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Committee on the Peaceful Uses of Outer Space

Thirteenth meeting of the International Committee on Global Navigation Satellite Systems

Note by the Secretariat

I. Introduction

A. Background

1. At the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), held in 1999 and at the forty-fourth session of the Committee on the Peaceful Uses of Outer Space, held in 2001, the issue of global navigation satellite systems (GNSS) was one of the agenda items under consideration. In 2005, a separate body completely devoted to GNSS, the International Committee on Global Navigation Satellite Systems (ICG), was established under the umbrella of the United Nations. The assumption was that current and future system operators would soon move from a competitive to a collaborative approach because they had a shared interest in the universal use of GNSS services regardless of the system used.

2. Following its establishment, ICG has met annually to discuss matters regarding GNSS on a worldwide scale. ICG represents a unique combination of GNSS service providers and major user groups that seek to encourage compatibility and interoperability among the various satellite systems, while increasing the use of those systems in developing countries to raise standards of living and to protect the environment.

3. With the participation of States Members of the United Nations, intergovernmental bodies and non-governmental organizations, ICG has become an important platform for communication and cooperation in the field of GNSS. The Office for Outer Space Affairs of the Secretariat continues to support progress towards achieving compatibility and interoperability among global and regional space-based navigation systems. As new systems emerge, signal compatibility and interoperability among GNSS systems and transparency in the provision of open civil services will be key factors in ensuring that civil users around the world receive the maximum benefit from GNSS and its applications.

4. Four working groups were set up by ICG to implement its workplan, each working group considering one of the following issues: systems, signals and services (Working Group S), co-led by the Russian Federation and the United States of America; enhancement of GNSS performance, new services and capabilities (Working Group B), co-led by China, India and the European Space Agency (ESA);

information dissemination and capacity-building (Working Group C), led by the Office for Outer Space Affairs; and reference frames, timing and applications (Working Group D), co-led by the International Association of Geodesy (IAG), the International Federation of Surveyors (FIG) and the International GNSS Service (IGS).

5. ICG held its thirteenth meeting in Xi'an, China, from 5 to 9 November 2018. The Providers' Forum held its twenty-first meeting in conjunction with that ICG meeting, on 4 and 8 November 2018. The China Satellite Navigation Office organized the meeting on behalf of the Government of China. A list of the States Members of the United Nations, United Nations entities and governmental, intergovernmental and non-governmental organizations participating in ICG is contained in annex I.

B. Structure and programme of the meeting

6. The programme of the thirteenth meeting of ICG included three plenary meetings and a series of meetings of the four working groups. The first plenary meeting was held on 5 November 2018. An update was provided on satellite-based navigation systems in operation and under development, and on research and development activities for the next generation of GNSS. For each system, a representative provided an overview, described current and planned characteristics and performance, presented updates and plans and summarized ongoing interactions with other service providers. ICG members, associate members and observers representing GNSS user groups shared their views and ideas on matters of interest to ICG and its working groups.

7. An expert seminar entitled "GNSS+" was held on 5 November 2018, for which invited speakers were asked to present innovative GNSS applications in combination with other technologies for consideration by ICG and its working groups.

8. The theme of a special session "The fiftieth anniversary of the first UNISPACE (UNISPACE+50)" was structured around the work of the Action Team on GNSS, carried out between 2001 and 2004, that led to the establishment of ICG. The session featured statements by Italy and the United States, as the Action Team co-chairs. The session also included the launch of the ICG booklet *The Interoperable Global Navigation Satellite Systems Space Service Volume* (ST/SPACE/75) published by the United Nations.

9. The four ICG working groups each met separately on 6 and 7 November 2018 to review progress in implementing the recommendations made at previous meetings and look at ways and means to carry them forward in 2019 and beyond.

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

11. In conjunction with the thirteenth meeting of ICG, the Providers' Forum held its twenty-first meeting on 4 and 8 November 2018 under the co-chairmanship of China and Japan (see sect. IV below).

