and ICG Working Group B. Space-based uses of the Global Positioning System (GPS) and other GNSS include real-time on-board navigation, Earth sciences, launch vehicles range operations, attitude determination and timing synchronization. Working Group B is actively improving capabilities of GNSS use in SSV by furthering compatibility and interoperability. Both missions conducted in the range from low Earth orbit to geosynchronous equatorial orbit and missions conducted beyond the space service volume (from geosynchronous equatorial orbit to lunar distance) can benefit from real-time navigation using GNSS.

The United States team presented results of the Antenna Characterization Experiment, which provided the first reconstruction of the full GPS antenna gain patterns from flight observations. This supports the priority task of measuring and publishing GNSS antenna gain patterns to support understanding of SSV and use of GNSS in mission simulations. Another important update pertaining to data collection is that an additional apogee-raising manoeuvre

is planned for the Magnetospheric Multiscale mission in February 2019 up to 29 Earth radii — the equivalent of half the lunar distance — which will produce data for presentation at the fourteenth meeting of ICG.

Recent international outreach efforts include actively engaging in ICG Working Group B to publish the SSV booklet for the thirteenth meeting of ICG and continuing work on the accompanying SSV video scheduled for release in the first half of 2019. The United States is very interested in continuing international collaboration, including supporting the international team on outreach and panel sessions. Ongoing international activities include a NASA lunar GPS visibility simulation, which demonstrates that current SSV-capable receivers can support navigation and timing at lunar distances, engagement in use of GNSS on board the planned Lunar Orbital Platform-Gateway, and alignment with and support for the International Space Exploration Coordination Group's Global Exploration Roadmap.

2019: [A/AC.105/1217, chapter IV, section A.1, para. 31 (a)]

Update on the International GNSS Monitoring and Assessment System and a preliminary assessment of multi-GNSS performance: China presented an update on its International GNSS Monitoring and Assessment System (iGMAS), including results and the enhancement of iGMAS by implementing new receivers to process all GNSS open signals. In addition, it was reported that iGMAS preliminary performance evaluation of multi-GNSS showed that use of multi-GNSS had obvious advantages in terms of position dilution of precision and convergence time for PPP. It was also reported that the routine assessment showed that BDS-3 had better performance than BDS-2.

2022: [A/AC.105/1276, chapter IV, section A.1, paras. 31 and 32]

The United States presented an update on its distress notification and tracking system for lunar exploration. LunaSAR allowed a crew member on the lunar surface to send a distress signal should they become endangered or separated from their crew members. In addition to the architecture of LunaSAR, the potential for international collaboration and cooperation, including possible interoperability with the European Space Agency Moonlight initiative, was also addressed.

The European Commission presented the current programme status of Galileo. The status of the Open Service Navigation Message Authentication function, High Accuracy Service, I/NAV message improvement, search and rescue, Emergency Warning Service and other upcoming services and features were also reported. In addition, an overview was provided of the Galileo second-generation satellites.

2023: [A/AC.105/1304, chapter IV, section A.1, para. 27]

The European Union gave an update on the Galileo programme, emphasizing the services already provided and the new services under preparation. Participants were also invited to participate in the upcoming User Consultation Platform.

2024: [A/AC.105/1327, chapter IV, section A.1, para. 24 - 26]

The organizers of the second ICG workshop on future low Earth orbit positioning, navigation and timing systems presented a summary. There was good engagement by those planning such systems, and a table of the expected systems, with key characteristics, were shown. Systems were either stand-alone or planned to augment existing GNSS. The importance of compatibility with existing medium Earth orbit and geostationary Earth orbit GNSS was emphasized. […]

ESA presented work conducted on the Proba-3, the Lunar Pathfinder and the GNSS Experiment, known as the EXPOL projects. They were aimed at supporting activities to provide robust, accurate and precise lunar and cislunar positioning, navigation and timing services by making improvements to precise orbit determination and in high-eccentric orbits and high dynamic environments, and at demonstrating the clear advantage of and need for interoperability.

The United States provided an update on the country's objectives and plans for an open architecture lunar positioning, navigation and timing system focusing on specific user needs, a gradual expansion from utilizing GNSS on the Moon to dedicated lunar systems and promoting interoperability specifications to enable international compatibility.

Service performance monitoring

2010: [A/AC.105/982, chapter IV, para. 32, section A.3, item 7]

It was suggested that a workshop on interference detection and mitigation be organized or multi-disciplinary ICG task force be established to make progress on the topic.

2012: [A/AC.105/1035, chapter IV, para. 33, section A.2, item 3]

China provided information on the status and progress of the International GNSS Monitoring Assessment System (iGMAS). It was noted that iGMAS would support various multi-GNSS monitoring activities such as cooperating with the International Global Navigation Satellite System Service Multi-GNSS Experiment (M-GEX) by sharing stations, data and geodetic receivers. China requested that more countries and organizations participate in future iGMAS activities.

2013: [A/AC.105/1059, chapter IV, para. 38, section A.3, item 4]

The United States made a presentation on GNSS civil performance monitoring, explaining that such monitoring provided benefits to both providers and users and supported the ICG principle of transparency. The Civil Monitoring Performance Specification addressed current civil GPS signals by specifying metrics that address performance measures based on the GPS performance standard.

2014: [A/AC.105/1083, chapter IV, para. 38, section A.2, item 7]

China noted two recommendations that had been proposed to Working Groups A, B and D: the first was for the establishment of an information portal for international GNSS

monitoring and assessment, and the second was for the international GNSS monitoring and assessment task force to hold a workshop in 2015.

2016: [A/AC.105/1134, chapter IV, para. 33, section A.2, item 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.

2022: [A/AC.105/1276, chapter IV, section A.2, para. 33]

China presented an update on its international GNSS monitoring and assessment System, including on system infrastructure and evaluation results. Monitoring and evaluation result analysis reflected the signal-in-space ranging error, availability and continuity, the Coordinated Universal Time offset error and positioning accuracy assessment results of the BeiDou Navigation Satellite System, Global Positioning System, Global Navigation Satellite System and Galileo. The system was recently updated to evaluate the BeiDou Navigation Satellite System precise point positioning service, showing the signal-in-space ranging error and positioning accuracy of precise point positioning signals. The service performance of multiple GNSS systems would be continuously evaluated and the service performance of new signals and services tracked.

2023: [A/AC.105/1304, chapter IV, section A.2, para. 28]

China gave an overview of progress made on its international GNSS monitoring and assessment system. The performance of four global navigation satellite systems was reviewed through daily monitoring of per-slot availability and continuity, signal-in-space range errors, Universal Time Coordinated offset errors, standard positioning accuracy, and ionosphere activity influences on positioning accuracy. The outcome was also shared of the latest work on continuous monitoring of the BeiDou Navigation Satellite System and Galileo precise point positioning services, analysis of advanced receiver autonomous integrity monitoring integrity support message parameters and global availability of multi-GNSS.

2024: [A/AC.105/1327, chapter IV, section A.2, para. 27]

China provided information on the progress made on its international GNSS Monitoring and Assessment System (iGMAS). The performance of four global navigation satellite systems was reviewed through daily monitoring of per-slot availability and continuity, signal-in-space range error, UTC offset error, standard positioning accuracy, and the BDS-3 B2b-PPP enhanced services over the past year. […]

Report on a multi GNSS demonstration project

2010: [A/AC.105/982, chapter IV, para. 32, section B.1, item 8]

It was proposed that ICG become more involved in the multi-GNSS demonstration project by frequently producing reports and inviting the co-chairs of Working Group A[2] and Working Group D[3] to be members of the steering committee of the project.

2011: [A/AC.105/1000, chapter IV, para. 36, section B.1, item 9]

The representative of Japan presented a report on the progress of the multi-GNSS demonstration project. It was noted that the Japan Aerospace Exploration Agency (JAXA) received 11 applications as a result of a call for hosting JAXA receivers. Six organizations were now investigating participation in the network with their own receivers. It was also noted that a new call for joint experiments would be issued in the middle of September 2011.

2012: [A/AC.105/1035, chapter IV, paragraph 33, section B.1, item 5]

The representative of Japan reported that there were currently 17 participating organizations and 8 joint experiments.

2013: [A/AC.105/1059, chapter IV, para. 38, section B.1, item 6]

The secretariat of Multi-GNSS Asia provided an update on the activities taking place. The three main activities were (a) the establishment of a multi-GNSS monitoring network, (b) working groups to conduct experiments and (c) the Asia-Oceania Regional Workshop on GNSS.

2014: [A/AC.105/1083, chapter IV, para. 38, section A.3, item 8]

The Secretariat of Multi-GNSS Asia informed that two experiments had been endorsed by the Multi-GNSS Asia steering committee, and the formation of a new working group on capacity-building had been proposed.

2015: [A/AC.105/1104, chapter IV, para. 38, section A.1, item 1]

Japan, as the secretariat of Multi-GNSS Asia, noted that 89 multi-GNSS monitoring network stations were currently in operation. It also explained that 24 proposals had been endorsed by Multi-GNSS Asia and were in progress.

---

[2] Working Group A on Compatibility and Interoperability is co-led by the United States of America and the Russian Federation

[3] Working Group D on Reference Frames, Timing and Applications is co-led by the International Association of Geodesy (IAG), International Federation of Surveyors (FIG), and International GNSS Service (IGS)

2016: [A/AC.105/1134, chapter IV, para. 33, section A.3, item 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. MGA discussed possible updates to its workplan enhancing the linkage with ICG.

2017: [A/AC.105/1158, chapter IV, section A.1(g), para. 55]

Japan provided an update on the multi-GNSS demonstration project in the Asia/Oceania region. Multi-GNSS Asia (MGA) is an organization that promotes the project with 57 participating organizations from 20 countries. The goals for 2018 and beyond are: strengthen the user community, working towards an open innovation hub; align more closely with ICG to support the regional implementation of its recommendations; transfer secretariat responsibilities from the Japan Aerospace Exploration Agency (JAXA) to the Institute of Positioning, Navigation and Timing, Japan; strengthen the role of local partners in MGA conferences; and develop a theme-based conference and membership structure.

2018: [A/AC.105/1191, chapter IV, section A.5, para.56 and 58]

Japan provided an update on the Multi-GNSS Asia (MGA) activities that took place in 2018. MGA was actively supporting capacity-building for GNSS utilization for the Asia-Oceania region. It promotes GNSS technology through webinars, lectures and projects. Participants in the Providers' Forum were encouraged to contact the co-chair (Japan) if they were interested in acting as a resource for the webinars.

MGA priorities for 2018 and 2019 include strengthening the user community for an open innovation hub, aligning more closely with ICG and encouraging a stronger role for local partners in MGA conferences.

2022: [A/AC.105/1276, chapter IV, section A.4, para. 35]

Japan provided an update on Multi-GNSS Asia, which promoted multi-GNSS in the Asia-Oceania region. The status of the Rapid Prototype Development Challenge 2022 was reported. […]

Spectrum protection: interference detection and mitigation

2011: [A/AC.105/1000, chapter IV, para. 36, section A.3, items 3, 5 – 7]

The representative of the United States provided information on the status of the United States domestic regulatory process related to conditional Federal Communications Commission (FCC) approval for LightSquared (LSQ) operations in the bands directly below and slightly above the radio-navigation satellite services (RNSS) L-1 allocation. FCC final approval was contingent upon determination that use of global positioning systems and global

navigation satellite systems (GNSS) services were not adversely impacted by the planned LSQ operations. The FCC process was ongoing, and no determination had been made at that time. Testing of LSQ equipment was conducted for the purpose of evaluating the impacts of those operations on GPS use. It was further noted that the matter of ancillary mobile-satellite service operations adjacent to the RNSS band might be considered by the World Radiocommunication Conference to be held in 2012 and might be addressed through the ITU working party process. The Providers' Forum noted that ITU referred to those operations as "complimentary ground component".

The representative of the European Union noted that similar operations had been studied in Europe and found to be disruptive to other mobile satellite service operations and had thus been discarded as an implementation option.

The representative of Japan noted that input had been provided to FCC, stating the concerns of Japan regarding the operation. It was also noted that the official position of the Asia-Pacific Telecommunity was to oppose any action favourable to the complementary ground component that might be considered at the World Radiocommunication Conference to be held in 2012.

The representative of China noted that with the establishment of new systems and the increase of new frequency bands and applications of new services, more and more space systems would face spectrum protection issues of that kind. It was envisioned that this might lead to additional overlapping of frequency bands and more interference between systems. Since GNSS was a service-oriented system aimed at serving all humankind, this issue warranted significant attention throughout the world. The BeiDou system, as a member of the GNSS systems, would like to join with others in the discussion of the issue of spectrum protection.

2013: [A/AC.105/1059, chapter IV, para. 38, section A.4, item 5]

The United States was currently working on a GPS adjacent-band capability assessment to draft new GPS spectrum interference standards. The purpose was to determine GPS spectrum-protection criteria to inform future proposals for non-space commercial uses of the adjacent bands. The United States wanted to be proactive in protecting GPS from interference. The United States also reported on efforts taking place in the ITU Joint Task Group 4-5-6-7 in preparation for the World Radiocommunication Conference. The Task Group was evaluating additional spectrum allocations for mobile broadband services, and the United States was working to protect GNSS spectrum bands from outside interference as a result of any changes to spectrum allocations. It was noted that the next Joint Task Group meeting would be held in Geneva from 20 to 28 February 2014, and the United States encouraged other entities to participate actively in activities leading to the final recommendations to the World Radiocommunication Conference, where the spectrum allocation changes would be finalized.

2021: [A/AC.105/1251, chapter IV, para. 36]

The providers discussed spectrum protection for S-band signals and agreed to recommend to ICG that further discussion on this topic should take place in the Working Group on Systems, Signals and Services under the subgroup on compatibility and spectrum protection.

2022: [A/AC.105/1276, chapter IV, section A.3, para. 34]

The United States presented a report of a recent interference event. It was reported that even for this accidental interference event, the Government's inter-agency GPS interference detection and mitigation process had functioned, including by issuing a notice to air missions. As part of its resilience posture outreach efforts, the United States had developed two guidance documents, entitled "GPS interference happens" and "Time guidance for Network Operations Operators, Chief Information Officers and Chief Information Security Officers", with a view to further educating infrastructure operators.

ICG information centres

2011: [A/AC.105/1000, chapter IV, para. 36, section B.2, item 10]

The Providers' Forum took note of the establishment of the International Committee on Global Navigation Satellite Systems (ICG) information centres at the regional centres for space science and technology education, affiliated to the United Nations, which were utilized as hubs for training and dissemination of information on global applications of GNSS. The Providers' Forum also noted that China offered to make available an information centre at the Beihang University in Beijing.

2013: [A/AC.105/1059, chapter IV, para. 38, section B.2, item 7]

The executive secretariat of the International Committee on Global Navigation Satellite Systems reported that the United Nations-affiliated regional centres on space science and technology education would implement the postgraduate course on GNSS from November 2013 to December 2014, using the *Global Navigation Satellite Systems Education Curriculum* (ST/SPACE/59). The improvement of the ICG information portal would continue to be discussed in Working Group C, on information dissemination and capacity-building.

2014: [A/AC.105/1083, chapter IV, para. 38, section A.4, item 10]

The first nine-month postgraduate course on GNSS had been completed at the African Regional Centre for Space Science and Technology – in French language held in Rabat.

2014: [A/AC.105/1083, chapter IV, para. 38, section A.4, item 11]

The ICG information portal was being redesigned by the Office for Outer Space Affairs and would include the addition of a webpage for ICG members, associate members and observers.

2015: [A/AC.105/1104, chapter IV, para. 38, section A.2, item 4]

The ICG information portal was being redesigned by the Office for Outer Space Affairs: www.unoosa.org/oosa/en/ourwork/icg/icg.html

Future structure of ICG

2011: [A/AC.105/1000, chapter IV, para. 36, section B.6, item 18]

The Providers' Forum agreed that, as proposed by the co-chair, an agenda item entitled "Future role and work of ICG and its Providers' Forum" should be considered at the next meeting of the Providers' Forum and that specific proposals might be made at that time.

2013: [A/AC.105/1059, chapter IV, para. 36, section B.3, items 8 - 9]

The discussion was based upon previous Providers' Forum meetings. The co-chairs reviewed two related papers: the summary of discussions concerning the future of ICG and the paper on the meeting with the associate members and observers that took place at the Seventh Meeting of ICG. The summary of discussions will be presented to ICG for adoption.

The co-chairs made a presentation on the way forward to increase user contributions to ICG. Several questions were identified regarding users and their relationship to ICG. The Providers' Forum agreed that the establishment of a users' forum would be premature, but noted that further discussion on ways to bring user input into ICG should continue.

Statement of the Providers' Forum

2012: [A/AC.105/1035, chapter IV, para. 33, Section B.5, item 11]

The Providers agreed upon a statement highlighting key achievements of ICG and the Providers' Forum, to be annexed to the ICG report (see Annex VIII).

Selection of the co-chairs of the Providers' Forum

2013: [A/AC.105/1059, chapter IV, para. 38, Section B.4, items 11 - 12]

The Russian Federation made a presentation proposing ideas to consider for the selection of future co-chairs. It also suggested updating the Providers' Forum terms of reference (see Annex II).

China made a presentation on the selection of co-chairs. The proposal would allow each provider to co-chair on a two-year rotational basis, and established a schedule for the next several years. The providers agreed to the schedule through 2017 and in the coming months would confirm the remaining schedule through 2019.

