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**Committee on the Peaceful
Uses of Outer Space****Report on the United Nations/International Astronautical
Federation Workshop on Global Navigation Satellite System
Applications for Human Benefit and Development**

(Prague, 24-25 September 2010)

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I. Introduction

A. Background and objectives

1. The Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), in particular through its resolution entitled “The Space Millennium: Vienna Declaration on Space and Human Development”,¹ recommended that activities of the United Nations Programme on Space Applications should promote collaborative participation among Member States at the regional and international levels, emphasizing the development of knowledge and skills in developing countries.²
2. At its fifty-second session, in 2009, the Committee on the Peaceful Uses of Outer Space endorsed the programme of workshops, training courses, symposiums and conferences of the Programme on Space Applications for 2010. Subsequently, the General Assembly, in its resolution 64/86, endorsed the activities to be carried out by the Office for Outer Space Affairs under the auspices of the United Nations Programme on Space Applications in 2010.
3. Pursuant to General Assembly resolution 64/86 and in accordance with the recommendations of UNISPACE III, the United Nations/International Astronautical Federation (IAF) Workshop on Global Navigation Satellite System Applications for Human Benefit and Development was held in Prague on 24 and 25 September 2010, in conjunction with the 61st International Astronautical Congress (IAC), held in Prague from 27 September to 1 October 2010.
4. The Workshop was jointly organized by the Office for Outer Space Affairs of the Secretariat, as part of the activities of the United Nations Programme on Space Applications in 2010, and IAF. It was co-sponsored by the European Space Agency (ESA) and the International Committee on Global Navigation Satellite Systems (ICG) and was hosted by the Ministry of Education, Youth and Sports of the Czech Republic.
5. It was the twentieth workshop organized jointly by the Office for Outer Space Affairs and IAF. It built upon the recommendations and experience gained from the previous 19 workshops, held between 1991 and 2009.
6. At the Workshop, a wide range of global navigation satellite system (GNSS) technologies, applications and services that contribute to sustainable economic and social development programmes, primarily in developing countries, were discussed.
7. Primary objectives of this event included the following: to increase awareness among decision makers and representatives of the research and academic community about ongoing activities and trends in the use of GNSS technologies, applications and services; to examine the GNSS technologies, applications and services available for addressing social and economic issues; to strengthen institutional and human capacity-building in the area of GNSS technologies,

¹ *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 19-30 July 1999* (United Nations publication, Sales No. E.00.I.3), chap. I, resolution 1.

² *Ibid.*, chap. II, para. 409 (d) (i).

applications and services; and to strengthen international and regional cooperation on those subjects.

8. The Workshop and its concluding round-table discussion also provided an opportunity for direct dialogue between space technology experts, policymakers, decision makers and representatives of the academic community and private industry from both developing and industrialized countries. All participants were encouraged to share their experiences and to examine opportunities for better cooperation.

9. The present report describes the background, objectives and programme of the Workshop. It has been prepared for submission to the Committee on the Peaceful Uses of Outer Space at its fifty-fourth session and to the Scientific and Technical Subcommittee at its forty-eighth session, both in 2011.

B. Programme

10. The programme of the Workshop was developed jointly by the Office for Outer Space Affairs and the programme committee of the Workshop, which included representatives of a number of national space agencies, international organizations and academic institutions. A substantial contribution was made by the honorary committee of the Workshop, which consisted of prominent representatives of the Committee on the Peaceful Uses of Outer Space, IAF and the United Nations Secretariat. The input received from both the honorary committee and the programme committee, in addition to the direct participation of members of those committees in the Workshop, ensured that the aims of the Workshop were achieved.

11. The programme of the Workshop focused on technologies, applications and services that could help maximize the benefits of the use and applications of GNSS to support sustainable development by improving medical and public health services through the use of space technologies; developing a comprehensive, worldwide environmental monitoring strategy; improving management of the Earth's natural resources; and enhancing the capacity of developing countries in this area through developing human and technical resources at various levels, enhancing regional and international cooperation, increasing public awareness, and developing appropriate infrastructures.

12. The Workshop included three technical sessions. Two sessions, held on the first day of the workshop, considered applications of GNSS technologies and services and included presentations on practical experiences and case studies by participants. The third session, held on the second day of the meeting, dealt with international and regional frameworks, initiatives and cooperation, and capacity-building in the area of GNSS technology and service applications.