C. Attendance

12. Representatives of the following States participated in the thirteenth meeting of ICG: China, India, Italy, Japan, Nigeria, Russian Federation, United Arab Emirates and United States. The European Union was also represented.

13. The following intergovernmental and non-governmental organizations dealing with GNSS services and applications were also represented at the meeting: Asia-Pacific Space Cooperation Organization, Civil Global Positioning System Service Interface Committee, ESA, Interagency Operations Advisory Group, International Aeronautical Federation, IAG, IAG Reference Frame Sub-Commission for Europe, International Association of Institutes of Navigation (IAIN), International Bureau of

Weights and Measures, FIG and IGS. Representatives of the Office for Outer Space Affairs and the International Telecommunication Union also participated.

14. ICG invited, at their request, observers for Australia, the Lao People's Democratic Republic and the Republic of Korea to attend the thirteenth meeting and to address it, as appropriate, on the understanding that it would be without prejudice to further requests of that nature and that doing so would not involve any decision of ICG concerning their status.

15. ICG invited, at its request, observers for the Arab Information and Communication Technologies Organization to attend the thirteenth meeting and to address it, as appropriate, on the understanding that it would be without prejudice to further requests of that nature and that it would not involve any decision of ICG concerning its status.

D. Expert seminar on global navigation satellite system applications

16. An expert seminar entitled "GNSS+" was held on 5 November 2018. The seminar focused on new innovative applications of GNSS in conjunction with other technologies, including the Internet and big data, and benefits of the GNSS technology for the economy and society. The seminar brought together experts from industry, science and governments for a broad overview and different perspectives. Presentations covered the following applications: meteorology, high-precision applications, intelligent transportation, emergency alerts and the monitoring and assessment of emergencies, smart phones, smart cities and space exploration. The work of the ICG Working Group on Enhancement of GNSS Performance, New Services and Capabilities (Working Group B) and its outcomes demonstrated the importance and relevance of the interoperability of GNSS systems. An outline was given of how GNSS and its integrated applications were playing an indispensable role in furthering the well-being of humanity.

E. UNISPACE+50 special session

17. The programme of the UNISPACE+50 special session included opening addresses by the co-chairs of the Action Team on GNSS. It was highlighted that ICG, which issued from UNISPACE III, held in 1999, which was a follow-up conference to UNISPACE I, held in 1968, and UNISPACE II, held in 1982, served as a model for how the United Nations could undertake action to follow up on global conferences and achieve tangible results within a fixed time frame.

18. In taking stock of what had been achieved to date, it was recognized that ICG was fulfilling its role as an important platform for international cooperation and coordination in achieving compatibility and interoperability among GNSS providers. In particular, first the Action Team on GNSS and subsequently ICG had worked on the cross-cutting areas considered by the Committee on the Peaceful Uses of Outer Space, such as capacity-building, interoperability and space for sustainable development.

19. In the session on UNISPACE+50, it was recognized that Italy and the United States, as co-chairs of the Action Team on GNSS, had played a pivotal role in leading the first ever focused review of new technology promoted by the United Nations that had created huge scientific and commercial opportunities.

20. The session on UNISPACE+50 also saw the launch of the ICG booklet *The Interoperable Global Navigation Satellite Systems Space Service Volume*. This booklet was produced by ICG Working Group B with the objective of defining, establishing, and promoting an interoperable GNSS space service volume for the benefit of GNSS space users and GNSS space receiver manufacturers. The information in the booklet provided GNSS space users and GNSS space receiver manufacturers with a single resource offering a concise overview on the

characteristics of the contribution of each GNSS system to an interoperable GNSS space service volume.

F. Documentation

21. A list of the documents before the thirteenth meeting is contained in annex II. Those documents and further information on the meeting agenda, background materials and presentations are available via the ICG information portal at the website of the Office for Outer Space Affairs (www.unoosa.org).