Potential areas of coordination between ICG and international organizations

2022: [A/AC.105/1276, chapter IV, section A.6, para. 37]

The liaisons from the Interagency Operations Advisory Group to ICG presented an update on the Group's twenty-fifth annual meeting, held on 9 May 2022, and its first

intersessional teleconference, held on 13 September 2022. At the annual meeting, the liaisons presented proposed areas of coordination with ICG and its space users subgroup in the context of lunar positioning, navigation and timing services. The Interagency Operations Advisory Group had created a lunar communications and navigation working group to study these services, which would include the ICG liaisons as members. The Advisory Group had also created an interim committee to study LunaNet governance, which would recommend a governance structure for interoperable lunar positioning, navigation and timing services under *the LunaNet umbrella.*

2023: [A/AC.105/1304, chapter IV, section A.5, para. 31]

The liaisons from the Interagency Operations Advisory Group to ICG presented an update on all activities under its five work packages, on the database of space missions that use GNSS and, in particular, activities in the area of lunar positioning, navigation and timing, on the fifth interoperability plenary meeting of the Interagency Operations Advisory Group, held in June 2023, and on the Group's twenty-sixth annual meeting, held in September 2023. Highlights from the activities under the five work packages included progress made on the LunaNet framework of standards for lunar communications and positioning, navigation and timing interoperability and a recommendation for a joint workshop led by the Interagency Operations Advisory Group and ICG to provide an international forum for the coordination of GNSS and lunar communications and navigation providers. […]

2024: [A/AC.105/1327, chapter IV, section A.5, para. 32]

The liaisons from the Interagency Operations Advisory Group to ICG presented an update on the Group's work to provide a forum for identifying the common needs of multiple international agencies for coordinating space communications policy, high-level procedures, technical interfaces and other matters related to interoperability and space communications.

Other matters

2014: [A/AC.105/1083, chapter IV, para. 38, section B, item 14]

The United States proposed debris mitigation in middle-Earth orbit and GNSS market access as topics for discussion by the providers. The providers agreed to consider that proposal at their next meeting, based on further information to be provided by the United States.

2014: [A/AC.105/1083, chapter IV, para. 38, section B, item 15]

The providers agreed to add to the agenda of the Providers' Forum an item on review of progress in the implementation of the recommendations of the ICG Working Groups.

2015: [A/AC.105/1104, chapter IV, para. 38, section B.1, items 6 - 8]

Orbital debris: The United States presented guidelines on orbital debris, which included the United States Government Orbital Debris Mitigation Standard Practices, Department of Defense Instruction 3100.12, Air Force Instruction 91-217 and the Inter-Agency

Space Debris Coordination Committee (IADC) Space Debris Mitigation Guidelines, which defined three disposal options and were applicable to United States government missions.

It was noted that that the United States had conducted a study on the GPS-IIF satellites and determined that the collision probability over 500 years for each of the 12 GPS-IIF satellites was less than 0.001. The United States was also in the process of conducting a study looking at the effects on the future medium-Earth orbit debris environment of two different strategies: delaying eccentricity growth, which was the current GPS practice; and accelerating eccentricity growth, a briefing on the results of which would be provided to IADC.

It was also noted that both the Italian Space Agency and the European Space Agency were doing work in that area and conducting additional studies, and it was suggested that the topic be further discussed at future Providers' Forum meetings.

Global navigation satellite system space service volume: The United States presented an update to the GNSS space service volume concept. The objective from the United States perspective was to expand the GPS space service volume into a multi-GNSS space service volume; further improvements could be obtained by increasing the availability of satellite signals in the space service volume, in most cases by utilizing the side lobes. There was great interest in ensuring the consistency of definitions so that they were common across all providers, which would help to create a unified analysis.

The presentation explained that space service volume specifications were crucial for providing navigation solutions in low-Earth orbit, medium-Earth orbit and highly elliptical orbit. The National Aeronautics and Space Administration (NASA) of the United States had issued a request for information for spaceborne receivers in order to better understand receiver technology currently available. Public input was welcome until the end of December 2015.

International GNSS monitoring and assessment project status and updates: China presented an update on its international GNSS monitoring and assessment project, explaining that the objectives were to establish a global tracking network and to monitor operational status and key indicators for all GNSS. The project had been operational on a trial basis since July 2014, providing users with raw observation data, basic products and monitoring and assessment information. The schedule included three stages until the end of 2020. There were currently eight completed monitor stations within China, as well as four international stations outside China. Three data centres and eight analysis centres had also been completed, and the operations and control centre was located in Beijing.

United States space weather strategy: The United States gave a presentation describing aspects of the United States national space weather strategy, which had been released to the public on 29 October 2015. The strategy had been developed to address societal and economic impacts in the event of a severe space weather event. The Space Weather Operations Research and Mitigation task force, consisting of 20 United States government departments and agencies, had responsibility for carrying out the six high-level goals outlined in the strategy. The United States noted that goal 6 called for increased international cooperation on space weather. Following the presentation, the European Union commented that they were looking at space situational awareness, which included both debris mitigation and space weather, and that they might report on the issue at a future Providers' Forum meeting.

2016: [A/AC.105/1134, chapter IV, para. 33, section B.1, item 1]

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.

2017: [A/AC.105/1158, chapter IV, section B.1, para. 57]

The ICG executive secretariat noted that the workplan of the Providers' Forum contained references to the "working group on compatibility and interoperability" and suggested that the workplan be updated to reflect the name change, at the tenth meeting of ICG, in 2015, to Working Group on Systems, Signals and Services. The co-chairs of the Working Group agreed to modify the workplan accordingly.

2018: [A/AC.105/1191, chapter IV, section B.1, para.61 and 62]

The providers agreed to adopt the changes to the workplan[4] that were reviewed and discussed at the twentieth meeting of the Providers' Forum held in June 2018 in Vienna.

The United States suggested including in the workplan a reference to the Medium Earth Orbit Search and Rescue system, since that had been discussed at previous meetings of the Providers' Forum. The providers agreed to discuss this at the next meeting of the Providers' Forum, with proposed language that would be adopted at the fourteenth meeting of ICG.

2019: [A/AC.105/1217, chapter IV, section B.1, para.37]

The Providers' Forum discussed and agreed on proposed changes to its terms of reference, as reflected in the latest version (ICG/PF/TOR/2016). They included the suggestion to add "Navigation with Indian Constellation (NavIC) or Indian Regional Navigation Satellite System (IRNSS)" to the list of members contained in the terms of reference of ICG

2022: [A/AC.105/1276, chapter IV, section B.2, para. 40]

The providers reviewed the terms of reference and agreed on the changes to be made to the Chair rotation procedure for future Providers' Forum meetings. The terms of reference of the Providers Forum were amended accordingly. (see ICG/PF/TOR/2022)

2023: [A/AC.105/1304, chapter IV, section B.2, para. 31]

On the basis of a proposal submitted by China, the providers reviewed the terms of reference of the Providers' Forum and agreed to reinstitute the rotation mechanism for the selection of the Chair of the Providers' Forum. On 19 October, the Providers' Forum adopted by consensus the revised terms of reference with a new paragraph 7, which reads as follows:

[4] Template for sharing information between service providers is contained in annex IV attached to this document

In the case a provider hosts an ICG annual meeting, it will chair the Providers' Forum meetings for the year of that ICG annual meeting. Otherwise, the chair of the Providers' Forum will rotate among its members subject to a decision on the basis of consensus. The Office for Outer Space Affairs of the United Nations Secretariat, consistent with its role as the executive secretariat of ICG, will also fulfil these responsibilities for the Providers' Forum, in support of the chair. (see ICG/PF/TOR/2023)

The Providers' Forum agreed that the United States would chair the meeting of the Providers' Forum to be held in 2024 and that China would chair the meeting to be held in 2025.

2024: [A/AC.105/1327, chapter IV, section B.4, para. 38]

The Providers' Forum agreed that China would chair the meetings of the Providers' Forum to be held in 2025.

3. EXTRACTS FROM THE JOINT STATEMENTS ADOPTED AT THE ICG MEETINGS, INCLUDING THE ICG RECOMMENDATIONS AND DECISIONS

ICG Information Centres

2008: [A/AC.105/928, chapter III, para. 23, item 5]

The regional centres[5] on space science and technology education, affiliated to the United Nations would act as ICG information centres.

Report on Current and Planned Global and Regional Navigation Satellite Systems and Satellite-based Augmentation Systems

2010: [A/AC.105/982, chapter III, para. 30, item 5]

ICG noted the achievements of the ICG Providers' Forum, as reflected in the publication entitled "Current and Planned Global and Regional Navigation Satellite Systems and Satellite-based Augmentation Systems" (ST/SPACE/50[6]).

10 years of achievement of the United Nations on Global Navigation Satellite Systems

2012: [A/AC.105/1035, chapter II, para. 23]

ICG noted the achievements of providers and users of positioning, navigation and timing services in promoting GNSS, as reflected in the publication "10 years of achievement of the United Nations on Global Navigation Satellite Systems" (ST/SPACE/55[7]).

Members, Associate Members and Observers of the International Committee on Global Navigation Satellite Systems

2012: [A/AC.105/1035, chapter II, para. 26]

Members, associate members and observers of ICG had held a meeting during the Seventh Meeting. It was noted that continued discussions were needed regarding the effective functioning of ICG and its current format in order to maximize the benefit for all GNSS users.

---

[5] The regional centres are located in Morocco and Nigeria for Africa, in Brazil and Mexico for Latin America and the Caribbean, in India and China, for Asia and the Pacific, and in Jordan for Western Asia: http://www.unoosa.org/oosa/en/SAP/centres/index.html

[6] See the report at http://www.unoosa.org/pdf/publications/icg_ebook.pdf

[7] See the report at: http://www.unoosa.org/pdf/icg/2011/11-85461_ICG-ST-55_eBook.pdf

2013: [A/AC.105/1059, chapter II, para. 31]

ICG heard statements by the representatives of the Arab Institute of Navigation (AIN) and the European Space Policy Institute (ESPI) on their organizations' plans for implementing GNSS applications and granted the organizations the status of observer.

2014: [A/AC.105/1083, chapter III, para. 37, item 2]

The Asia-Pacific Space Cooperation Organization (APSCO) was recognized by ICG as a new observer.

2018: [A/AC.105/1191, chapter III, para. 38, item 3]

Australia was recognized by ICG as a new member, and the International Association of Institutes of Navigation was recognized as a new associate member.

2019: [A/AC.105/1217, chapter III, para. 28, item 3]

New Zealand was recognized by ICG as a new member.

2021: [A/AC.105/1251, chapter III, para. 31, item 6]

Consensus was reached on accepting the request for membership of the Republic of Korea received in December 2019.

Principle of Transparency for Open Service

2009: [A/AC.105/948, chapter II, para. 21]

The ICG endorsed the recommendation that, consistent with the principle of transparency, every GNSS provider should publish documentation containing signal and system information, the policies of provision and the minimum levels of performance offered by its open service.

Tenth Meeting of the ICG in 2015

2013: [A/AC.105/1059, chapter II, para. 23]

In preparation for its Tenth Meeting, to be held in 2015, ICG recommended that a list of accomplishments within ICG be prepared, which would include the excerpts document and inputs from the working groups and ICG members, associate members and observers.

Joint Meeting with the Providers and ICG members, associate members and observers

2013: [A/AC.105/1059, chapter II, para. 24]

ICG agreed that a joint meeting with the providers and ICG members, associate members and observers should be introduced as a regular item on the agenda of the ICG annual meetings in order to report on the status of the recommendations and to exchange views on the providers' response to input from the user communities. ICG noted that that item could serve as a way to gain insight into users' needs and requirements, and to get information on how services are performing. It was also noted that the ICG outreach activities would increase the visibility of ICG.

Interaction with the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO)

2013: [A/AC.105/1059, chapter II, para. 25]

ICG agreed that, taking into account the roles and functions of GNSS service providers and intergovernmental bodies, such as the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO), an effort should be made to encourage their participation in the ICG meetings.

Future role and work of ICG and its Providers' Forum

2013: [A/AC.105/1059, chapter II, para. 26]

ICG took note with appreciation of the paper summarizing discussions concerning the future of ICG, which had been submitted by the co-chairs of the Providers' Forum. Its purpose was to provide a number of possible options and modalities that could strengthen the effectiveness of ICG in the future. It was agreed that that summary would serve as a basis for assessing the progress made by ICG. (see Annex VIII).

Mission Statement of the ICG

2013: [A/AC.105/1059, chapter II, para. 36, item 5]

ICG considered the future scope of its work and organizational structure, and ways and means to enhance user input and the visibility of ICG, and other proposals to increase the effective implementation of its recommendations. In this regard, ICG adopted a mission statement, contained in annex X.

Vision Statement of the ICG

2014: [A/AC.105/1083, chapter III, para. 37, item 17]

ICG adopted a Vision Statement, which is contained in annex XI of the present document.

Continuation of the United Nations experts' meetings on GNSS and its applications

2014: [A/AC.105/1083, chapter II, para. 24]

ICG noted that the continuation of the United Nations experts' meetings on GNSS and its applications in the future would ensure that a forum for ongoing dialogue and feedback was possible between users and system providers in order to enhance positioning, navigation and timing services worldwide.

10th anniversary booklet

2014: [A/AC.105/1083, chapter II, para. 27]

In preparation for its tenth meeting, to be held in 2015, ICG noted that the 10th anniversary booklet would include key information about ICG membership, presenting the role of members and the benefits of participation in ICG.

Joint Working Group session

2015: [A/AC.105/1104, chapter III, para. 22 - 25]

ICG noted that the joint working group session had discussed the implementation status of recommendations made at previous meetings related to: (a) the international GNSS monitoring assessment; (b) the template for GNSS space service volume; and (c) the working groups' workplans and potential revisions thereto.

The working groups discussed cross-cutting issues relating to the international GNSS monitoring assessment, highlighting the work performed by the task force. It was noted that utilizing existing resources such as IGS and the providers' monitoring and assessment systems, which might include signal quality monitoring, could maximize benefits in the early stages of the international GNSS monitoring assessment road map.

In the course of the discussion on matters related to GNSS space service volume, the advantages of an interoperable GNSS space service volume for the space user community were highlighted. It was noted that GNSS service providers had already provided their space service volume characterizations to be included into the space service volume booklet.

The view was expressed that, in order to develop unified GNSS space service volume analysis, ICG should develop standard definitions of minimum number of satellites and constellation geometry.

2016: [A/AC.105/1134, chapter II, para. 21 - 24]

The joint working group session 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).

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.

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.

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.

Economic benefits of utilizing GNSS

2015: [A/AC.105/1104, chapter III, para. 29]

ICG noted that the Working Group on Information Dissemination and Capacity-building would elaborate on various studies on the economic benefits of utilizing GNSS for the purpose of dissemination to current and future GNSS users.

The Interoperable Global Navigation Satellite Systems Space Service Volume

2021: [A/AC.105/1251, chapter II, para. 24]

ICG welcomed with appreciation the publication of The Interoperable Global Navigation Satellite Systems Space Service Volume (ST/SPACE/75/Rev.1) by the Office for Outer Space Affairs (available on the website of the Office). ICG noted the individual efforts led by participants in the working group on enhancement of GNSS performance, new services and capabilities included the following: documenting and publishing space service volume (SSV) performance metrics for each individual constellation; developing standard assumptions and definitions to perform multi-GNSS SSV performance analyses; encouraging the design and manufacture of GNSS receivers that could operate in SSV; characterizing GNSS antenna performance to more accurately predict SSV mission performance; providing a reliable reference for space mission analysts; and working towards the formal specification of SSV performance by each GNSS provider.

4. EXTRACTS FROM THE WORKING GROUP REPORTS

4.1. Working Group S on systems, signals and services (formerly Working Group A on compatibility and interoperability)

2010: [A/AC.105/982, chapter III, para. 30, item 6]

Working Group A called on interested members to focus on proposals for addressing interference detection and mitigation, and to draft a plan for consideration by ICG.

2011: [A/AC.105/1000, chapter III, para. 32, item 5]

Working Group A on compatibility and interoperability addressed all four areas of its current workplan through an intersessional meeting held in June 2011 at the United Nations Office at Vienna and the two days of presentations and discussions conducted during the Sixth Meeting of ICG. Interference detection and mitigation, and open service provision and performance monitoring by multi-GNSS networks were the major areas of focus, leading to three of the working group's four recommendations. The session on multi-GNSS monitoring and the session on interoperability were held jointly with Working Groups B and D, resulting in constructive dialogue with those working groups and an agreed plan of practical steps, including the establishment of a subgroup to collectively investigate international GNSS monitoring and assessment.

2012: [A/AC.105/1035, chapter III, para. 31, item 6]

Working Group A on compatibility and interoperability had addressed all four areas of its current workplan at an intersessional meeting held on 23-27 July 2012, in conjunction with the International Global Navigation Satellite System Service workshop held in Olsztyn, Poland, in 2012, and additional presentations and discussions had been conducted during the Seventh Meeting of ICG. The compatibility and international GNSS monitoring and assessment subgroups of Working Group A also provided, at the intersessional meeting, reports that formed the basis for recommendations on spectrum protection and open service performance monitoring. Working Group A organized and completed the first ICG interference detection and mitigation workshop, held in Vienna on 7 and 8 June 2012, and reported on the conclusions at the Seventh Meeting of ICG, including a recommendation to conduct additional workshops.

2013: [A/AC.105/1059, chapter III, para. 36, item 7]

Working Group A, on compatibility and interoperability, addressed all four areas of its current workplan during its intersessional meeting held in Vienna from 11 to 13 June 2013 and during the Eighth Meeting of ICG. The compatibility and international GNSS monitoring and assessment subgroups of Working Group A provided reports at the intersessional meeting that formed the basis for recommendations on spectrum protection, open service performance and the monitoring of open services. Recommendations were also presented to ICG related to

interoperability and interference detection and mitigation. In addition to the intersessional meeting, Working Group A organized and completed the second ICG interference detection and mitigation workshop and the first interoperability workshop, held in Honolulu, United States, from 19 to 22 April 2013, and reported the conclusions to the working group. The next interference detection and mitigation workshop will take place on 20 May 2014, immediately preceding the China Satellite Navigation Conference, to be held in Nanjing, China, from 21 to 23 May 2014. Two regional interoperability workshops involving users and manufacturers from China and the Russian Federation, as well as members of the interoperability task force, will be held, one in Moscow in conjunction with the Moscow Satellite Navigation Forum, on 23 and 24 April 2014, and the other in Nanjing in conjunction with the China Satellite Navigation Conference. A meeting of the International GNSS Monitoring and Assessment subgroup is planned for 22 to 26 June 2014 in Pasadena, United States in conjunction with the twentieth anniversary International Global Navigation Satellite System Service workshop, and the 2014 intersessional meeting is tentatively scheduled for 16 to 18 July at ITU, in Geneva.

2014: [A/AC.105/1083, chapter III, para. 37, items 6, 7 and 8]

Beginning at its intersessional meeting held in Geneva and hosted by ITU, and continuing during the ninth meeting of ICG, Working Group A, on compatibility and interoperability, addressed all four areas of its current workplan. The compatibility and performance standard subgroup reported on the status of ongoing work in those areas and updated its recommendation on compatibility between international mobile telecommunications and the radio determination satellite service and radio navigation satellite services spectrum. In addition to the intersessional meeting, the newly formed interference detection task force organized and completed the third ICG interference detection and mitigation workshop at ITU. That event and the subsequent deliberations led to three recommendations on interference detection and mitigation capabilities and the conduct of the United Nations workshops on spectrum protection and interference detection and mitigation to be organized by the Office for Outer Space Affairs on a regional basis.

The international GNSS monitoring and assessment task force also presented two recommendations to the Working Group, based on three meetings that had been held in 2014, including a proposal to hold an international GNSS monitoring and assessment workshop in Xi'an, China, immediately preceding the sixth China Satellite Navigation Conference, to be held in 2015.

Finally, the interoperability task force reported on three workshops held in China, Japan and the Russian Federation, where inputs from industry and users on the subject of multi-GNSS interoperability had continued to be collected and analysed. The task force will continue its work in 2015, to include an interoperability workshop in Europe, leading to potential recommendations for consideration by the Working Group and the Committee at the tenth meeting of ICG.

2015: [A/AC.105/1104, chapter III, para. 36, items 6 and 7]

The compatibility and performance standard subgroup decided to continue addressing the need for worldwide GNSS spectrum protection through a recommendation to providers and user community member States to promote the implementation of protection measures for GNSS operations in their nations and/or regions as well as other parts of the world.

Deliberations within the Working Group had led to a recommendation to the Committee on the Peaceful Uses of Outer Space to establish a multi-year agenda item focused on national efforts to protect the radio navigation satellite services spectrum and pursue GNSS interference detection and mitigation in member States.

The international GNSS monitoring and assessment task force conducted several meetings in 2015. The task force intended to initiate a joint trial project with IGS that would demonstrate a global GNSS monitoring and assessment capability after the completion of several preliminary items. The task force, under a restructuring and revised workplan completed by the group, would become the interoperability and service standards subgroup, with the international GNSS monitoring and assessment task force continuing under its auspices, as well as the ongoing work on open service performance standards. The existing compatibility and performance standards subgroup, which had been renamed the compatibility and spectrum subgroup, would also have responsibility for the interference detection and mitigation task force. The approved new workplan included a new area of possible work focused on system-of-systems operations, pending the assignment of tasks by the Providers' Forum. The new structure compromised the work of the Working Group, which had been renamed Working Group on Systems, Signals and Services.

2016: [A/AC.105/1134, chapter III, para. 31, items 6 and 7]

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.

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.

2017: [A/AC.105/1158, chapter III, para. 28, items 7 and 8]

The Working Group on Systems, Signals and Services (Working Group S) completed its 2016–2017 activities under its organizational structure and workplan that were adopted, at the tenth meeting of ICG, held in Boulder, United States, in 2015. That structure included a subgroup on compatibility and spectrum protection and a subgroup on interoperability and service standards. The subgroup on compatibility and spectrum protection decided to continue addressing the need for worldwide GNSS spectrum protection through a recommendation for ICG members to encourage national regulators to protect the radio navigation satellite service spectrum from unwanted emissions. The Working Group continued its outreach and education efforts on spectrum protection by holding an expert seminar on the GNSS spectrum in Kathmandu in December 2016, in conjunction with the United Nations/Nepal workshop on the applications of GNSS. The interference detection and mitigation (IDM) task force working under the subgroup organized and completed a sixth workshop on IDM in Baška, Croatia, in May 2017. That workshop resulted in a recommendation to work with the Third Generation Partnership Project 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 workshop on IDM in conjunction with the GNSS conference to be held in Baška in May 2018.

The subgroup on interoperability and service standards held a meeting in Paris 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 was 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 a workshop on IGMA, held in Shanghai, China, in May. The work focused on carrying out joint trial project activity with IGS to demonstrate a global GNSS monitoring and assessment capability for a limited set of GNSS parameters. A workshop on performance standards and IGMA will be hosted by the European GNSS Agency at the Galileo Reference Centre in Noordwijk, Netherlands, in 2018. 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.

2018: [A/AC.105/1191, chapter III, para. 38, items 6 and 7]

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 the twelfth and thirteenth meetings of ICG. Through intersessional coordination that included a meeting of the subgroup held in Vienna in June 2018, progress in encouraging national regulators to use relevant ITU protection criteria for GNSS was assessed, and the

compatibility of search and rescue downlink broadcasts by GNSS in the L band was added to the scope of the subgroup's work, as cooperation with the International Satellite System for Search and Rescue (Cospas-Sarsat) programme was envisaged, and taking into account the role of ITU and national administrations.

The subgroup on interoperability and service standards held two workshops during the intersessional period. The first workshop, held in Noordwijk, Netherlands, in July 2018, focused on open service performance standards and international GNSS monitoring and assessment. A dedicated team of experts working under the auspices of the subgroup was able to complete a document defining guidelines for developing open service performance standards, completing work that has been under way since 2012. Working Group S recommended that those guidelines be formally adopted by ICG. The subgroup also organized a second workshop focused on GNSS system time, as recommended at the twelfth meeting of ICG; that workshop was held in Vienna in June 2018 in conjunction with ICG Working Group D. The workshop and subsequent deliberations by the Working Group resulted in immediate actions related to assessing two concepts proposed by the European Space Agency (ESA) and consideration of future actions. These will be further discussed at a third workshop on multi-GNSS time interoperability. The Working Group also plans to join Working Groups B and D in conducting a workshop focused on precise point positioning services in 2019.

2019: [A/AC.105/1217, chapter III, para. 28, items 7 and 8]

Working Group S recommended the establishment of a task force on PPP interoperability, which was adopted by ICG. The task force will be co-chaired by Australia, the European Union and Japan and will prepare a workshop in 2020 to continue the discussions and address the issues raised at the 2019 workshop.

The Working Group also highlighted the need for consultation with the Inter-Agency Space Debris Coordination Committee regarding implementation of the recommendation from the thirteenth meeting of ICG to study the issue of debris mitigation practices relevant to the medium Earth orbit and inclined geosynchronous orbit orbital regimes used for GNSS.

2021: [A/AC.105/1251, chapter III, para. 31, items 11 - 13]

The subgroup on compatibility and spectrum protection also maintained awareness of GNSS/radionavigation satellite service (RNSS)-related ITU activities. The Working Group tasked the subgroup with conducting workshops in 2022 focused on utilizing Automatic Dependent Surveillance–Broadcast (ADS-B) and the 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.

An updated version 2.0 of the performance standard guidelines document was adopted by the Working Group. 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. During a joint working group session on timing interoperability, a new recommendation for calculating GNSS offsets was presented by 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 whether consensus can be reached on a recommendation. 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.

Under the Working Group's focus on system of system operations, a report was received from 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 and inclined geosynchronous satellite orbit orbital regimes used by GNSS.

2022: [A/AC.105/1276, chapter III, para. 27, items 9, 10 and 11]

[…] Under the leadership of the subgroup on compatibility and spectrum protection, the Working Group had continued its campaign to promote adequate protection of the GNSS spectrum by reviewing relevant GNSS and radionavigation satellite service-related International Telecommunication Union activities. The subgroup agreed to conduct a workshop on interference detection and mitigation prior to the next ICG meeting, focused on the use of Automatic Dependent Surveillance - Broadcast (ADS-B) and the Automatic Identification System (AIS) for interference detection and investigating national processes for notification of interference testing. The Working Group also finalized a recommendation regarding the resilient use of GNSS for critical infrastructure, which was adopted by ICG. A potential future recommendation related to notification for GNSS testing was discussed, but no consensus was reached.

The subgroup on interoperability and service standards had held a virtual meeting during the intersessional period, focused on continuing to make progress on the objectives in its workplan. The performance standards group had held monthly virtual meetings in conjunction with the international GNSS monitoring and assessment task force. The performance standards group continued work on a "hints and tips" document and agreed to organize a workshop in 2023 to examine existing and future low Earth orbit positioning, navigation and timing systems, including those provided by commercial industry. The international GNSS monitoring and assessment task force continued to make progress on calculation methodologies and data formats for the joint ICG-International Global Navigation Satellite System Service trial project and planned to hold an in-person workshop focused on addressing issues that could not be resolved through virtual meetings. The task force also planned to meet in 2022 or 2023 to review the terms of reference for the trial project. The task force and the performance standards group planned to continue to hold combined virtual meetings on a monthly basis. During a joint working group session on timing interoperability, discussion focused on the need for an in-person workshop to be held in conjunction with working groups B and D, to discuss timing interoperability in more detail. There was broad consensus that the timing needs of terrestrial users were different from the timing needs of space users. Lastly, the precise point positioning interoperability task force had continued compiling information on planned systems through the collection of information from service providers on the characteristics of their services. The task force planned to hold a meeting and workshop in 2022 or 2023 to continue discussing future plans and identify ways to further enhance interoperability.

Under the Working Group's workplan, which was focused on system of system operations, the providers continued to provide feedback on the 2020 report of the Inter-Agency Space Debris Coordination Committee that followed a recommendation made at the thirteenth meeting of ICG to study the issue of debris mitigation practices relevant to the medium Earth orbit and inclined geosynchronous orbit orbital regimes used by GNSS. The Working Group intended to complete a response to the report and further discuss ways that ICG providers could work together to mitigate the risk of satellite collisions. Lastly, the Working Group received presentations from system providers, who were investigating methods of authenticating open civil signals.

2023: [A/AC.105/1304, chapter III, para. 24, items 10 - 12]

[…] In December 2022, the subgroup had conducted a workshop on interference detection and mitigation, focused on the use of Automatic Dependent Surveillance – Broadcast (ADS-B) and the Automatic Identification System (AIS) for interference detection, and the further investigation of national processes for notification of interference testing. The subgroup had agreed to conduct an eleventh workshop on interference detection and mitigation, focused on the reporting process in the aviation and maritime sectors. A potential future recommendation related to notification for GNSS testing was discussed, but no consensus was reached.

The subgroup on interoperability and service standards continued to make progress on the work in its workplan, including overseeing the work of its task forces. The performance standards group organized and led a workshop on future low Earth orbit positioning, navigation and timing systems, including those provided by commercial industry. The performance standards group also continued to hold monthly virtual meetings in conjunction with the international GNSS monitoring and assessment task force and continued its work on a "hints and tips" document. The aforementioned task force held a workshop focused on reviewing the terms of reference for the joint ICG-International Global Navigation Satellite System Service trial project, which resulted in a recommendation for ICG to adopt those revisions. The international GNSS monitoring and assessment task force also continued to make progress on calculation methodologies and data formats for the trial project and planned to hold another workshop in 2024. The task force and the performance standards groups planned to continue to hold combined virtual meetings on a monthly basis. Timing experts from the subgroup on interoperability and service standards held a meeting to discuss next steps, and agreed on a recommendation for members of the Working Group to reach out to industry for views on timing interoperability and to conduct a workshop in order to share the results. Lastly, the precise point positioning interoperability task force held a workshop in 2023 and continued compiling information on planned systems through the collection of information from service providers on the characteristics of their services. […]

Under the Working Group's workplan, which was focused on system of system operations, the Working Group received several presentations related to Open Service Navigation Message Authentication. Providers continued to provide feedback on the 2020 report of the Inter-Agency Space Debris Coordination Committee that followed a recommendation made at the thirteenth meeting of ICG to study the issue of debris mitigation practices relevant to the medium Earth orbit and inclined geosynchronous orbit orbital regimes used by GNSS. The Working Group was planning to work with China to develop a response to the Inter-Agency Space Debris Coordination Committee based on the collection of

information on orbital parameters from the providers. On the topic of system of system operations, the Working Group received presentations from system providers, who were investigating methods for the authentication of open civil signals. Lastly, the Working Group agreed to a recommendation supporting the further inclusion of low Earth orbit positioning, navigation and timing providers, who might also be from industry, in ICG discussions on that topic. […]

2024: [A/AC.105/1327, chapter III, para. 21, items 7 - 9]

[…] Under the leadership of the subgroup on compatibility and spectrum protection, the Working Group had continued its campaign to promote adequate protection of the GNSS spectrum by reviewing relevant GNSS and radionavigation satellite service-related activities of the International Telecommunication Union. In April 2024, the subgroup had conducted a workshop on interference detection and mitigation focused on the aviation and maritime sectors, with discussion of existing processes as a possible baseline/reference for other industry sectors using GNSS services that could be used and implemented in their sector interference detection and mitigation strategies. […]

[…] The precise point positioning interoperability task force had held a workshop in January 2024 and completed the fourth edition of the "PPP/PPP-RTK service providers report", providing information about planned service. The international GNSS monitoring and assessment task force had conducted a workshop focused on discussing plans for the second run of the joint trial project with the IGS data exchange formats. […]

[…] Under the Working Group's workplan focused on system of system operations, the Working Group had organized a workshop on future low Earth orbit positioning, navigation and timing systems focused on examining compatibility and interoperability issues and the role of future low Earth orbit positioning, navigation and timing system providers in ICG. […] Under the topic of system of system operations, the Working Group received presentations from system providers, who were looking into methods for the authentication of open civil signals. […]

4.2. Working Group B on enhancement of GNSS performance, new services and capabilities (formerly Working Group B on enhancement of the performance of GNSS services)[8]

2010: [A/AC.105/982, chapter III, para. 30, item 7]

A new item on techniques for radio-frequency interference mitigation and detection in the GNSS bands was added to the workplan[9].

[8] Working Group B is co-led by India, China (since 2015, the 10th meeting of the ICG, Colorado, United States) and the European Space Agency

[9] The revised workplan of the Working Group B is available at: http://www.unoosa.org/pdf/icg/2010/ICG5/wgB/icg-wgb2010.pdf

2011: [A/AC.105/1000, chapter III, para. 32, item 6]

Working Group B on enhancement of the performance of GNSS services discussed, among other things, the dissemination of disaster information. It was noted that satellite navigation systems might provide essential contributions, but the service concept still needed further elaboration. Therefore, a new item on monitoring and examining techniques supporting disaster management via satellite navigation was added to the Working Group's workplan. In addition, the existing actions in the current workplan were confirmed and were reflected by the Working Group members in their presentations, and good progress was shown in various areas, including indoor positioning, signal authentication, precise positioning, transportation, maritime and space applications. Since more and more application-related issues were introduced and discussed within Working Group B, it was agreed to form a dedicated subgroup on applications.

2012: [A/AC.105/1035, chapter III, para. 31, item 7]

Working Group B on enhancement of the performance of GNSS services discussed the benefits of an interoperable GNSS space service volume. All Working Group participants believed that a fully interoperable GNSS space service volume would result in significant benefits for future space users as it would allow for a performance that no single system could provide on its own. Concepts for ensuring the integrity of signal coverage in maritime areas by exploiting the arising multiplicity of new satellite navigation signals were discussed, and the significance of multipath-resistant navigation signals for good ranging performance was confirmed. The value of multi-GNSS application demonstrations was noted.

2013: [A/AC.105/1059, chapter III, para. 36, item 8]

Working Group B, on the enhancement of GNSS service performance, made significant progress in establishing an interoperable GNSS space service volume during the Eighth Meeting of ICG through significant advance work, presentations at the Meeting and additional robust contributions from the administrations of China and the Russian Federation. The Working Group further discussed the benefits of an interoperable GNSS space service volume. All Working Group B participants believed that a fully interoperable GNSS space service volume would result in significant benefits for future space users, as it would allow performance that no single system could provide on its own. The Working Group will continue to work within ICG towards an interoperable GNSS space service volume.

2014: [A/AC.105/1083, chapter III, para. 37, items 9, 10 and 11]

Working Group B, on the enhancement of GNSS service performance, made progress in establishing an interoperable GNSS space service volume. Space service volume-relevant characteristics were presented by Global Positioning System, Global Navigation Satellite System (GLONASS), BeiDou navigation satellite system and Quazi-Zenith Satellite System. Galileo aims to release its space service volume-related characteristics in the first quarter of 2015. Members of Working Group B will develop a booklet on interoperable GNSS space service volume and will continue to work towards an interoperable GNSS space service

volume. The Working Group members acknowledged the benefits of signals broadcast from satellites in non-nominal orbit or from satellites not part of the operational constellation for a wide range of users, including space service volume users.

Alongside the issue of space service volume, the Working Group continued to work according to its workplan. Good-quality ionospheric error compensation models were identified in order to provide single frequency users with better accuracy. Results obtained from one of those, the NeQuick Galileo model, which had demonstrated good performance, were discussed. Following the recommendation of the eighth meeting of ICG, the discussion continued on the Time To First Fix estimation methodology, leading to the identification of additional figures of merit. Interference mitigation techniques at the antenna level and at the digital signal processing level were discussed and the importance of investigating interference mitigation techniques at the user level was confirmed.

The application subgroup of Working Group B held dedicated meetings and continued monitoring application needs. The findings were being summarized in a report. The way forward to the tenth meeting of ICG for the Working Group and its application subgroup was defined.

2015: [A/AC.105/1104, chapter III, para. 36, items 8 - 11]

The Working Group on enhancement of GNSS service performance made important progress in establishing an interoperable GNSS space service volume. All service providers recognized the importance of GNSS for space missions. Characteristics to establish an interoperable GNSS space service volume were given by all six providers. ICG appreciated the efforts made by all service providers to establish these characteristics. Members of the Working Group would continue to develop a booklet on interoperable GNSS space service volume for presentation at the next Providers' Forum and conduct the necessary simulations as a joint effort.

The Working Group reviewed the progress made in analysing the benefits of the NeQuick Galileo ionospheric model for single frequency users based on the assessment made by different service providers. Promising results had been obtained with the model. Space users in low-Earth orbit could also benefit from it.