22. A description of the activities undertaken or supported by the Office for Outer Space Affairs in 2018 in the framework of the workplan of ICG, and the main results achieved, can be found in document A/AC.105/1192.

II. Observations, recommendations and decisions

23. After considering the various items before it at its thirteenth meeting, ICG made the observations, recommendations and decisions set out below.

24. ICG took note with appreciation of the reports of its working groups and its Providers' Forum, which contained the results of their deliberations in accordance with their respective workplans.

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

26. ICG took note of the schedule of the working groups' intersessional meetings and workshops for 2019, which would be held in conjunction with space-related international conferences and symposiums.

27. The chairman of the meeting informed participants that a request from Australia for membership in ICG had been received. The chair of the meeting summarized the letter of request and the relevant correspondence.

28. ICG took note of a presentation by the representative of Australia on its Satellite-based Augmentation System (SBAS) test-bed programme. It was noted that transmissions of SBAS signals over pseudo-random noise sequences of frequencies (PRN 122) began in June 2017. Those transmissions had continued uninterrupted since then, with ongoing provision of test-bed services supporting the L1 legacy service, which was transmitted on the L1 frequency and was able to achieve sub-metre positioning in real time.

29. ICG welcomed the application of Australia for membership in ICG.

30. ICG took note of the request from IAIN for a change of status from observer to associate member of ICG. The chair of the meeting summarized the letter of request and the relevant correspondence.

31. ICG heard the presentation by the representative of IAIN on the evolution of the ongoing contribution of IAIN to international debate, and that IAIN had strengthened its outreach policy by endeavouring to be more proactive in the international bodies in which it had recognized status.

32. ICG granted IAIN the status of associate member.

33. The executive secretariat was requested to amend the terms of reference of ICG to reflect the addition of the new member and to reflect the change in the status of IAIN.

34. ICG took note of the initiative of ICG Working Group B under way to ensure that GNSS signals within the space service volume were available and interoperable across all international global constellations and regional augmentations. It was noted that through ICG, all providers had agreed on the information presented in the ICG

booklet *The Interoperable Global Navigation Satellite Systems Space Service Volume* and on a number of recommendations to continue development, support, and expansion of the multi-GNSS space service volume concept.

35. ICG accepted the invitation extended by India to host the fourteenth meeting of ICG, in 2019, and noted the offer made by the Office for Outer Space Affairs to host the fifteenth meeting, in 2020. ICG also noted the expressions of interest by the United Arab Emirates and Nigeria to host the annual meetings of ICG in 2021 and 2022, respectively.

36. ICG agreed on a tentative schedule for the preparatory meetings for its fourteenth meeting, to be held during the fifty-sixth session of the Scientific and Technical Subcommittee and the sixty-second session of the Committee, both in 2019. It was noted that the Office for Outer Space Affairs, as the executive secretariat of ICG and its Providers' Forum, would assist in preparations for those meetings and the activities of the working groups.

37. At the closing ceremony, participants expressed their appreciation to the China Satellite Navigation Office for organizing the meeting and to the Office for Outer Space Affairs for its work in support of ICG and its Providers' Forum, including carrying out planned activities.

III. Joint statement

38. ICG adopted by consensus the following joint statement:

1. The thirteenth meeting of the International Committee on Global Navigation Satellite Systems (ICG) was held in Xi'an, China, from 5 to 9 November 2018 to continue reviewing and discussing developments in global navigation satellite systems (GNSS) and to allow ICG members, associate members and observers to address recent developments in their organizations and associations regarding GNSS services and applications. ICG also addressed GNSS technology and services in a wide range of applications related to meteorology, space exploration, smart phones and smart cities, high-precision applications, intelligent transportation, and emergency alerts and the monitoring and assessment of emergencies.