The members of the Working Group acknowledged the benefits of ranging signals broadcast from Galileo satellites in eccentric, non-nominal medium-Earth orbit for position, velocity and time applications and scientific demonstrations. Information was provided regarding progress made on the use of the Global Navigation Satellite System for geodetic applications showing similar performance to other GNSS. It was noted that high-precision applications benefited from satellite-based augmentation system geosynchronous satellite (GEO) ranging if sufficient quality ephemeris data for the GEO satellite was provided. The group confirmed that wide band signals would minimize multipath error and could significantly improve accuracy for users.

The application subgroup continued its work and presented an application catalogue. The findings of the group will be summarized in a report for the Eleventh Meeting of ICG in 2016. The Working Group reviewed and updated its workplan. The updated workplan continued to address future integrity solutions, the monitoring of application developer needs and atmospheric correction models. In addition, new areas of work related to space service volume and space weather and remote sensing communities were introduced. China was

appointed as the third co-chair of the Working Group to support the follow-up of the updated workplan.

2016: [A/AC.105/1134, chapter III, para. 36, items 8 - 12]

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.

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.

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.

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

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.

2017: [A/AC.105/1158, chapter III, para. 28, items 9,11 and 13]

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 Working 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. Exploiting the interoperability between all systems makes it possible to achieve GNSS signal availability very close to 100 per cent.

The excellent cooperation among all members of the SSV action team enabled it to prepare a final draft of the SSV booklet, which will be submitted to ICG for distribution to GNSS providers, so that they can review and endorse the booklet prior to its publication in time for UNISPACE+50, in June 2018.

Search-and-rescue services are implemented by Galileo and GLONASS and will be implemented by GPS and BDS in accordance with the standards of the International Satellite System for Search and Rescue (COSPAS-SARSAT). The Working Group will continue to assess the interoperability specifications at the level of COSPAS-SARSAT in line with the Working Group's workplan. Matters of signal-level compatibility of search-and-rescue downlink signals will be followed up by the compatibility and spectrum subgroup of Working Group S.

2018: [A/AC.105/1191, chapter III, para. 38, items 9, 11 and 13]

The Working Group on Enhancement of GNSS Performance, New Services and Capabilities (Working Group B) made significant progress. China, the European Union and the United States presented results on lunar GNSS analyses and architectural studies. The National Aeronautics and Space Administration (NASA) of the United States informed the Working Group about the benefits of combined communications and navigation capabilities for space users.

On the topic of space weather, the Working Group was briefed by China on the space weather payloads of the BeiDou Navigation Satellite System (BDS), in particular BDS-2 and BDS-3. China, India and Japan presented the status of space weather and ionospheric research. Acknowledging the importance of space weather information for GNSS and space users of GNSS, the working group encouraged the open exchange of space weather data. The Working Group agreed that dedicated mechanisms should be investigated to share space weather data in the international community and disseminate it to potential users in all regions. Next-generation broadcasting services were one such potential mechanism.

The European Union and Japan jointly presented the common emergency warning services. The members of the Working Group agreed that there was a need to further discuss the emergency warning service within the Working Group. For this purpose, a correspondence group to propose a common format for early warning services will be set up.

2019: [A/AC.105/1217, chapter III, para. 28, items 10 and 17]

The space user subgroup informed the Working Group on the progress made since the thirteenth meeting of ICG, when the subgroup was established. The subgroup made major progress related to the updates for the next envisaged release of the GNSS space service volume (SSV) booklet, in line with its workplan for the period 2019–2020. The finalization of a video, produced to explain the basic concept of the GNSS SSV to the general public, was expected in the first quarter of 2020. It was envisaged that the name of that subgroup would be finalized in that same period. New activities had 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 proposed 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 missions to the Moon and beyond.

The Working Group expressed its appreciation for the variety of the contributions and noted the growing importance of the scientific use of GNSS. In addition, the Working Group agreed to organize the joint session held with Working Groups S and D on the topics of PPP

and timing interoperability.

2021: [A/AC.105/1251, chapter III, para. 31, items 15, 17, 18, 21 and 22]

The space users subgroup 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, the space users subgroup announced the release of the companion SSV video (available on the website of the Office for Outer Space Affairs). Both efforts had been developed to convey the significant improvements afforded by the use of a multi-GNSS SSV and its benefits to science and humanity.

The space users subgroup also announced its new workplan for the period 2021–2022, which outlines five major areas of future work: (a) availability of provider antenna data, (b) GNSS space user mission data, (c) GNSS space user timing requirements, (d) lunar GNSS SSV and (e) GNSS space user standards. The space users subgroup requested and encouraged collaboration with the other ICG working groups in each of these areas. Further coordination with international bodies such as IOAG, the International Space Exploration Coordination Group (ISECG), the Space Frequency Coordination Group (SFCG) and others was planned.

The application subgroup proposed to start a new initiative entitled "GNSS applications: for present and future", to survey GNSS applications that identify challenges and facilitates the development of solutions that serve society. These actions were intended to provide assistance, lessons learned and guidance to GNSS users. This initiative would lead to a research report entitled "GNSS applications for sustainable development: case studies".

Working Group appreciated the variety of the contributions received, such as from the Emergency Warning Service (EWS) of the European satellite navigation system (Galileo), the Indian Regional Navigation Satellite System (NavIC) NavCom (an electronic navigation and communication system) and scientific applications, the Beidou Satellite Navigation System (BDS) search and rescue service, and LunaSAR, illustrating the convergence of science, position, navigation and timing and communication systems. The growing importance of the scientific use of GNSS was noted by the Working Group.

Working Group recognized the potential impact that the rising solar activities of twenty-fifth 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.

2022: [A/AC.105/1276, chapter III, para. 27, items 13 thru 16 and 18 thru 20]

The Working Group B space users subgroup informed the Working Group of the progress made since the fifteenth meeting of ICG. The subgroup had met 13 times in that period, including one face-to-face meeting in Vienna in June 2022. The subgroup reviewed the progress made on its workplan for the period 2021–2022, including on the five work packages. The activities of nearly all work packages had started and meetings were held on a regular basis. Good working progress had been made for all the initiated work packages.

The space users subgroup also gave a summary of its interactions with the Interagency Operations Advisory Group through the ICG-Interagency Operations Advisory Group liaisons.

The proposed areas of coordination between the two organizations related to the development of lunar positioning, navigation and timing architecture and included establishing necessary liaison roles, documenting lunar use cases, encouraging lunar flight experiments and making recommendations to maximize the interoperability, compatibility and availability of the combined GNSS and lunar positioning, navigation and timing system of systems.

Since the fifteenth meeting of ICG, the Working Group B application subgroup had been working on an initiative entitled "GNSS applications: for present and future". The subgroup's current activities focused on studying cases of GNSS applications that were on the market or were under final development before market release. The subgroup's activities were intended to provide assistance, lessons learned and guidance to GNSS users. The initiative would lead to a research report entitled "GNSS applications for sustainable development: case studies".

The applications of GNSS in the field of disaster prevention and mitigation were an area of focus for the application subgroup. Working Group B and the subgroup recognized that the proposed study area, namely, GNSS applications for disaster risk reduction, intersected with the subgroup's current activities and therefore supported the recommendation to study novel GNSS applications for disaster prevention systems. The Working Group and, in particular, the subgroup would actively contribute to the new joint task force of working groups D and B on applications of GNSS for disaster risk reduction.

The Working Group appreciated the variety of the contributions received, such as the Emergency Warning Service of the European satellite navigation system (Galileo), the BeiDou Navigation Satellite System search and rescue service, the Space Service Volume Applications and Lunar Search and Rescue (LunaSAR), illustrating the convergence of science, positioning, navigation and timing services and communication systems. The Working Group noted the efforts made in relation to the interoperability of the Emergency Warning Service. The growing importance of the scientific and commercial use of GNSS (in the agricultural sector, for example) was also noted by the Working Group.

The Working Group recognized the early development of lunar search and rescue capabilities and the importance of interoperability among lunar communication and navigation providers intending to offer these services. The Working Group discussed and agreed on the recommendation that developers of lunar communication and navigation services consider the integration of interoperable and easily accessible search and rescue services.

The Working Group recognized the potential impact that the rising solar activities of the twenty-fifth solar cycle could have on GNSS services and satellites. Further discussions among experts should be conducted through workshops to understand the possible impact of space weather events and the need for alert systems. This would be subject to further discussion at the Working Group's intersessional meeting in 2023.

2023: [A/AC.105/1304, chapter III, para. 24, items 14 - 15, 17 - 18, and 21 - 22]

The Working Group B space users subgroup organized a joint session between all the ICG working groups on lunar positioning, navigation and timing in order to provide them with a consolidated introduction to and overview of lunar positioning, navigation and timing activities. Presentations were made on the following topics: (a) a condensed overview of the current status of systems being proposed, including by China, the European Space Agency, the Japan Aerospace Exploration Agency and the National Aeronautics and Space Administration

of the United States; (b) an overview of lunar spectrum considerations and the Space Frequency Coordination Group; (c) an introduction to and overview of the status of the LunaNet Interoperability Specification and the coordination of lunar reference frames and time systems; and (d) the introduction of a recommendation for ICG to jointly organize with the Interagency Operations Advisory Group a multilateral workshop on cis-lunar positioning, navigation and timing. A presentation was also delivered by the European Commission and the European Space Agency announcing the upcoming public availability of transmit antenna gain patterns for the full constellation of European Satellite Navigation System (Galileo) satellites. In addition, the Indian Space Research Organization highlighted its concept of lunar pseudolites.

The Working Group noted, on the basis of discussions in the joint session between all the ICG working groups and Working Group B, that several space agencies were planning to provide in situ lunar services, including communication, positioning, navigation and timing and search and rescue services, within the current decade. The Working Group also noted that the LunaNet Interoperability Specification working group was working to define a framework of mutually agreed standards aimed at creating an interoperable network of compliant services, including positioning, navigation and timing services, around the Moon. On the basis of the experience acquired and lessons learned by ICG participants in achieving interoperability between GNSS services, and with the goal of promoting the use of lunar positioning, navigation and timing services, the Working Group encouraged developers of lunar positioning, navigation and timing systems to collaborate towards interoperability through open, inclusive multilateral mechanisms, including the LunaNet Interoperability Specification.

Since the fifteenth meeting of ICG, the Working Group B application subgroup had been working on an initiative entitled “GNSS applications: for present and future”. The subgroup’s current activities focused on studying cases of operational GNSS applications that were on the market or were under final development before market release.

The subgroup’s activities were intended to provide assistance and guidance to GNSS users on the basis of lessons learned. The initiative would lead to a research report entitled “GNSS applications for sustainable development: case studies”.

The Working Group discussed the progress made on the Medium Earth Orbit Search and Rescue system, Lunar Search and Rescue (LunaSAR) and the Emergency Warning Service of Galileo. The Working Group recognized the early development of LunaSAR capabilities and the importance of interoperability among lunar communication and navigation providers intending to offer those services.

A suggestion was made to include in the agenda of the intersessional meetings organized by the Working Group the research subject of the integration of communication and navigation signals, with a view to improving the resiliency of positioning, navigation and timing systems. The Working Group agreed to initiate discussions on the subject at its intersessional meeting and invited interested experts in Working Groups S and D to join the discussion.

2024: [A/AC.105/1327, chapter III, para. 21, items 10, and 12 - 14]

[…] The Working Group B space use subgroup presented its accomplishments since the seventeenth meeting of ICG. Monthly virtual meetings had been held to make progress on its workplan. The subgroup had organized a dedicated space service volume session at the Munich Satellite Navigation Summit in March 2024, including on lunar activities, which reflected

increasing interest in this topic. The subgroup had held a hybrid meeting in Vienna in June 2024, in which it had adopted status definitions for its workplan activities and began discussions towards a third edition of the space service volume booklet. The progress made by the subgroup work package two on space user profiles and needs was presented, including analysis of available mission databases, and a space use term list was drafted. […]

[…] The space use subgroup provided an update on the successful joint working group session on lunar positioning, navigation and timing held in Vienna in June 2024. […] During the session, the need had been identified to establish a centralized, dedicated working group within ICG at the earliest opportunity in order to continue the active and necessary coordination among the lunar positioning, navigation and timing community without affecting the scope and work of the existing Earth-focused working groups. […]

[…] the Working Group B application subgroup had made significant progress on its initiative entitled "GNSS applications: for present and future". The subgroup's current activities focused on studying cases of operational GNSS applications that were on the market or were under final development before market release. The subgroup was finalizing the research report entitled "GNSS applications for sustainable development: case studies", which was intended to provide assistance and guidance to GNSS users based on lessons learned. […]

[…] The formation of a task force under Working Group B would be considered in a dedicated workshop focused on the impact of solar activities on GNSS and their usage. […]

4.3. Working Group C on information dissemination and capacity building[10]

2010: [A/AC.105/982, chapter III, para. 30, item 8]

Working Group C reiterated the importance of deploying instruments for the International Space Weather Initiative, and applying GNSS in support of sustainable development.

Working Group C also called for the support to be provided in developing a GNSS curriculum.

2011: [A/AC.105/1000, chapter III, para. 32, item 7]

Working Group C on information dissemination and capacity-building addressed further aspects of its workplan, including training for capacity-building in developing countries; promoting the use of GNSS technologies as tools for scientific applications; the International Space Weather Initiative; and regional workshops on applications of GNSS. A new item on education and training programs on GNSS was added to its workplan.

[10] Working Group C is led by the United Nations Office for Outer Space Affairs

2011: [A/AC.105/1000, chapter III, para. 31, item 8]

Working Group C on information dissemination and capacity-building addressed education and training programmes related to GNSS for purposes of building capacity in developing countries through the regional centres for space science and technology education, affiliated to the United Nations, and centres of excellence, such as the international centre for GNSS science, technology and education at the Beihang University of China. It was noted that those centres, acting as information centres for ICG, might grow into a network of centres and provide a major springboard for the transfer and enhancement of skills and knowledge in GNSS research and applications. A new item on information dissemination, including materials for publication on the web, was introduced in the Working Group's workplan.

2013: [A/AC.105/1059, chapter III, para. 36, item 9]

Working Group C, on information dissemination and capacity-building, focused on the available capacity-building opportunities and the status of operations of the United Nations-affiliated regional centres for space science and technology education and centres of excellence, such as the Russian Education Centre led by the Federal Space Agency of the Russian Federation, the Beihang University of China and the Geospatial and Space Technology Consortium for Innovative Social Services of Japan. In that context, Working Group C noted that providing additional new GNSS education opportunities at different levels would be the best way to cover the different needs in the GNSS field in order to maximize the benefits of the use of GNSS to support sustainable development, particularly in developing nations. The Working Group recommended that new technical knowledge generated by ICG should be effectively communicated to the public, the GNSS-related scientific research community and industry at large, through the ICG information portal and through the use of existing electronic infrastructure and brochures. The Working Group noted that EIAST would also provide capacity-building and contribute to information dissemination on the use of GNSS and its applications.

2014: [A/AC.105/1083, chapter III, para. 37, items 12 and 13]

Recognizing the present status of GNSS and the prospects for the continued development of a wide variety of applications critical to science, commerce and infrastructure, Working Group C, on information dissemination and capacity-building, recommended that more workshops and training courses should continue to be held on specific areas of interest to end users. The Working Group encouraged knowledge transfer via e-learning systems using existing web-based distance learning programmes, as well as communication and outreach to the wider community through the regional centres for space science and technology education, affiliated to the United Nations, which also acted as information centres for ICG.

To improve cooperation between the existing and/or developing user information centres of the providers, Working Group C recommended that all the provider and GNSS user information centres consider the development and adoption of a process for referring enquiries to each other, where appropriate.

2015: [A/AC.105/1104, chapter III, para. 36, items 12 and 13]

Noting the benefits of increased cooperation and support among providers' service centres and the United Nations-affiliated regional centres for space science and technology education, the Working Group on Information Dissemination and Capacity-building proposed the expansion of knowledge-sharing by means of engaging in faculty and student exchange programmes and providing textbooks and teaching materials.

In addition, the Working Group recommended that the ICG members consider the value of national and regional positioning, navigation and timing advisory committees and share their findings at future ICG meetings, when available. It also recommended that providers and GNSS user information centres continue to develop and adopt a process for referring enquiries to each other, where appropriate.

2016: [A/AC.105/1134, chapter III, para. 36, items 13 and 14]

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.

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.

2017: [A/AC.105/1158, chapter III, para. 28, items 16 and 17]

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, the 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, affiliated to the United Nations, to promote the use of GNSS capabilities, particularly in developing countries.

The Working Group emphasized that ICG should join forces with educational institutions to strengthen and deliver targeted capacity-building and technical advisory activities with the goal of sharing ideas and expertise regarding GNSS technology and its applications, particularly encouraging the participation of women and young professionals. In addition, 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 an open data-sharing policy and real-time data accessibility should be taken into account.

2018: [A/AC.105/1191, chapter III, para. 38, item 15]

The Working Group on Information Dissemination and Capacity-building (Working Group C) considered educational programmes and activities carried out by FIG, the Istituto Superiore Mario Boella (ISMB/LINKS), Beihang University, the BeiDou International Exchange and Training Centre, the Civil Global Positioning System Service Interface Committee (CGSIC), the University of Tokyo, Tokyo University of Marine Science and Technology, the Russian Federation, the European Commission and the United Nations-affiliated regional centres for space science and technology education located in India, China, Morocco and Nigeria, in promoting the use of GNSS capabilities, particularly in developing countries.

2019: [A/AC.105/1217, chapter III, para. 28, item 20]

The Working Group noted that a communication framework for the sharing of short-term training opportunities should be developed, enabling efficient use of programmes provided by the regional centres for space science and technology education, affiliated to the United Nations and other institutions. By virtue of the experience in conducting short-term training courses, the Regional Centre for Space Science and Technology Education for Asia and the Pacific in India could take a leading role in organizing such courses.

2021: [A/AC.105/1251, chapter III, para. 31, item 25]

Experience from the International Space Weather Initiative (ISWI) instrument network, which was developing space weather science, showed that the instrument network required 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.

2022: [A/AC.105/1276, chapter III, para. 27, item 23]

The Working Group's project team made progress in: (a) exploring low-cost GNSS receivers that could be used to compute total electron content-related parameters; (b) exploring software that could be used to process data from low-cost GNSS receivers in order to compute total electron content; and (c) design a prototype low-cost GNSS receiver for space weather related applications.