2. President Xi Jinping of China sent a congratulatory letter, which was delivered by Wang Zhaoyao, Chairman of the China Satellite Navigation Committee. Officials from the Shaanxi provincial government and the Chinese Academy of Sciences also addressed the meeting, followed by the representative of the Office for Outer Space Affairs. During the UNISPACE+50 session, statements were delivered by the representatives of Italy and the United States, as co-chairs of the Action Team on GNSS. In the UNISPACE+50 session, participants reflected on the achievements of providers and users of positioning, navigation and timing services in promoting GNSS technology that benefits all people on Earth.

3. The Meeting was hosted and organized by the China Satellite Navigation Office on behalf of the Government of China. The Meeting was attended by representatives of China, India, Italy, Japan, Nigeria, the Russian Federation, the United Arab Emirates, the United States of America and the European Union, as well as the following intergovernmental and non-governmental organizations: Asia-Pacific Space Cooperation Organization, Civil Global Positioning System Service Interface Committee, European Space Agency, Interagency Operations Advisory Group, International Aeronautical Federation, International Association of Geodesy (IAG), IAG Reference Frame Sub-Commission for Europe, International Association of Institutes of Navigation, International Bureau of Weights and Measures, International Federation of Surveyors and International Global Navigation Satellite System Service. Representatives

of the Office for Outer Space Affairs and the International Telecommunication Union (ITU) also participated. Australia, the Lao People's Democratic Republic and the Republic of Korea were invited to attend as observers. The representatives of the regional centres for space science and technology education, affiliated to the United Nations, that are located in China, India, Morocco and Nigeria attended the meeting. A representative of the Arab Information and Communication Technologies Organization was invited to attend as an observer. Australia was recognized by ICG as a new member, and the International Association of Institutes of Navigation was recognized as a new associate member.

4. ICG recalled that the General Assembly, in its draft resolution A/C.4/73/L.4,[1] to be adopted, was to note with satisfaction the continuous progress made by ICG towards achieving compatibility and interoperability among global and regional space-based positioning, navigation and timing systems and in the promotion of the use of GNSS and their integration into national infrastructure, particularly in developing countries.

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

6. The Working Group on Systems, Signals and Services (Working Group S), through its subgroups and task forces, advanced all aspects of its workplan in the intersessional period between the twelfth and thirteenth meetings of ICG. The subgroup on compatibility and spectrum protection, continuing its campaign to promote adequate protection of GNSS spectrum through education and outreach, conducted a third spectrum protection seminar, on this occasion in conjunction with the United Nations/Argentina workshop on the applications of GNSS held in Falda del Carmen, Argentina, from 19 to 23 March 2018. That was followed by the seventh GNSS interference detection and mitigation workshop, organized and conducted under the auspices of the subgroup, which was held, for the second time, in conjunction with the annual Baška GNSS Conference, held in May 2018 in Baška, Croatia. At the workshop, participants continued to investigate methods of implementing interference detection and mitigation capabilities through permanent network-based solutions and through crowdsourcing techniques. 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.

7. 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

[1] Subsequently adopted as General Assembly resolution 73/91 on 7 December 2018.

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.

8. Finally, Working Group D continued to investigate methods to improve system-of-system operations with a focus on the need to assess the adequacy of current orbital debris mitigation guidelines applicable to GNSS. The Working Group subsequently recommended that ICG ask the Inter-Agency Space Debris Coordination Committee to conduct a study on medium Earth orbit and inclined geosynchronous orbit in coordination with system providers.

9. 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.

10. Thanks to the excellent cooperation among all members of the GNSS space service volume task force, a major milestone has been reached by successfully completing the work on the GNSS space service volume booklet, which will serve as “the reference” for the space user community. A new subgroup on space applications was created by Working Group B to focus on these issues. The space applications subgroup will be co-chaired by interim co-chairs from China, the United States and ESA.

11. 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.