2023: [A/AC.105/1304, chapter III, para. 24, items 26 and 27]

The Working Group's project team on space weather monitoring using low-cost GNSS receiver systems, which was established in 2021 and consisted of experts representing the Abdus Salam International Centre for Theoretical Physics (Italy), Boston College (United States), the University of Tokyo (Japan) and the Laboratory of Plasma Physics (France), continued to explore the possibility of using low-cost receiver systems for space weather monitoring and the implementation of a prototype system. The Working Group noted that the preliminary results of a comparison between high-end and low-cost GNSS receivers showed a

good correlation with regard to vertical total electron content, the rate of change of total electron content index and code phase scintillation.

The Working Group would invite other interested institutions, including the United Nations-affiliated regional centres, to contribute to the project by collecting additional data or providing software in order to perform further data analysis to compute space weather-related parameters.

2024: [A/AC.105/1327, chapter III, para. 21, items 19 and 20]

[…] the Working Group's project team on space weather monitoring using low-cost GNSS receiver systems, led by the Office for Outer Space Affairs and consisting of experts representing the Abdus Salam International Centre for Theoretical Physics (Italy), Boston College (United States), the University of Tokyo (Japan) and the Laboratory of Plasma Physics (France).

[…] the Working Group had been invited to collaborate with international initiatives that offered capacity-building programmes and applications, such as the newly established Antarctic Geospace and Atmosphere Research Scientific Research Programme under the Scientific Committee on Antarctic Research. […]

4.4. Working Group D on reference frames, timing and applications

2010: [A/AC.105/982, chapter III, para. 30, item 9]

The agreement was reached by system providers to liaise with relevant international bodies to ensure that receiver output formats for future GNSS signals would be unambiguously defined.

2011: [A/AC.105/1000, chapter III, para. 32, item 8]

Working group D on reference frames, timing and applications completed development of templates describing the geodetic and timing references for the navigation satellite systems currently represented in ICG. The Working Group also proposed that the templates be published on the ICG information portal. ICG also welcomed progress in work by the International Bureau of Weights and Measures towards production of "Rapid Coordinated Universal Time (UTC)" as a more immediately accessible time reference that could be used to better harmonize the UTC broadcast by each GNSS. The Working Group recommended that interested system providers supply data from their respective monitor stations for inclusion in regular processing with the International GNSS Service (IGS) network of reference stations. Such inclusion is aimed at improving the alignment of the various GNSS reference frames with each other and with the International Terrestrial Reference Frame.

An important new development was the endorsement by ICG of the IGS Multi-GNSS Experiment, which follows on from the previous endorsement by ICG of the multi-GNSS campaign in Asia and Oceania.

2011: [A/AC.105/1000, chapter II, para. 22]

Working group D on reference frames, timing and applications reiterated its recommendation that it would be important to involve an official representative of the European Union in its discussions and deliberations.

2011: [A/AC.105/1000, chapter III, para. 31, item 9]

Working Group D on reference frames, timing and applications noted significant continued progress on the geodetic and timing references for GNSS providers currently represented in ICG. Specific progress was noted in the alignment of the China Geodetic Coordinate System 2012 (CGS-2012) for BeiDou, the Japan satellite navigation Geodetic System 2010 (JGS-2010) for the Quasi-Zenith Satellite System (QZSS), the Parametry Zemli 1990 (PZ-90) geodetic datum for the Global Navigation Satellite System (GLONASS) of the Russian Federation and the World Geodetic System 1984 (WGS-84) for global positioning systems to the latest realization of the International Terrestrial Reference System in the form of ITRF-2008. The Working Group also made recommendations in relation to developments in the recognition of the International Terrestrial Reference System and Coordinated Universal Time (UTC). A notable development was the progress on a pilot service by the International Bureau of Weights and Measures and associated timing laboratories to produce "Rapid UTC".

2013: [A/AC.105/1059, chapter III, para. 36, item 10]

Working Group D[11], on reference frames, timing and applications, noted significant continued progress on the geodetic and timing references for the GNSS currently represented in ICG. Specific progress was noted in (a) the refinement of the alignments of GNSS-associated reference frames to the latest realization of the International Terrestrial Reference System (ITRF2008), and (b) on timing references in relation to rapid Coordinated Universal Time (UTCr), the BIPM publication and GNSS time offsets. Working Group D had contributed and would continue to contribute significantly to the ICG international GNSS monitoring and assessment initiative. The Working Group also made five recommendations: one in relation to the assessment of the level of reference frame alignments to the International Terrestrial Reference Frame and four on timing issues related to: the work of the proposed redefinition of UTC; the official provision of UTCr by BIPM; the BIPM publication; and the monitoring of offsets between GNSS times.

2014: [A/AC.105/1083, chapter III, para. 37, items 14, 15 and 16]

Working Group D, on reference frames, timing and applications, apprised ICG of developments within the Economic and Social Council to establish the Committee of Experts on Global Geospatial Information Management, and within the Working Group on Global Geodetic Reference Frame. The Committee of Experts had noted that the services derived from GNSS technology provide a framework for all geospatial activity, as a key enabler of spatial

[11] See the report at: http://www.unoosa.org/pdf/icg/2013/icg-8/wg/ICG_WGD_2013_report.pdf

data interoperability, disaster mitigation and sustainable development. The co-chairs of Working Group D were involved in the Working Group on Global Geodetic Reference Frame and suggested that ICG and the United Nations Initiative on Global Geospatial Information Management explore close cooperation.

Working Group D noted significant continued progress on the geodetic and timing references for GNSS currently represented in ICG. Specific progress was noted in the refinement of the alignments of GNSS-associated reference frames to the latest realization of the International Terrestrial Reference (ITRF) System, in the form of ITRF2008, and in timing references in relation to rapid Coordinated Universal Time, International Bureau of Weights and Measures publications and GNSS time offsets.

Working Group D had contributed and would continue to contribute to the international GNSS monitoring and assessment initiative. The Group also made two recommendations: one in relation to the United Nations Initiative on Global Geospatial Information Management initiative regarding a General Assembly resolution on the global geodetic reference frame, and one on the possible provision by GNSS providers of satellite data that would improve orbit modelling and accuracy.

2015: [A/AC.105/1104, chapter III, para. 36, items 14 - 16]

The Working Group on Reference Frames, Timing and Applications apprised ICG of General Assembly resolution 69/266 on the global geodetic reference frame for sustainable development. The Committee of Experts on Global Geospatial Information Management had endorsed the establishment of a working group on the global geodetic reference frame, whose task was to develop a "road map" for its realization. The co-chairs of the working group were engaged in the global geodetic reference frame working group.

The Working Group noted that significant progress had been made on the geodetic and timing references for the GNSS currently represented in ICG, with the refinement of (a) the alignments of GNSS associated reference frames to the latest realization of the International Terrestrial Reference Frame (ITRF2008) and (b) timing references in relation to rapid Coordinated Universal Time. The Working Group reported on several developments at BIPM, including updates on its Circular T, Coordinated Universal Time and the revision of the definition of Coordinated Universal Time being discussed at World Radiocommunication Conference 2015. The Working Group informed ICG of progress in the computations of the new ITRF2014. ITRF2014 would be a significant improvement over the current ITRF2008.

The Working Group had contributed to the international GNSS monitoring assessment initiative as one of the co-chairs of the international GNSS monitoring assessment task force. Since the Ninth Meeting of ICG, the work of the task force had focused on the definition of the parameters to be monitored. Considerable progress had been made at the Tenth Meeting of ICG, with the recommendation to launch a joint ICG-IGS trial project. The Working Group had undertaken to review its workplan and define new tasks in the lead-up to the Eleventh Meeting of ICG in 2016, paying particular attention to issues related to precise/scientific applications of GNSS.

2016: [A/AC.105/1134, chapter III, para. 36, items 15 – 17]

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.

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.

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.

2017: [A/AC.105/1158, chapter III, para. 28, items 19 and 20]

The Working Group on Reference Frames, Timing and Applications (Working Group D) noted significant progress on geodetic and timing references by GNSS providers, including: (a) the recent establishment of the subcommittee on geodesy by the Committee of Experts on Global Geospatial Information Management as part of the work under the United Nations Initiative on Global Geospatial Information Management; (b) the evaluation of the quality of the new release of the International Terrestrial Reference Frame (ITRF2014) and the significant contribution of GNSS data; (c) the refinement of the alignments of GNSS reference frames to ITRF, and (d) the information on the GNSS timing references and the comparisons of GNSS time offsets. There is a need to update some of the geodetic and timing templates.

The Working Group noted that the issue of sustainability of the geodetic infrastructure of 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 subcommittee on geodesy.

2018: [A/AC.105/1191, chapter III, para. 38, item 18]

The Working Group on Reference Frames, Timing and Applications (Working Group D) took note of the significant progress on geodetic and timing references by GNSS providers. Specific progress in the following areas was noted: the refinement of the alignment of GNSS reference frames to the International Terrestrial Reference Frame (ITRF); and information on GNSS timing references and the inter-comparison of GNSS time offsets. The working group noted that the templates on geodetic and timing references should be updated by the GNSS providers to reflect the changes.

2019: [A/AC.105/1217, chapter III, para. 28, items 22, 29 and 30]

It was noted that the work of ICG and the Working Group had resulted in significant progress in the realization of GNSS reference frames, and especially with regard to their

alignment to ITRF. This progress included deformation of the terrestrial scale. As this work progressed into a high accuracy positioning community service, participants were encouraged to consider how to address potential issues of reference frame interoperability.

The chairs of Working Groups C and D recognized the synergies that existed between the activities of the two working groups in the fields of GNSS, geodesy and reference frames. The two working groups therefore both agreed to continue to work together and contribute to capacity building in the field of GNSS and the utilization of GNSS in geodesy and reference frames.

The Working Group held a joint meeting with the Working Groups B and S to discuss the Interoperability of GNSS PPP services. The discussions in the joint meeting highlighted the importance of harmonizing key aspects of system-provided PPP services, which subsequently led to a recommendation to establish a task force under the interoperability subgroup of Working Group S.

2021: [A/AC.105/1251, chapter III, para. 31, items 26 – 28, 30, 31 and 33]

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: (a) the refinement of the alignments of GNSS reference frames to the International Terrestrial Reference Frame (ITRF); and (b) the information on the GNSS timing references and the intercomparisons of GNSS time offsets.

The Working Group reiterated that satellite physical and geometrical properties related to the shape, mass, optical properties, dimensions and locations of radiating antennas permitted improved orbit modelling, which in turn increased the accuracy of satellite ephemerides and clock correction determination.

The Working Group noted that there had been some progress made in the provision of satellite properties by the GNSS providers based on ICG recommendation No. 23 in accordance with the whitepaper entitled “Satellite and operations information for generation of pecise GNSS orbit and clock products” released by IGS. IGS collects and makes available GNSS satellite properties to the user community. Access to satellite metadata was essential for enabling scientific applications and for high-accuracy precise positioning. The Working Group also noted that the provision of GNSS satellite phase centre offsets significantly contributed to the determination of the scale of the GNSS/IGS reference frame and allowed intercomparing with satellite laser ranging and very-long-baseline interferometry scales used to determine the ITRF scale. The Working Group recognized the significant progress made in the release of additional satellite metadata by the Quasi-Zenith Satellite System (QZSS), Galileo and BeiDou-2.

The Working Group noted the progress made by BIPM towards implementation of IGS recommendation No. 20 through the publication by BIPM of the clock data [UTC–GNSS time] and [UTC–UTC(k)_GNSS]. Details on the procedure leading to the publication for all four GNSS systems had been presented. The Working Group noted the great progress in the development of the NavIC infrastructure by India and encouraged experimentation on the NavIC system time, also in collaboration with other metrological laboratories. The Working Group also noted proposal by India for NavIC to be included in the BIPM publication of the clock data [UTC–GNSS time] and [UTC–Brdc_UTCGNSS], as first mentioned at the fourteenth meeting of ICG.

Working Group recognized that the extension of the BIPM publication to regional and national systems was not foreseen at the moment and had to be discussed by BIPM international committees based on the needs of international users. So, updating recommendation No. 20 in this direction was not mature at the present stage. The Working Group examined developments relating to recommendation No. 21-B (On the monitoring of offsets of GNSS times). It noted 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–GNSS time] provide a ready-to-use and robust method to determine GNSS-to-GNSS timing offsets (GGTO). The Working Group discussed a recommendation of CCTF of 2021 (On the use of existing time scales to generate GNSS inter-system information). That recommendation solicits GNSS providers to evaluate the possible use of the broadcast predictions of [UTC-GNSS time] 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 through collaboration with Working Groups S and B, it would continue to further assess the user needs in view of considering support of the recommendation of CCTF of 2021, at the sixteenth meeting of ICG.

The Working Group noted the recent efforts of the United Nations Committee of Experts on Global Geospatial Information Management and its Subcommittee on Geodesy, namely, the ongoing work of building and maintaining a global geodetic reference frame, as well as the plans for establishment of a United Nations global geodetic centre of excellence in early 2022 at the United Nations campus in Bonn, Germany.

2022: [A/AC.105/1276, chapter III, para. 27, items 26 thru 39]

The Working Group reiterated that satellite metadata information such as physical and geometrical properties related to the shape, mass, optical properties, dimensions and locations of radiating antennas permitted improved orbit modelling, which in turn increased the accuracy of satellite ephemerides and clock correction determination. This information would greatly benefit the scientific and research community. The Working Group noted that some progress had been made in the provision of satellite properties by the GNSS and radionavigation satellite service providers on the basis of recommendation 23, entitled “Improving the accuracy of multi-GNSS orbits determined by the International Global Navigation Satellite System Service”, in accordance with the white paper entitled “Satellite and operations information for generation of precise GNSS orbit and clock products”, issued by the International Global Navigation Satellite System Service. The Service collected and made GNSS satellite properties available to the user community. Access to satellite metadata was essential for enabling scientific applications and for high-accuracy precise positioning. The Working Group also noted that the provision of GNSS satellite phase centre offsets significantly contributed to the determination of the scale of the GNSS/International Global Navigation Satellite System Service reference frame and allowed intercomparing with satellite laser ranging and very long baseline interferometry scales used to determine the International Terrestrial Reference Frame scale. The Working Group acknowledged the significant progress made in the release of additional satellite metadata by Galileo, the Quasi-Zenith Satellite System and the Beidou Navigation Satellite System. The Galileo phase centre offsets had been used to determine the scale of the GNSS/International Global Navigation Satellite System Service reference frame in the third ICG reprocessing campaign (Repro3) solution, contributing to the realization of the International Terrestrial Reference Frame 2020. GNSS providers were requested to continue

publishing satellite metadata, including phase centre offsets.

The Working Group noted little progress on recommendation 12, entitled "Interoperability of geodetic references among the different GNSS systems". Some providers were providing GNSS data from their tracking stations to the International Global Navigation Satellite System Service. The working group would continue to monitor progress (in conjunction with the international GNSS monitoring and assessment task force), demonstrate the benefits and encourage all GNSS providers to contribute. The Working Group continued to contribute to the task force's initiative, in particular through involvement in the joint trial project.

In a meeting of the Working Group D task force on timing, the European Space Agency and the National Centre for Space Studies presented their work in the field of accurate multi-GNSS time monitoring, emphasizing the crucial need for the accurate calibration of multi-GNSS receiver chains.

The Working Group noted the progress made by the International Bureau of Weights and Measures in implementing recommendation 20, entitled "International Bureau of Weights and Measures publication of [UTC-GNSS times] and [UTC-UTC(k)_GNSS]". Details of the procedure leading to the publication for all four GNSS had been presented. With respect to recommendation 16-A, entitled "Information on the works related to the proposed redefinition of Coordinated Universal Time", the Bureau presented the status of the discussions on continuous, Universal Time Coordinated, noting that agreement might be achieved at the General Conference on Weights and Measures, to be held in November 2022, and at the World Radio Conference, to be held in 2023.

The Working Group noted the status of GNSS calibrations performed by the International Bureau of Weights and Measures for the computation of Universal Time Coordinated. The calibration performed in 2020 included Galileo and the Global Positioning System, and in 2022, BIPM will also include BDS.

The Working Group noted the considerable progress made by India in the development of the Indian Regional Navigation Satellite System Rubidium Atomic Frequency Standard. The country presented a scenario in which timing derived from the Indian Regional Navigation Satellite System could be applied in quantum communications experiments and the testing that was carried out using the System to support quantum communication by entanglement. India gave a presentation on International Global Navigation Satellite System Service stations, whose work was enabled by the Indian Regional Navigation Satellite System.

The Working Group examined developments relating to recommendation 21-B on the monitoring of offsets of GNSS times. It noted the work carried out by the Consultative Committee for Time and Frequency and its working groups and task groups, emphasizing that the current broadcast predictions of Universal Time Coordinated broadcast by GNSS through the message [bUTCGNSS-GNSS time] provide a ready-to-use and robust method to determine GNSS-to-GNSS timing offsets, in addition to existing methods. The Working Group also noted that Recommendation GNSS 1, issued by the Consultative Committee for Time and Frequency in 2021, invited receiver manufacturers to consider this possibility for interoperability.

The Working Group concluded that the inter-system bias could be determined using three different methods: (a) direct determination using GNSS measurements when enough satellites were in view (single-station method); (b) the use of direct broadcast GNSS-to-GNSS timing offsets; or (c) the [bUTCGNSS-GNSS time] predictions currently broadcast by GNSS.

Studies showed that the difference between broadcast predictions of Universal Time Coordinated had negligible consequences for mass market ground users. Therefore, there was no need to create an ad hoc timescale as a common pivot for timing interoperability. The Working Group acknowledged the fact that the needs of space users might lead to different requirements. The evaluation of these space users' needs had been initiated by Working Group B. Working Group D proposed that follow-up discussions on timing interoperability for space users be held at a joint meeting with working groups B, S and D.

At the joint session with working groups B, D and S on timing interoperability, agreement was reached on the development of a joint recommendation that aligned with Recommendation GNSS 1 for ground users. The recommendation was expected to be ready for consideration at the seventeenth meeting of ICG, to be held in 2023.

The Working Group noted the recent efforts of the United Nations Committee of Experts on Global Geospatial Information Management and its Subcommittee on Geodesy, namely, the ongoing work of building and maintaining a global geodetic reference frame, as well as the plans for the establishment of a United Nations global geodetic centre of excellence at the United Nations campus in Bonn, Germany.

The Working Group expressed its support for the GPS Environmental and Earth Science Information System scientific programme, including its mission. By providing space ties between four different geodetic techniques, the mission had the potential to improve determination of the International Terrestrial Reference Frame and support the International Association of Geodesy and Global Geodetic Observing System requirements, in accordance with General Assembly resolution 69/266, entitled "A global geodetic reference frame for sustainable development". The mission would provide a wide range of benefits, including in relation to geodesy, precise navigation, Earth science and climate change monitoring. In addition, its focus on social benefit through technological community-building aligned closely with the spirit of international collaboration in geodesy, with global users of openly available data and products benefiting from the advances made. Furthermore, the option of advanced time transfer techniques, in addition to the primary geodetic objectives, would be very useful in order to compare ground clocks in relation to the redefinition of the International System of Units second. Therefore, Working Group D supported the GPS Environmental and Earth Science Information System project and strongly encouraged the European Space Agency to continue to carry out this fundamental mission.

The Working Group proposed that a joint task force on the applications of GNSS for disaster risk reduction be established under Working Group D and co-chaired by working groups B and D. The task force would focus on novel applications of GNSS data and infrastructure to support sustainable development and disaster risk reduction and would be in alignment with the Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction 2015–2030. The first application to be considered would be the use of GNSS to enhance tsunami early warning systems.

Working Group D, together with working groups B and S, highlighted the importance of harmonizing key aspects of system-provided precise point positioning services, in particular, the definition of precise point positioning terminology, as well as the coordinates reference frame and timing system. Working Group D reiterated that the interoperability of GNSS precise positioning required the timing and geodetic references to be consistent in order to reduce ambiguities for users with regard to the interpretation of navigation and timing solutions. The Working Group found it desirable, from the point of view of the user, to relate or align different

GNSS frames to the International Terrestrial Reference Frame.

2023: [A/AC.105/1304, chapter III, para. 24, items 29 - 30, 32 - 38, and 40]

The Working Group thanked the Russian Federation for installing 45 new GNSS stations in the country's national basic astronomical and geodetic network and for following the International Global Navigation Satellite System Service guidelines and standards.

The Working Group acknowledged and expressed appreciation for the release of satellite metadata by the Galileo, BeiDou Navigation Satellite System, Quasi-Zenith Satellite System and Global Positioning System constellations.

The International Bureau of Weights and Measures reported that a new naming convention had been decided on for the broadcast predictions of Universal Time Coordinated broadcast by GNSS, or bUTC_GNSS. The Bureau had defined a new, more robust approach to determining UTC-bUTC_GNSS and was ready to publish the new UTC-bUTC_GNSS values in Section 4 of Circular T for the Global Positioning System, Galileo, the Global Navigation Satellite System of the Russian Federation and the BeiDou Navigation Satellite System. The Bureau would give a deadline, but also some time for all laboratories to adapt.

The International Bureau of Weights and Measures also reported that under resolution 4 of the General Conference on Weights and Measures of 2022, an increased maximum value for the difference (UT1-UTC) in or before 2035 had been decided on. UT1-UTC differences broadcast by some GNSS would therefore go beyond 1 second, which might not have been foreseen. The possibility of a negative leap second in the next 10 years called for the UT1-UTC tolerance increase to be implemented more quickly. A task group named "Towards continuous UTC" had been created under the Consultative Committee for Time and Frequency in order to prepare a draft resolution to decide on the new tolerance.

The International Bureau of Weights and Measures highlighted the work carried out by a dedicated working group under the Consultative Committee for Time and Frequency on the traceability to Universal Time Coordinated through GNSS measurements. Different kinds of users had been identified and for each of them, the traceability chain to Universal Time Coordinated and the requested calibration had been defined. Some recommendations had been formulated for the users, GNSS receiver manufacturers and GNSS providers. The latter were invited to engage in collaboration with national metrology institutes regarding GNSS time realization and monitoring, and to describe the realization of GNSS times and the information contained in the navigation messages following metrological practice and vocabulary.

The Consultative Committee for Time and Frequency working group on GNSS time transfer gave a presentation on the organization of GNSS calibrations within the Universal Time Coordinated community. Since 2020, all calibrations included Galileo (E1 and E5a), while calibrations that included the BeiDou Navigation Satellite System (B1C and B2a) started in 2022.

The European Space Agency gave a presentation on its activities relating to the absolute calibration of GNSS receiver chains. The Agency was using its GNSS station with absolute calibration to monitor the different UTC-bUTC_GNSS. The Agency called for further cooperation among the various GNSS providers in order to improve understanding of the observed inter-system biases.

The Working Group noted the installation of a Navigation with Indian Constellation

(NavIC) timing receiver at the National Metrology Institute (PTB) of Germany, allowing the monitoring of NavIC time with reference to Universal Time Coordinated (PTB) and Universal Time Coordinated. The Working Group also noted the willingness of NavIC to include NavIC time in Section 4 of Circular T of the International Bureau of Weights and Measures. The Bureau recommended that NavIC representatives establish contact with the Consultative Committee for Time and Frequency for that purpose.

The Working Group noted the good performance of the Indian Rubidium Atomic Frequency Standard on board the navigation satellite NVS-01 and the impact of a continuous Universal Time Coordinated for NavIC. The current broadcast of UT1-UTC could go up to approximately 1 minute; overall, NavIC had spare bits to represent UT1-UTC up to one hour.

The National Time Service Centre of China presented a comparison between the following computation techniques for the Global Positioning System-Galileo time offset: (a) the single-station approach and (b) taking bUTC_GNSS as a pivot. Working Group D confirmed that there was currently a difference between the actual and broadcast time offset (UTC-GNSS time) for the Global Navigation Satellite System of the Russian Federation and the BeiDou Navigation Satellite System, and that the single-station Global Positioning System-Galileo time offset method was indeed the preferred method when satellite visibility permitted.

2024: [A/AC.105/1327, chapter III, para. 21, items 22, 23, 25 - 27, 30, 32, 33, 36, 37, 39, 40, 42, 44, and 46 - 48]

The IGS Real-Time Working Group presented an update on its real-time service and recent activities. The real-time service provides real-time corrections for all four main constellations, clock corrections being of particular interest to the IGS Working Group. IGS noted a desire to increase collaboration with system providers in order to improve the IGS real-time tracking network, in particular in Africa and large parts of Asia, and to strengthen the IGS real-time data infrastructure in view of the increase in the number of user requests.

In a joint working group discussion, a representative of the United Nations Global Geodetic Centre of Excellence highlighted weaknesses in the global geodesy supply chain,[12] in particular issues relating to the reliability of geodetic products such as Earth orientation parameters and future realizations of the International Terrestrial Reference Frame, which were essential to the operation of GNSS satellites. ICG members openly acknowledged the risks that had been highlighted by the Centre and recognized that strengthening the global geodesy supply chain should be prioritized in order to ensure that GNSS services were made more robust.

The International Bureau of Weights and Measures (BIPM) provided updates on the new Section 4 of Circular T, which publishes the difference between UTC and the bUTC_GNSS. BIPM reported an improvement of the processing chain, which now featured a pool of UTC Group 1 laboratories, each of them providing calibrated multi-GNSS observations

12 The global geodesy supply chain refers to ground observatories (very-long-baseline interferometry, satellite laser ranging, GNSS, Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) and gravitational wave); data centres; analysis, correlation and combination centres; and the development of geodetic products including terrestrial reference frames and Earth orientation parameters (see https://ggim.un.org/UNGGCE/).

that were then combined by the Bureau. […]

[…] BIPM had launched a survey among GNSS providers to assess the impact of the forthcoming Universal Time (UT1)-UTC tolerance increase and to gather potential preferred values for the maximum tolerance; responses had been received from the operators of the Global Positioning System (GPS) of the United States, the Global Navigation Satellite System (GLONASS) of the Russian Federation, the European Satellite Navigation System (Galileo), the BeiDou Navigation Satellite System (BDS) and NavIC.

BIPM noted that a negative UTC leap second might become necessary in the near future and acknowledged that this might create a risk of disruption. BIPM urged ICG members and GNSS providers to consider the unprecedented possibility of a negative leap second and its broader impact. Some States members of BIPM asked for the implementation of continuous UTC before 2035 to avoid the risk of a negative leap second. Unfortunately, limited knowledge and models of the Earth's rotation did not allow an accurate forecast to be made of UT1-UTC in the long term.

ESA reported on the development of operating tools to monitor GNSS timing systems and to perform receiver calibrations. Routine calibrations are performed yearly, with a set (non-changing) procedure; sequential calibrations show good stability as a function of time.

ESA reported on a new cross-support agreement between ESA and ISRO focused on network operations and calibration facilities. Two GNSS timing receivers supplied by ISRO were to be calibrated by ESA, and the calibration report would be shared with ISRO. These receivers would be used as references for NavIC timing, and ISRO would broadcast the calibrated time offset through the NavIC system.

[…] The National Time Service Centre of China showed that the deviation from UTC of the reference time UTC(k) involved in GNSS timekeeping is getting smaller. This was beneficial for the application of the UTC pivot method.

The Shanghai Astronomical Observatory of China provided transformation parameters for the differences between the BeiDou Coordinate System and the international terrestrial reference frames ITRF14 and ITRF20, reporting millimetre-level agreement on the alignments. The Observatory also provided updates and recent results on the satellite laser ranging tracking of BDS satellites, highlighting the value of this effort for validating GNSS ephemerides and improving solar radiation pressure models and antenna phase centre offsets.

ESA reported that the Galileo terrestrial reference frame (GTRF), a high-accuracy realization of ITRF, continued to be developed. ESA was working towards a requirement that differences of position compared to the most recent ITRF should not exceed 3 cm and reported that the GTRF reference frame would be updated and published in the next few months.

The National Geospatial-Intelligence Agency of the United States reported the release of a new realization (G2296) of the World Geodetic System 1984 (WGS 84) terrestrial reference frame and provided a comprehensive report to the Working Group. The new release was aligned with both the ITRF2020 and IGS20 reference frames, and remained a linear frame defined by station positions and velocities. WGS 84 (G2296) improved the estimation technique by fitting both annual and semi-annual signals to the time series. These improvements introduced enhanced means of handling station discontinuities due to antenna movements, including post-seismic deformation terms after a significant earthquake. In addition, the new realization adopted the antenna phase centre offsets for the entire GPS constellation as provided by the IGS20 Antenna Exchange Format (ANTEX) file.

ISRO reported on its interest in establishing a widespread network with multi-frequency NavIC (L1, L5 and S bands) tracking capabilities. ISRO offered to support station operators in augmenting existing infrastructure or establishing new stations. […]

The Russian Federation reported on annual coincidence and monthly repeatability results for different terrestrial reference frames between 2021 and 2024. According to the analysis, the agreement between WGS84 and ITRF2020 was assessed at an accuracy of 1–4 cm, the BeiDou Coordinate System (BDCS) at 3–4 cm, and GTRF at 2–5 cm; Parametri Zemli (PZ-90.11) was at the level of 10 cm according to the GLONASS technical requirements. The best terrestrial reference frames repeatability performance was found for both GTRF and WGS84 (around 5 cm), while BDCS and PZ-90.11 showed discrepancies up to 7 cm and 12 cm, respectively.

The task force, recognizing the need for more extensive outreach and advocacy with respect to the role of GNSS in natural hazard monitoring, had drafted a policy brief to clearly articulate the benefits of GNSS in disaster risk reduction and encourage the implementation of GNSS technology among stakeholders and policymakers. […]

The Working Group highlighted the importance of relating the existing (Earth) reference frames to lunar reference frames, and the careful consideration of the point of transition and transformation parameters to convert coordinates between reference frames.

The Working Group noted that there was a need for further research on the potential for joint services between Earth-based GNSS and Lunar positioning, navigation and timing, noting that the reference frames services provided at present by Earth-based GNSS did not fully meet the needs of a joint service covering both the Earth and the Moon. […]

BIPM recommended that any timescale on the Moon (and other celestial bodies) should have a clear and traceable connection to UTC, and that the work be carried out in close collaboration with the relevant international organizations. […]

ANNEX I: TERMS OF REFERENCE OF THE INTERNATIONAL COMMITTEE ON GLOBAL NAVIGATION SATELLITE SYSTEMS

ICG/TOR/2023

Terms of Reference[13]

of the International Committee on Global Navigation Satellite Systems

A. Background

1. Global navigation satellite systems (GNSS) have evolved from an early period of limited programmes to a point where a number of systems and their augmentations are operating or planned. In the future, a number of international and national programmes will operate simultaneously and support a broad range of interdisciplinary and international activities. Discussions taking place at national, regional and international levels have underscored the value of GNSS for a variety of applications. The emergence of new GNSS and regional augmentations has focused attention on the need for the coordination of programme plans among current and future operators in order to enhance the utility of GNSS services.

2. The representatives of GNSS core system providers, GNSS augmentation providers and the international organizations primarily associated with the use of GNSS and representatives of international projects in developing countries,

   Aware of the overlap of GNSS mission objectives and of the interdisciplinary applications of GNSS services,

   Recognizing the advantages of ongoing communication and cooperation among operators and users of GNSS and their augmentations,

   Recognizing the need to protect the investment of the current user base of GNSS services through the continuation of existing services,

   Aware that the complexity and cost of user equipment should be reduced whenever possible,

   Convinced that GNSS providers should pursue greater compatibility and interoperability among all current and future systems in terms of spectrum, signal structures, time and geodetic reference standards to the maximum extent possible,

   Desiring to promote the international growth and potential benefits of GNSS,

   Noting that General Assembly resolution 59/2 (paragraph 11) invites GNSS and augmentation providers to consider establishing an international committee on GNSS in order to maximize the benefits of the use and applications of GNSS to support sustainable development,

[13] The Section C, Participants (Members, Associate Members and Observers), item 4 (a) was modified (highlighted in Bold Italic) as proposed and adopted at the sixteenth meeting of the ICG.

Have agreed to establish on the basis of these non-binding terms of reference, the ICG for the purpose of promoting the use and application of GNSS on a global basis.

B. Objectives

3. The objectives of the ICG are to:

   a) Benefit users of GNSS services through consultations among members of the ICG;

   b) Encourage coordination among providers of GNSS core systems and augmentations in order to ensure greater compatibility and interoperability;

   c) Encourage and promote the introduction and utilization of satellite positioning, navigation and timing services, particularly in the developing countries through assistance with the integration of GNSS services into their infrastructures;

   d) Assist both the members of the ICG and the international user community by, inter alia, serving as the focal point for international information exchange related to GNSS activities, respecting the roles and functions of GNSS service providers and intergovernmental bodies such as the International Telecommunication Union (ITU), the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO);

   e) Better address future user needs in the GNSS development plans and applications; and

   f) Report periodically on its activities to the Committee on the Peaceful Uses of Outer Space.

   These objectives will be accomplished by an indicative workplan of the ICG.

C. Participants (Members, Associate Members and Observers)

4. The International Committee will be open to States Members of the United Nations, international organizations or international entities that are responsible for GNSS and their augmentations operating under governmental authority or involved in implementing or promoting GNSS services and applications. There will be three categories of participants in the Committee: Members, Associate Members and Observers.

   a) Members:

      Current and future core system providers, including China (Compass/BeiDou Navigation Satellite System (CNSS)), the European Union (European Satellite Navigation System (Galileo)), the Russian Federation (Global Navigation Satellite System (GLONASS)) and the United States of America (Global Positioning System (GPS));

      States Members of the United Nations with an active programme in implementing or promoting a wide range of GNSS services and applications (Algeria, Australia, Italy, Malaysia, New Zealand, Republic of Korea, Türkiye and United Arab Emirates);

Current and future space-based regional or augmentation system providers including, for example, the European Space Agency (European Geostationary Navigation Overlay Service ((EGNOS)), India (Navigation with Indian Constellation (NavIC) or Indian Regional Navigation Satellite System (IRNSS) and GPS Aided Geostationary (GEO) Augmented Navigation (GAGAN)), Japan (Michibiki Satellite-based Augmentation System (MSAS)) and Quasi-Zenith Satellite Space Based Augmentation System (QZSS)), Nigeria (Nigerian Communication Satellite Space Based Augmentation System(NigComsat-1 SBAS)), the Russian Federation (Wide-area System of Differential Corrections and Monitoring (SDCM) and the United States (Wide-area Augmentation System (WAAS));

b) Associate Members:

International and regional organizations and associations dealing with GNSS services and applications, including the Office for Outer Space Affairs of the United Nations Secretariat, the Civil GPS Service Interface Committee (CGSIC), the European Position Determination System (EUPOS), the Fédération Aéronautique Internationale (FAI), the Fédération internationale des géomètres (FIG), the International Association of Institutes of Navigation (IAIN), the International Association of Geodesy (IAG), the International Association of Geodesy Reference Frame Sub-Commission for Europe (EUREF), the International Cartographic Association (ICA), the International GNSS Service (IGS, formerly International GPS Service), the International Earth Rotation and Reference Systems Service (IERS) and the International Society for Photogrammetry and Remote Sensing (ISPRS).

c) Observers:

The Arab Institute of Navigation (AIN), the Asia-Pacific Space Cooperation Organization (APSCO), the Committee on Space Research (COSPAR), the Bureau international des poids et mesures (BIPM), the European Space Policy Institute (ESPI), the International Telecommunication Union (ITU), the Interagency Operations Advisory Group (IOAG), Radio Technical Commission for Maritime Services (RTCM) and the Union radio-scientifique internationale (URSI).

5. The ICG will make decisions by consensus of the Members. Associate Members and Observers will provide advice, monitor the work of the ICG participate in working groups established in accordance with paragraph 8 below, participate in activities identified in the workplan of the ICG and report back to their own organizations. Members and Associate Members may host meetings of the ICG and chair and participate in working groups and host or provide support to the executive secretariat that supports the ICG. The admission of new Members, Associate Members and Observers will be with the consensus of the Members of the ICG.

D. Procedures of work, structure and organization

6. The structure of the ICG consists of a chairperson, a plenary session of the Committee, an executive secretariat and working groups. The chair will rotate on an annual basis among the Members and Associate Members.