12. The Working Group expressed appreciation for the information provided by China on the planned BDS return link service and the overview provided by NASA on the discussions on return link service within Cospas-Sarsat. The Working Group shared the interest in interoperability of the search and rescue radar return link service. Taking note of the creation of a correspondence group by Cospas-Sarsat, the Working Group encouraged the discussion of the return link service and an overall concept of operations by Cospas-Sarsat. The Working Group would like to receive feedback on the outcomes and will work to achieve interoperability within ICG.

13. 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.

14. The working activities and achievements of the subgroup on space applications were reported on by the co-chairs of the subgroup. The

structure and strategy of the questionnaire were defined, and points of contact from each provider were identified. China made a presentation on BDS applications on civil transport aircraft, indicating that the BDS short message function provides a new technological approach of real-time flight surveillance, tracking and emergency communication. India made a presentation on the Indian Regional Navigation Satellite System (NavIC) messaging services and novel applications. Japan provided an update on the advantages of the inclined geosynchronous orbit satellites of the Quazi-Zenith Satellite System (QZSS) for offering a seamless and robust navigation integrity monitoring service. The Working Group was encouraged by the ongoing International Civil Aviation Organization standardization activities for dual-frequency multi-constellation SBAS, which includes consideration of the benefits that can be provided by the use of inclined geosynchronous orbit.

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.

16. The Working Group emphasized that ICG should strengthen cooperation with industry, government, academia and other relevant institutions to improve GNSS education, training and capacity-building. This would be accomplished through continued outreach to policymakers and decision makers, supporting the exchange of experts and educational resources, and through the increased engagement of women and young professionals.

17. The Working Group noted that the education capacity-building index proposed by the Regional Centre for Space Science Technology and Education in Asia and the Pacific (China) would require further evaluation by the United Nations-affiliated regional centres to improve global facilitation of GNSS education development and capacity-building.

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.

19. With respect to education and capacity-building in developing countries, members of the Working Group also participated in education and outreach projects, in partnership with ICG Working Group C, on the “reference frames in practice” workshops. Two such workshops were held: at the FIG Congress held in Istanbul, Turkey, in May 2018, and in Suva, Fiji in September 2018.

20. Working Group D continued to contribute to the International GNSS Monitoring and Assessment (IGMA) initiative, in particular through involvement in the IGMA-International GNSS Service (IGS) joint trial project. A related issue raised at the twelfth meeting of ICG was the looming overload of the International Laser Ranging Service (ILRS)

ground network with respect to its capability to track all GNSS satellites fitted with laser retroreflectors, which resulted in the Working Group recommendation (recommendation No. 25). Laser tracking of GNSS satellites is an important means of independently determining the precise GNSS ephemerides, and hence evaluating the quality of GNSS satellite orbits computed by the GNSS providers and third parties using GNSS measurements and models. IGS made recommendations to ILRS on guidelines for the selection of GNSS satellites to be tracked by the ILRS, and for which periods and intervals they are to be tracked. The Working Group approved the IGS recommendation as the basis for future GNSS tracking and therefore recommendation No. 25, as adopted by ICG, is completed and closed.

21. Satellite physical and geometrical properties related to the shape, mass, optical properties, dimensions and locations of radiating antennas permit improved orbit modelling, which in turn increases the accuracy of ephemerides and satellite clock correction determination. The Working Group acknowledged that there had been some progress made in the provision of satellite properties by the GNSS providers based on the Working Group recommendation (recommendation No. 23) in accordance with the white paper entitled “Satellite and operations information for generation of precise GNSS orbit and clock products” published by IGS. IGS collects and makes available to the user community data on GNSS satellite properties.

22. The Working Group noted that some providers were providing GNSS data from their tracking stations to IGS. Working Group D will continue to monitor progress (in conjunction with IGMA), demonstrate the benefits of the combined use of multiple constellations, and encourage all GNSS providers to contribute.