7. The ICG will convene at least once every year in plenary session. Meetings of the ICG will be organized by the designated host. Each Member, Associate Member

and Observer should designate its principal and its point of contact. Any change to the principals and/or points of contact should be communicated to the chairperson of the ICG through the executive secretariat. Interim planning meetings may be required and can be organized as needed by the executive secretariat.

8. The ICG may establish, as mutually agreed and on an ad hoc basis, working groups to investigate specific areas of interest, cooperation and coordination and to report at subsequent plenary sessions. The chairpersons of such groups shall report at each plenary session on accomplishments and future plans. Continuation of each working group requires confirmation at each plenary session by the Members.

9. All recommendations of the ICG or its working groups will be decided on the basis of consensus of its Members, do not create legal obligations, and will be acted upon at the discretion of each Member, Associate Member and Observer. Recommendations should not be disseminated outside the ICG or its participants until careful deliberations have been conducted in plenary, and full consensus is reached.

10. The ICG may revise these terms of reference on the basis of proposals made by Members or Associate Members and adopted by consensus of the Members.

11. The ICG may revise the workplan on the basis of proposals made by Members, Associate Members and Observers and adopted by consensus of the Members.

12. Members, Associate Members and Observers will fund their own participation in the activities of the ICG, including the working groups. Requirements for financial support to the executive secretariat (in-kind or direct funding) will be determined by the Members and Associate Members of the ICG.

ANNEX II: TERMS OF REFERENCE OF THE INTERNATIONAL COMMITTEE ON GLOBAL NAVIGATION SATELLITE SYSTEMS PROVIDERS' FORUM

ICG/PF/TOR/2023

Terms of Reference[14]

of the International Committee on Global Navigation Satellite Systems Providers' Forum

A. Background

1. The International Committee on Global Navigation Satellite Systems (ICG) was established on a voluntary basis as an informal body to promote cooperation, on matters of mutual interest related to civil satellite-based positioning, navigation, timing and value-added services, as well as the compatibility and interoperability of global navigation satellite systems, while increasing their use to support sustainable development, particularly in developing countries.

2. In response to a recommended action in the ICG workplan, providers of global and regional navigation satellite systems and satellite-based augmentation systems proposed establishing a Providers' Forum to enhance compatibility and interoperability among current and future systems. The first Providers' Forum meeting, co-chaired by the United States of America and India, was held on 4 September 2007, immediately preceding the second meeting of the ICG. China, India, Japan, the Russian Federation and the United States, as well as the European Union, were present at the meeting.

B. Objectives

3. The objectives of the Providers' Forum are to:

   a) Promote compatibility and interoperability among current and future global and regional navigation satellite systems by exchanging detailed information about planned or operating systems and the policies and procedures that govern their service provision, consistent with the template for information sharing among providers that was circulated prior to the first meeting;

   b) Act as a mechanism to continue discussions on important issues addressed by the ICG that require focused inputs from system providers.

4. The Providers' Forum is not a policymaking body, but provides a means to promote discussion among system providers based on agreed guidelines for provision of open services, including transparency, cooperation, performance

[14] Section D, Procedures of work, structure and organization were modified (highlighted in Bold Italic) as proposed and adopted at the twenty-sixth meeting of the Providers' Forum held in conjunction with the sixteenth meeting of ICG

monitoring and spectrum protection; and agreed principles for ensuring compatibility and interoperability among systems.

C. Membership

5. The Providers' Forum will be open to States Members of the United Nations that are or will be global or regional navigation satellite systems providers. Current members and their respective systems are as follows:

   a) *China:* BeiDou Navigation Satellite System (BDS);

   b) *India*: Navigation with Indian Constellation (NavIC) or Indian Regional Navigation Satellite System (IRNSS) and Global Positioning System Aided Geostationary (GEO) Augmented Navigation System (GAGAN);

   c) *Japan:* Quasi-Zenith Satellite System (QZSS) and Michibiki Satellite-based Augmentation System (MSAS);

   d) *Russian Federation*: Global Navigation Satellite System (GLONASS) and Wide-area System of Differential Corrections and Monitoring (SDCM);

   e) *United States*: Global Positioning System (GPS) and Wide-area Augmentation System (WAAS);

   f) *European Union*: European Satellite Navigation System (Galileo) and European Geostationary Navigation Overlay Service (EGNOS).

6. Additional Member States who are or will become global or regional navigation satellite system providers may be invited to join the Providers' Forum upon consensus of the current members.

D. Procedures of work, structure and organization

7. In the case a provider hosts an ICG annual meeting, it will chair the Providers' Forum meetings for the year of that ICG annual meeting. Otherwise, the chair of the Providers' Forum will rotate among its members subject to a decision on the basis of consensus. The Office for Outer Space Affairs of the United Nations Secretariat, consistent with its role as the Executive Secretariat of ICG, will also fulfil these responsibilities for the Providers' Forum, in support of the chair.

8. The Providers' Forum will convene once every year in conjunction with the ICG annual meeting and more often if needed. Actions and recommendations developed by working groups of ICG that could impact the compatibility and interoperability, system development and operations, and/or service provision policies and procedures of providers of GNSS will be of particular interest to the Providers' Forum. Therefore, the results of Providers' Forum deliberations and consensus decisions on these and other issues will be reported to ICG as appropriate and when possible, at the next scheduled plenary session of ICG immediately following a Providers' Forum meeting.

9. The meetings of the Providers' Forum will be organized by the chairs and designated host, with support from the Office for Outer Space Affairs of the United Nations, acting as the Forum's Executive Secretariat. Each member should designate its principal and additional points of contact.

10. Any recommendations resulting from Providers' Forum meetings will be decided on the basis of consensus of its members.

11. Members will fund their own participation in the activities of the Providers' Forum. Financial support (in-kind or direct funding) to the Executive Secretariat that is above and beyond the annual budget of the Office for Outer Space Affairs or existing funds provided for ICG secretariat services will be provided by members on a voluntary basis.

12. The Providers' Forum may revise these terms of reference on the basis of proposals made by members and adopted by consensus.

ANNEX III: WORKPLAN OF THE PROVIDERS' FORUM

ICG/PF/WP/2018

Workplan of the Providers' Forum

In order to accomplish the objectives of the Providers' Forum as described in the terms of reference, the members of the Providers' Forum have agreed to pursue the following actions.

Promotion of compatibility and interoperability

1. The principles of compatibility and interoperability and their definition were adopted at the first meeting of the Providers' Forum, held in Bangalore, India, in 2007 (A/AC.105/901). At the third meeting of the Providers' Forum, held in Pasadena, California, United States of America, in 2008, these principles and their definition were updated (see appendix). The Providers' Forum will continue to refine these principles of compatibility and interoperability and their definition.
2. The providers will actively support the actions of the International Committee on Global Navigation Systems (ICG) Working Group on Systems, Signals and Services, which is focused on achieving compatibility and interoperability among the global navigation satellite systems (GNSS). This may include sponsoring and participating in workshops and meetings designed to solicit input from GNSS users. It may also require elaboration on an approach for quantitative evaluation.
3. The providers will draft individual reports on their respective planned or operating systems and the policies and procedures that govern their service provision, consistent with the template for information sharing:
   (a) The reports will be consolidated and maintained by the ICG Executive Secretariat on behalf of the providers and updates will be provided at least annually in preparation for each major meeting of ICG;
   (b) The reports will emphasize each provider's 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.

Open service information dissemination

4. Consistent with the principle of transparency in the provision of open services, each individual provider will strive to publish and disseminate all signal and system information necessary to allow manufacturers to design and develop GNSS receivers on a non-discriminatory basis.
5. Based on individual publication of open service signal information, the Providers' Forum will consider templates for sharing and disseminating information as developed by the ICG Working Group on Systems, Signals and Services.

Service performance monitoring

6. Providers will consider the development and discussion of proposals to widely monitor the performance of their open signals and provide timely updates to users regarding critical performance characteristics such as timing accuracy, positioning accuracy and service availability.

7. These discussions should focus on potential cooperation in the development of the necessary ground infrastructure to monitor signal and service performance for open services, recognizing that the actual implementation of this infrastructure is subject to the budgetary limitations of each system provider, and the completion of provider-to-provider agreements as necessary and appropriate.

Spectrum protection: interference detection and mitigation

8. The Providers' Forum will pursue the protection of radio-navigation satellite services (RNSS) spectrum through appropriate domestic and international regulation. When necessary and appropriate, providers will share their views on RNSS spectrum issues and related agenda items under consideration by the International Telecommunication Union and its working parties.

9. In addition, the Providers' Forum will pursue the development of a strategy to detect and mitigate interference in GNSS worldwide by supporting the efforts of the ICG Working Group on Systems, Signals and Services in this regard. This could lead to concrete proposals for detecting interference.

10. This workplan will be reviewed on an annual basis and revised as necessary in order to address important issues that require the attention and focus of system providers.

ICG/PF/WP/SEP2009

Providers' Forum principles of compatibility and interoperability and their further definition

Global and regional system providers agreed that at a minimum, all global navigation satellite systems (GNSS) signals and services must be compatible. To the maximum extent possible, open signals and services should also be interoperable, in order to maximize benefit to all GNSS users. For many applications, common carrier frequencies are essential to interoperability and commonality of other signal characteristics is desirable. In some cases, carrier frequency diversity may be preferable to improve performance. The Providers' Forum will continue to investigate the benefits of carrier frequency commonality and diversity, as well as of compatibility and interoperability, as these latter terms are defined below:

(a) *Interoperability* refers to the ability of global and regional navigation satellite systems and augmentations and the services they provide to be used together to provide better capabilities at the user level than would be achieved by relying solely on the open signals of one system:

  (i) Interoperability allows navigation with signals from different systems with minimal additional receiver cost or complexity;

  (ii) Multiple constellations broadcasting interoperable open signals will result in improved observed geometry, increasing end-user accuracy everywhere and improving service availability in environments where satellite visibility is often obscured;

  (iii) Geodetic reference frames realization and system time steerage standards should adhere to existing international standards to the maximum extent practical;

  (iv) Any additional solutions to improve interoperability should be encouraged.

(b) *Compatibility* refers to the ability of global and regional navigation satellite systems and augmentations to be used separately or together without causing unacceptable interference and/or other harm to an individual system and/or service:

  (i) The International Telecommunication Union (ITU) provides a framework for discussions on radiofrequency compatibility. Radiofrequency compatibility should involve thorough consideration of detailed technical factors, including effects on receiver noise floor and cross-correlation between interfering and desired signals;

  (ii) Compatibility should also respect spectral separation between each system's authorized service signals and other systems' signals. Recognizing that some signal overlap may be unavoidable, discussions among providers concerned will establish the framework for determining a mutually acceptable solution;

  (iii) Any additional solutions to improve compatibility should be encouraged.

ANNEX IV: LIST OF STATES MEMBERS OF THE UNITED NATIONS AND GOVERNMENTAL, INTERGOVERNMENTAL AND NON-GOVERNMENTAL ORGANIZATIONS PARTICIPATING IN INTERNATIONAL COMMITTEE ON GLOBAL NAVIGATION SATELLITE SYSTEMS

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

Algeria

Australia

China

India

Italy

Japan

Malaysia

New Zealand

Nigeria

Republic of Korea

Russian Federation

Türkiye

United Arab Emirates

United States of America

European Union

Arab Institute of Navigation (AIN)

Asia-Pacific Space Cooperation Organization (APSCO)

Civil Global Positioning System Service Interface Committee (CGSIC)

Committee on Space Research (COSPAR)

European Space Agency (ESA)

European Space Policy Institute (ESPI)

Interagency Operations Advisory Group (IOAG)

International Aeronautical Federation (FAI)

International Association of Geodesy (IAG)

International Association of Geodesy Reference Frame Sub-Commission for Europe (EUREF)

International Association of Institutes of Navigation (IAIN)

International Bureau of Weights and Measures (BIPM)

International Cartographic Association (ICA)

International Earth Rotation and Reference Systems Service (IERS)

International Federation of Surveyors (FIG)

International Global Navigation Satellite System Service (IGS)

International Society for Photogrammetry and Remote Sensing (ISPRS)

International Steering Committee of the European Position Determination System (EUPOS)

International Telecommunication Union (ITU)

International Union of Radio Science (URSI)

Radio Technical Commission for Maritime Services (RTCM)

United Nations Office for Outer Space Affairs (OOSA)

ANNEX V: TEMPLATE FOR SHARING INFORMATION BETWEEN SERVICE PROVIDERS

Template for sharing information between service providers[15]

I. System description:

A. Space segment: technical parameters such as altitude and inclination or geosynchronous orbit (GEO) slot position. As appropriate, it could also address satellite disposal procedures and orbit information, to establish a baseline for ensuring deconfliction with other constellations;

B. Ground segment;

C. Signals: current and planned signals;

D. Performance: performance standards versus actual performance;

E. Timetable for system deployment and operation.

II. Services provided and provision policies.

III. Perspective on compatibility and interoperability:

A. Definition of compatibility and interoperability;

B. Efforts to ensure radiofrequency compatibility through bilateral and multilateral venues;

C. Efforts to pursue interoperability through bilateral and multilateral venues.

IV. Global navigation satellite system (GNSS) spectrum protection activities:

A. National-level radio-navigation satellite system (RNSS) spectrum regulation/management procedures;

B. Views on International Telecommunication Union (ITU) RNSS spectrum issues or agenda items of the World Radiocommunication Conference, as appropriate or necessary;

C. RNSS interference detection and mitigation plans and procedures.

V. Participation in the International Committee on Global Navigation Satellite Systems:

A. Discussion of the service providers' involvement in the working groups and workplan activities of the Committee;

B. Views on future areas of focus and activities of the Committee as appropriate.

[15] Available in all official languages of the United Nations at the ICG Information Portal: http://www.unoosa.org/oosa/en/SAP/gnss/icg/providersforum.html

ANNEX VI: MEETINGS OF THE INTERNATIONAL COMMITTEE ON GLOBAL NAVIGATION SATELLITE SYSTEMS

Meetings of the International Committee on Global Navigation Satellite Systems

Meeting	Dates	Venue	Document Symbol[16]
First Meeting of the International Committee on Global Navigation Satellite Systems	1 - 2 November 2006	United Nations Office for Outer Space Affairs (UNOOSA), Vienna, Austria	A/AC.105/879
Second Meeting of the International Committee on Global Navigation Satellite Systems	5 - 7 September 2007	Indian Space Research Organization (ISRO), Bangalore, India	A.AC.105/901
Third Meeting of the International Committee on Global Navigation Satellite Systems	8 - 12 December 2008	United States State Department and the Jet Propulsion Laboratory (JPL), Pasadena, United States of America	A/AC.105/928
Fourth Meeting of the International Committee on Global Navigation Satellite Systems	14 - 18 September 2009	Federal Space Agency (ROSCOSMOS), Saint-Petersburg, Russian Federation	A/AC.105/948
Fifth Meeting of the International Committee on Global Navigation Satellite Systems	18 - 22 October 2010	Italy and the European Commission, Turin, Italy	A/AC.105/982
Sixth Meeting of the International Committee on Global Navigation Satellite Systems	5 - 9 September 2011	Government of Japan, Tokyo, Japan	A/AC.105/1000
Seventh Meeting of the International Committee on Global Navigation Satellite Systems	5 – 9 November 2012	Government of China, Beijing, China	A/AC.105/1035

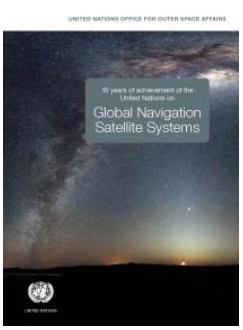
[16] Documents in all official languages of the United Nations and available from the ICG Information Portal at www.unoosa.org or directly at: http://www.unoosa.org/oosa/en/ourwork/icg/documents/105.html

Eighth Meeting of the International Committee on Global Navigation Satellite Systems	9 – 14 November 2013	Government of Dubai, Dubai, United Arab Emirates	A/AC.105/1059
Ninth Meeting of the International Committee on Global Navigation Satellite Systems	10 – 14 November 2014	European Union, Prague, Czech Republic	A/AC.105/1083
Tenth Meeting of the International Committee on Global Navigation Satellite Systems	1 – 6 November 2015	Government of the United States, Boulder, Colorado, United States of America	A/AC.105/1104
Eleventh Meeting of the International Committee on Global Navigation Satellite Systems	6 – 10 November 2016	Government of the Russian Federation, Sochi, Russian Federation	A/AC.105/1134
Twelfth meeting of the International Committee on Global Navigation Satellite Systems	2 – 6 December 2017	Government of Japan, Kyoto, Japan	A/AC.105/1158
Thirteenth meeting of the International Committee on Global Navigation Satellite Systems	4 – 8 November 2018	Government of China, Xi'an, China	A/AC.105/1191
Fourteenth meeting of the International Committee on Global Navigation Satellite Systems	8 – 12 December 2019	Government of India, Bengaluru, India	A/AC.105/1217
Fifteenth meeting of the International Committee on Global Navigation Satellite Systems	27 September – 1 October 2021	United Nations Office for Outer Space Affairs (UNOOSA), Vienna, Austria	A/AC.105/1251
Sixteenth meeting of the International Committee on Global Navigation Satellite Systems	9 – 14 October 2022	Government of the United Arab Emirates, Abu Dhabi, United Arab Emirates	A/AC.105/1276
Seventeenth meeting of the International Committee on Global Navigation Satellite Systems	15 – 20 October 2023	European Union in collaboration with the Spanish Presidency of the European Union, Madrid, Spain	A/AC.105/1304

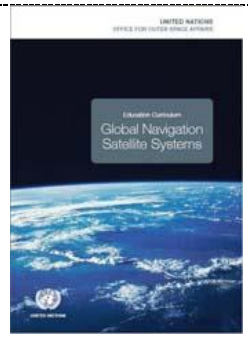
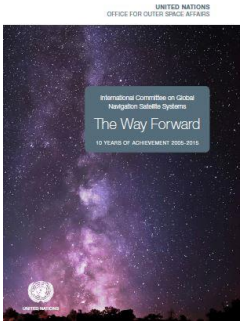
Eighteenth meeting of the International Committee on Global Navigation Satellite Systems	*6 – 11 October 2024*	*Governments of Australia and New Zealand*	*A/AC.105/1327*
Eighteenth meeting of the International Committee on Global Navigation Satellite Systems Corrigendum	*6 – 11 October 2024*	*Governments of Australia and New Zealand*	*A/AC.105/1327/Corr.1*

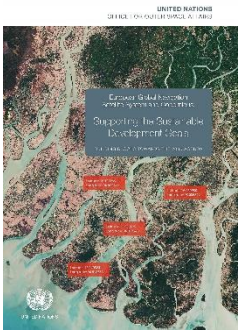
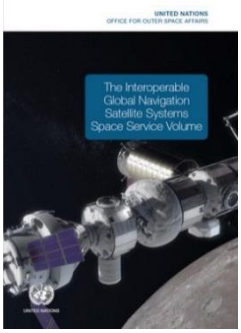
ANNEX VII: PUBLICATIONS – INFORMATION MATERIAL

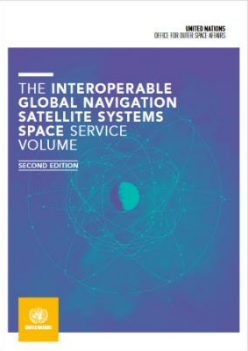
Publications – Information material

Year	Title/Document Symbol	Description/Languages	Cover page[17]
2007	Brochure on the International Committee on Global Navigation Satellite Systems (ICG)	The International Committee on Global Navigation Satellite Systems (ICG): a forum to discuss Global Navigation Satellite Systems (GNSS) to benefit people around the world. *Available in the following languages: Arabic, Chinese, English, French, Russian, Spanish*	
2010	Current and Planned Global and Regional Navigation Satellite Systems and Satellite-based Augmentations Systems *(ST/SPACE/50)*	Report prepared on behalf of the International Committee on Global Navigation Satellite Systems (ICG), based on reports submitted by the members of the ICG Providers' Forum on planned or existing global navigation satellite systems and on relevant policies and procedures. *Available in the following languages: English*	
2011	10 Years of Achievement of the United Nations on Global Navigation Satellite Systems *(ST/SPACE/55)*	This publication describes achievements of providers and users of positioning, navigation, and timing services, under the umbrella of the United Nations, in promoting Global Navigation Satellite Systems (GNSS) over the past 10 years. *Available in the following languages: English*	

[17] The ICG publications are available from the ICG Information Portal at: www.unoosa.org or directly at: http://www.unoosa.org/oosa/en/ourwork/icg/documents/publications.html

2012	Education Curriculum on Global Navigation Satellite Systems (GNSS) *(ST/SPACE/59)*	The GNSS education curriculum was developed by taking into account GNSS course outlines as used at the university level in a number of developing and industrialized countries. The incorporation of elements of GNSS science and technology into university-level education curricula served a dual purpose: (a) it could enable countries to take advantage of the benefits inherent in the new technologies, which, in many cases, are spin-offs from science and technology; or (b) to introduce the concepts of high technology in a non-esoteric fashion and help create national capacities in science and technology in general. *Available in the following languages: Arabic, English, French, Spanish*	
2016	International Committee on Global Navigation Satellite Systems: The Way Forward – 10 Years of Achievement, 2005 – 2015 *(ST/SPACE/67)*	The purpose of this publication is to provide the GNSS user community and manufacturers of GNSS receivers with a clear and consistent description of the global and regional navigation satellite systems and satellite-based augmentation systems that are currently operating and that will operate in the future. This publication also provides key facts about international and regional organizations and associations dealing with GNSS services and applications, including the United Nations Office for Outer Space Affairs, and the role of those organizations and associations in ICG as associate members and observers. *Available in the following languages: English*	

2018	European Global Navigation Satellite System and Copernicus: Supporting the Sustainable Development Goals. Building Blocks towards the 2030 Agenda *(ST/SPACE/71)*	This report investigates how European Union space technologies support the fulfilment of the SDGs. It has been jointly prepared by the United Nations Office for Outer Space Affairs (UNOOSA)—in charge of promoting international cooperation in the peaceful use and exploration of space, and in the utilization of space science and technology for sustainable economic and social development—and the European GNSS Agency (GSA), which is the European Union agency operating EGNOS and Galileo and is in charge of ensuring the maximization of socioeconomic benefits from the use of the European Union satellite navigation systems. *Available in the following languages: English*	
2018	The Interoperable Global Navigation Satellite Systems Space Service Volume *(ST/SPACE/75)*	The availability and performance of global navigation satellite systems (GNSS) signals at high altitude is documented as the GNSS Space Service Volume (SSV). While different definitions of the SSV exist and may continue to exist for the different service providers, within the context of this booklet it is defined as the region of space between 3,000 km and 36,000 km above the Earth's surface, which is the geostationary altitude. For space users located at low altitudes (below 3,000 km), the GNSS signal reception is similar to that for terrestrial users and can be conservatively derived from the results presented for the lower SSV in this booklet. *Available in the following languages: English*	

2021	The Interoperable Global Navigation Satellite Systems Space Service Volume – 2nd Edition *(ST/SPACE/75/Rev.1)*	Global navigation satellite systems (GNSS), which were originally designed to provide positioning, velocity and timing services for terrestrial users, are now also being increasingly utilized for autonomous navigation in space. Historically, most space users have been located at low altitudes, where GNSS signal reception is similar to that on the ground. More recently, however, users are relying on these signals at high altitudes, near to or above the GNSS constellations themselves. The first edition of this booklet was published at the 13th meeting of the ICG in December 2018. This fully revised second edition includes updates to the GNSS constellations and simulation results according to the latest information from each provider. Chapter 6 has been added to demonstrate the on-orbit capability of GNSS space use, beyond the formal characteristics of each constellation. Finally, simulation results now include a geometric dilution indicator (GDI) representing the quality of signal geometry. The geometric diversity of available signals is an important factor in navigation performance and is often improved by an interoperable GNSS SSV. *Available in the following languages: English*	

ANNEX VIII: STATEMENT OF THE PROVIDERS' FORUM CONCERNING THE INTERNATIONAL COMMITTEE ON GLOBAL NAVIGATION SATELLITE SYSTEMS

Statement of the Providers' Forum concerning the

International Committee on Global Navigation Satellite Systems

On 6 November 2012, at its Ninth Meeting, in Beijing, the Provider's Forum adopted the following statement:

The International Committee on Global Navigation Satellite Systems (ICG) was established in 2005 and has steadily developed into an important platform for the system providers, the user communities, observers and interested United Nations Member States to exchange views and information concerning the field of satellite navigation. ICG has taken a leading role internationally to promote collaboration in the utilization of global navigation satellite systems (GNSS) services for a range of commercial, scientific and technological applications. Specific areas of interest to ICG and its working groups include compatibility and interoperability, service performance and service performance enhancement, timing and geodetic reference frames, education and training, and global applications.

The Providers' Forum was established in 2007, at the Second Meeting of ICG. Since then, each of the global and regional system providers has hosted a meeting of ICG, achieving an important milestone in demonstrating the commitment of the Providers to the goals and objectives of ICG. This commitment serves as a foundation to enhance collaboration and to increase global awareness of GNSS.

During its series of meetings, in particular, at its Ninth Meeting, held in conjunction with the Seventh Meeting of ICG in Beijing on 4-9 November 2012, the Providers' Forum considers user recommendations, works cooperatively to enable better service, supports the protection of the radio navigation satellite services (RNSS) spectrum, considers activities that promote GNSS awareness and education, and considers proposals to enhance service performance and performance monitoring and assessment.

The Providers' Forum promotes compatibility and interoperability among current and future global and regional space-based systems by exchanging detailed information about planned or operating systems and the policies and procedures that govern their service provision. More importantly, the Providers' Forum is a mechanism to continue discussions on important issues addressed by ICG that require focused inputs from system providers.

In its Ninth Meeting, the Providers' Forum considered the future role of ICG and agreed to keep that item on its agenda.

ANNEX IX: SUMMARY OF DISCUSSIONS CONCERNING THE "FUTURE OF THE INTERNATIONAL COMMITTEE ON GLOBAL NAVIGATION SATELLITE SYSTEMS"

Summary of discussions concerning the

"Future of the International Committee on Global Navigation Satellite Systems"

At the seventh meeting of the Providers' Forum held in conjunction with the sixth meeting of the International Committee on Global Navigation Satellite Systems (ICG), in Tokyo, Japan, 5 – 9 September 2011, the topic of the future of ICG was raised and discussed. This included a discussion on: the efficiency of the working groups, the designation of working group chairs, possible establishment of a Users' Forum, the status of recommendations and conclusions made by the Providers' Forum and ICG, and the future of the ICG Secretariat. The Providers' Forum agreed to adopt a proposal by the co-chairs to add an agenda item to the next Providers' Forum meeting on the "Future role and work of ICG and its Providers' Forum", and that specific proposals could be made at that time. Furthermore, the co-chairs proposed to include an agenda item at the United Nations International Meeting on the applications of global navigation satellite systems (GNSS), in Vienna, Austria, 12 -16 December 2011, giving experts an opportunity to exchange views on an informal basis regarding the future work of the ICG and its Providers' Forum.

During the United Nations International Meeting on GNSS held 12 -16 December 2011 in Vienna, Austria, a small group of experts met and brainstormed ideas related to the future of the ICG. At the conclusion of the meeting, a presentation was put together summarizing the discussion and different options that were raised. This summary was not exhaustive but meant to capture the essence of what was discussed and pave the way for further discussion at the eighth meeting of the Providers' Forum on 4 June 2012 in Vienna, Austria.

Discussion on the future of the ICG continued during the first planning and organizational meeting for the seventh meeting of the ICG, held on 13 February 2012 in Vienna, Austria. A presentation entitled "Key considerations on the future of the ICG" was given by the United States of America, which was based on the summary of the December 2011 informal meeting. The topics were classified into top priorities, organizational issues, and questions to be addressed. Since time was limited, the providers decided to convene the next discussion in conjunction with China's Satellite Navigation Conference 15 – 19 May 2012, in Guangzhou, China.

The informal meeting of the Providers' Forum was held on 17 May 2012 on the margins of the Third China Satellite Navigation Conference (CSNC2012) in Guangzhou, China. The discussion of the "Key considerations on the future of the ICG" was continued. To facilitate further discussion, a table was created on "Key considerations on the future of the ICG". The issues of the nature of working groups versus study groups, the designation of working group chairs, and the Users' Forum were identified and discussed.

At the eighth meeting of the Providers' Forum held on 4 June 2012 in Vienna, Austria, the future role and work of the ICG and its Providers' Forum was discussed as

an agenda item. A report of the informal meeting of the Providers' Forum held in May 2012 on the margins of CSNC2012, was presented by the co-chairs of the Providers' Forum. A summary of the other meetings was also noted and a list of issues/questions for prioritization was presented. During this meeting, the providers discussed and reviewed the issues/questions and organized them into the following three categories: (1) currently under consideration (easy to implement); (2) further consideration will be given; (3) more in-depth study to be conducted.

The following issues/questions were categorized as "under consideration and easy to implement":

1. The ICG, as a platform for open discussions and information exchange, is a great success. It provides a better understanding of general trends in user needs, applications and GNSS development. Informally the providers and the represented users take findings into account in their plans and programs, to improve performance, compatibility and interoperability. Communication among system providers has been improved by the Providers' Forum;

2. Some ICG recommendations aimed at providers have already become principles, such as compatibility, interoperability and transparency in the provision of open services;

3. Recommendations to organizations outside the ICG should be targeted to specific actors and include specific actions;

4. Ensuring that the ICG is properly structured will require a review of:

    - Procedure for selection of chairs or co-chairs;
    - Terms of Reference of the Providers' Forum in relation to current working groups;
    - Maintenance of permanent working groups or ad hoc working groups;
    - Procedures for plenary and intersessional meetings;
    - Executive Secretariat;

5. The number of user communities represented at the ICG should be increased;

6. Compatibility efforts should be separated from interoperability efforts;

7. The number of working groups should be limited;

8. Retaining the existing working groups structure, meetings could still be organized differently to maximize problem solving;

9. Working groups could be required to develop recommendations prior to ICG meetings rather than during ICG meetings.

The questions about the establishment of a Users' Forum, which includes its role within the ICG, its structure, its membership, its terms of reference, and its methods of work, were put forward for consideration at the Providers' Forum meeting, 5 – 9 November 2012 in Beijing, China. It was noted that the main objective of the Users' Forum would be to discuss common problems, and provide feedback to the providers on what could be done to increase the efficiency of GNSS applications in the multi-GNSS environment. It was also noted that the ICG members/associate members and observers should be contacted and informed to be prepared to lead discussions about the Users' Forum and to present their views and recommendations.

The view was expressed that to ensure the working groups achieve progress and meet their milestones, a permanent chair is needed for some working groups. Also it is

often useful, and perhaps inevitable, to establish a sub-group (study group and task force) under a working group to develop proposals to solve particular problems.

The eighth meeting of Providers' Forum also noted that consideration should be given to the staff capacity of the ICG Executive Secretariat, assisting with the planning and organization of the meetings of the ICG and Providers' Forum, and its working groups in the future structure of the ICG.

An agenda item on the future role of the ICG provoked a healthy discussion at the Ninth meeting of the Providers' Forum, held 5 – 9 November 2012 in Beijing, in conjunction with the seventh meeting of ICG. During this meeting, the Providers' Forum agreed to the following conclusions:

1. The function of the Office for Outer Space Affairs as the Executive Secretariat should continue for now;
2. General consensus that there would be benefit to having a Users' Forum. The details of how it would be integrated need to be discussed and considered before a final decision is made;
3. No changes to the working groups should be made at this time;
4. Discussion on selection of Providers' Forum co-chairs will occur at the next Providers' Forum meeting.

In conjunction with the seventh meeting of ICG, a meeting of the members, associate members and observers took place. During this meeting, a presentation was made by the co-chair of the Providers' Forum, summarizing the ideas discussed by the providers over the past year, concerning the future of the ICG. The intent was to obtain feedback on some of the ideas being discussed by the providers. The members, associate members and observers offered the following comments:

1. Suggestion for ICG to include an agenda item during the plenary session for providers to comment on the status of past recommendations;
2. Associate members and observers agreed to help share information on the value of ICG in the various organizations;
3. Recommendation for ICG to adopt a User's Forum (or other terminology) as a way for users to have input in the ICG:
    a. Would consist of international non-governmental (NGO)'s (that would currently qualify as associate members);
    b. Would support increasing awareness and adoption of GNSS, and help users address problems in fully exploiting GNSS across a broad range of users and in all nations;
    c. Would enable users to help lobby on issues of concern to the GNSS community.

At the planning meeting for the tenth Providers' Forum meeting, held 18 February 2013 in Vienna, Austria, the participants continued discussions about a Users' Forum, noting that the process of establishing such a group should not be complicated. It was emphasized that all user groups should be well represented by the Users' Forum. It was also suggested that developing a Mission Statement for the ICG would be helpful in identifying how the Users' Forum fits in the construct of the ICG.

The tenth meeting of the Providers' Forum was held on 10 June 2013 in Vienna, Austria. At that meeting, a draft Mission Statement was introduced, and recommended for review and consideration at the eighth meeting of the ICG, 9 – 14 November 2013 in Dubai, United Arab Emirates. A view was expressed that ICG was trying to consider many issues in a limited period of time (one week during the ICG annual meeting), and that not enough work was being accomplished outside of the meetings. One suggestion was offered for the ICG Executive Secretariat and/or ICG points of contact to keep track of the ICG recommendations. Another idea that was floated is for the ICG host country to send a person to Vienna, the year prior to the annual ICG meeting, to work with the Secretariat on preparation activities for the upcoming meeting.

The Users' Forum was also discussed. It was suggested that the providers focus on getting user input in order to better understand the users' needs and requirements. It was agreed that it is important to hear input from the users and associate members specifically about what they are doing to collect user requirements, and to get input from associate members on how the ICG is helping them accomplish their mission. The providers therefore agreed to change the agenda for the eighth meeting of the ICG to include a second plenary session in place of the second Providers' Forum session, to allow for this discussion.

A discussion and decision on the selection of future Providers' Forum co-chairs was postponed until the eleventh meeting of the Providers Forum, in conjunction with the eighth meeting of the ICG in Dubai, 9-14 November 2013.

At the eleventh meeting of the Providers' Forum held in Dubai, on 9, 11 and 13 November 2013, the providers agreed to co-chair the Providers' Forum meetings on a 2-year rotational basis, and established a schedule for the next several years through 2017 and will confirm the remaining schedule through 2019 in the coming months.

The ICG adopted a Mission Statement contained in the Annex to this summary.

ANNEX X: MISSION STATEMENT OF THE INTERNATIONAL COMMITTEE ON GLOBAL NAVIGATION SATELLITE SYSTEMS

Mission Statement of

the International Committee on Global Navigation Satellite Systems

The International Committee on Global Navigation Satellite Systems (ICG), established in 2005 under the umbrella of the United Nations, promotes voluntary cooperation on matters of mutual interest related to civil satellite-based positioning, navigation, timing and value-added services. ICG contributes to the sustainable development of the world. Among the core missions of ICG are to encourage coordination among providers of global navigation satellite systems (GNSS), regional systems and augmentations in order to ensure greater compatibility, interoperability and transparency, and to promote the introduction and utilization of those services and their future enhancements, including in developing countries, through assistance, if necessary, with the integration into their infrastructures. ICG also serves to assist GNSS users with their development plans and applications by encouraging coordination and serving as a focal point for international information exchange.

ANNEX XI: VISION STATEMENT OF THE INTERNATIONAL COMMITTEE ON GLOBAL NAVIGATION SATELLITE SYSTEMS

Vision Statement of

the International Committee on Global Navigation Satellite Systems

The International Committee on Global Navigation Satellite Systems strives to encourage and facilitate compatibility, interoperability and transparency between all the satellite navigation systems, to promote and protect the use of their open service applications and thereby to benefit the global community. Our vision is to ensure the best satellite-based positioning, navigation and timing for peaceful uses for everybody, anywhere, any time.