23. The Working Group noted the progress made on its recommendation No. 21 on monitoring the offsets between GNSS times. In collaboration with Working Group S, a second joint workshop on this topic was held in Vienna in June 2018, and a common session was organized at the thirteenth meeting of ICG. Studies had been conducted by some GNSS providers and within the timing community, and the presented results allowed characterization of the offsets and identified several methods to improve their determination. Additional work was necessary for the providers to assess the goals for accuracy in the determination of the GNSS time offsets, in order to specify a recommended method to determine and monitor them. The common session between the Working Group S and Working Group D concluded that a further focused workshop should address these questions in 2019.

24. Working Group D held a joint meeting with Working Group B and Working Group S to discuss “Interoperability of GNSS precise point positioning services”. It was agreed that it was too early to decide whether this should become a new work item of ICG. However, there was a consensus that the topic was worthy of further exploration and that all three working groups (B, D and S) should be involved. It was agreed that a useful way forward was to hold a dedicated workshop on precise point positioning services in the first half of 2019. There was considerable discussion on whether such a workshop should involve current commercial providers of precise point positioning services. It was agreed in the joint meeting that the issue needs further discussion. In the meeting of the Working Group, it was suggested that a possible approach could be to hold a workshop in 2019 including all relevant stakeholders, which would be immediately followed by a closed session among ICG members and associate members.

IV. Providers' Forum

39. The twenty-first meeting of the Providers' Forum, co-chaired by China and Japan, was held in conjunction with the thirteenth meeting of ICG, on 4 and 8 November 2018, in Xi'an, China. China, India, Japan, the Russian Federation, the United States and the European Union were represented at the meeting. In the opening remarks, the co-chairs welcomed the participants and expressed hope for a successful meeting.

40. After considering the items on its agenda, the Providers' Forum adopted the report on its twenty-first meeting, containing the discussions and recommendations set out below.

A. Summary of discussions and recommendations

1. Open service information dissemination

41. Presentations were made on the following topics.

(a) BeiDou Navigation Satellite System featured service

42. 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.

43. 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.

44. 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.

45. As for PPP service, the precise information of multi-GNSS systems will be broadcast by the three geostationary orbit satellites. The positioning accuracy is at the decimetre level for the lower dynamics scenario, and at the centimetre level for the static scenario.

46. China proposed that return link capabilities should become an international standard to enhance the search and rescue service, and that SMC service can provide life safety service and enrich better methods of search and rescue. China also proposed that GNSS providers should discuss a universal template for PPP service.

47. The providers agreed to discuss search and rescue and PPP services at meetings of the ICG working groups.

(b) Update on the space service volume

48. 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.

49. Coordinated analyses from GNSS observations of the space service volume were consolidating understanding of what missions could accomplish when GNSS constellations were used together. It was important for providers to specify SSV capabilities so that they were included in future builds of GNSS constellations. The priorities are for providers, space agencies and research institutions to support SSV capabilities through baselining of specifications, measuring and publishing antenna patterns to understand what can be accomplished, and to share user experiences and lessons learned to work together towards better capabilities. The United States Air Force and NASA signed a joint memorandum of understanding to support SSV signal continuity goals for future space users that will employ the latest block build of GPS III satellites.

50. 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.

51. 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.

(c) Identification and distinction of GNSS civil liability

52. The providers took note of the presentation on "Identification and distinction of GNSS civil liability", made by China.

2. Presentations by invited observers

53. The providers took note of the presentation on "Overviewing Australia's SBAS programme", made by Australia, and the presentation on "The Nigerian Satellite Augmentation System's role and contribution to GNSS" made by Nigeria.

3. Service performance monitoring

54. It was noted by the co-chairs that the topic of service performance monitoring was being discussed in ICG Working Group S.

4. Spectrum protection: interference detection and mitigation

55. It was noted by the co-chairs that the topic of "spectrum protection: interference detection and mitigation" was being discussed in ICG Working Group S.

5. Multi-GNSS demonstration project in the Asia-Oceania region

56. 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.

57. In 2018, MGA supported a summer school programme on GNSS for students and young researchers, which was conducted at the Tokyo University of Marine Science and Technology. It also held the tenth MGA Conference in Melbourne, Australia, in October 2018, which was attended by 200 participants from 20 countries. Major topics from the conference included the Australian Space Agency initiative on GNSS, updates on all global and regional navigation satellite systems, an intelligent transport system (in a panel discussion), early warning service via GNSS, applications that use raw measurements from smartphones, and a forum for young professionals and students on the rapid prototype development project. The MGA Young Professional and Student Forum gave students, researchers and professionals an opportunity to interact. Networking events were held for forum participants and industry representatives. In addition, six scholarships were provided by the Office for Outer Space Affairs.

58. 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.

59. In 2019, MGA activities will include the eleventh MGA conference, webinars and support of summer schools, and projects with demonstrations by young professionals. MGA is actively encouraging start-ups in the Asia-Oceania region. The eleventh MGA conference will be held in Bangkok in May 2019 and will be organized in conjunction with events in the Asia and the Pacific region such as a space business idea contest, “S-booster Asian Round”, supported by the Government of Japan, as well as “Start-up Thailand”.

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

60. The ICG executive secretariat provided an overview of the activities carried out by the United Nations-affiliated regional centres for space science and technology education, which acted as ICG information centres. Participants of the Providers’ Forum were invited to contribute to the work of the centres by providing educational materials and expertise.

B. Other matters

1. Review of the Providers’ Forum workplan

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

62. 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.

2. Statement of the Providers’ Forum

63. GNSS offers civil positioning, navigation and timing services throughout the world on a continuous basis. These services are unique with respect to accuracy, availability, and coverage. As a result, GNSS is, and is expected to remain, a core element of existing and future positioning, navigation and timing architecture for most countries.

64. The providers will continue to promote compatibility, interoperability, and transparency in civil service provision, and to support technological innovations in navigation satellite systems, taking into account their needs for land, sea, air and space applications, in order to contribute to domestic civil positioning, navigation and

timing architecture that fully meet their users' requirements. The providers will also continue their cooperation through ICG and other international forums.

3. Request by Australia to join the International Committee on Global Navigation Satellite Systems as a member

65. Australia was invited to present details of their interest in membership to the providers.

Annex I

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

Australia

China

India

Italy

Japan

Malaysia

Nigeria

Russian Federation

United Arab Emirates

United States of America

European Union

Arab Institute of Navigation

Asia-Pacific Space Cooperation Organization

Civil Global Positioning System Service Interface Committee

Committee on Space Research

European Space Agency

European Space Policy Institute

Interagency Operations Advisory Group

International Aeronautical Federation

International Association of Geodesy

International Association of Geodesy Reference Frame Sub-Commission for Europe

International Association of Institutes of Navigation

International Bureau of Weights and Measures

International Cartographic Association

International Earth Rotation and Reference Systems Service

International Federation of Surveyors

International Global Navigation Satellite System Service

International Society for Photogrammetry and Remote Sensing

International Steering Committee of the European Position Determination System

International Telecommunication Union

International Union of Radio Science

Office for Outer Space Affairs of the Secretariat

Annex II

Documents before the thirteenth meeting of the International Committee on Global Navigation Satellite Systems

Symbol	*Title or description*
ICG/WGS/2018	Report of the Working Group on Systems, Signals and Services
ICG/WGB/2018	Report of the Working Group on Enhancement of GNSS Performance, New Services and Capabilities
ICG/WGC/2018	Report of the Working Group on Information Dissemination and Capacity-building
ICG/WGD/2018	Report of the Working Group on Reference Frames, Timing and Applications
ICG/TOR/2018	Terms of reference of the International Committee on Global Navigation Satellite Systems (as amended)
ICG/PF/WP/2018	Workplan of the Providers' Forum (as amended)