13. A total of 24 oral presentations were made during the technical sessions, and 13 papers were submitted for a poster session. All the presentations and papers focused on national, regional and international projects and initiatives in the application of GNSS technologies, information and services in sustainable development programmes in developing countries.

14. Opening statements were delivered by representatives of the Ministry of Education, Youth and Sports of the Czech Republic, the IAC local organizing

committee, IAF, ESA, ICG and the Office for Outer Space Affairs. At the opening session, keynote addresses were delivered by Chris Gibson (Trimble Navigation, United States of America) and Giorgio Solari (ESA). Closing remarks were made by representatives of IAF, the local organizing committee, ICG, the Office for Outer Space Affairs, ESA and the Chair of the Committee on the Peaceful Uses of Outer Space.

15. Each technical session was followed by open discussions, which focused on specific topics of interest and provided additional opportunities for participants to voice their opinions. The discussions were continued in depth and were summarized by two working groups established by the participants in order to develop a set of questions to be presented to panellists at the round-table discussion that took place after the working group meetings.

16. A detailed programme of the Workshop is available on the website of the Office for Outer Space Affairs (www.unoosa.org).

C. Attendance and financial support

17. The United Nations, on behalf of the co-sponsors, invited developing countries to nominate candidates to participate in the Workshop. Participants were required to have a university degree or well-established professional experience in a field related to the overall theme of the Workshop. In addition, participants were selected on the basis of their work experience in programmes, projects or enterprises that were already using GNSS technology applications or that could potentially benefit from using the technology. The participation of specialists at the decision-making level from both national and international entities was particularly encouraged.

18. Funds allocated by the United Nations, IAF, ESA, ICG and the local organizing committee for the organization of the Workshop were used to provide financial support for 31 participants from developing countries to attend. Full financial support was received by 22 participants, which included international round-trip air travel, hotel accommodation and a living allowance for the duration of the Workshop and IAC. Nine participants received partial funding (air travel and/or hotel and living allowance, and/or IAC registration). Those 31 participants came from 28 developing countries. The co-sponsors also covered the cost of IAC registration fees for 25 funded participants, thus enabling them to attend the 61st Congress, which was held shortly after the Workshop.

19. The local organizing committee provided conference facilities, secretariat and technical support, and local transportation, as well as transportation from the airport for funded participants. It also organized a number of social events for all Workshop participants.

20. The Workshop was attended by more than 80 participants from the following 43 countries: Afghanistan, Angola, Australia, Austria, Belarus, Brunei Darussalam, Canada, China, Colombia, Czech Republic, Egypt, France, Germany, Guatemala, India, Lao People's Democratic Republic, Latvia, Madagascar, Malaysia, Nepal, Netherlands, Nigeria, Pakistan, Peru, Philippines, Romania, Russian Federation, Rwanda, Singapore, South Africa, Sri Lanka, Sudan, Switzerland, Syrian Arab Republic, Thailand, Tunisia, Turkey, Ukraine, United Kingdom of Great Britain and

Northern Ireland, United States of America, Uzbekistan, Venezuela (Bolivarian Republic of) and Viet Nam. The following international organizations and other entities were also represented: IAF, the International Academy of Astronautics, ICG, ESA, the Space Generation Advisory Council and the Office for Outer Space Affairs.

II. Overview of technical sessions and round-table discussion

21. The first technical session was on applications of GNSS technologies and services. The presentations at the session demonstrated the potential of GNSS technology in various areas, including aviation and land transportation, mapping and surveying, disaster management and natural resources monitoring. The participants were shown examples of how certification of intelligent transportation systems could be improved through the use of GNSS technology, thus increasing the safety, effectiveness and quality of transportation services. Participants in the session were also updated on the status of the global positioning system (GPS)-based Ground-Based Augmentation System, which was designed for aviation use and, when combined with the Wide Area Augmentation System, could provide aviation with numerous benefits, including increased runway access, more direct flight paths, new precision approach services, and reduced and simplified equipment on board aircraft. It could also save air navigation service providers money by eliminating some ground-based navigation aids.

22. Presentations at the session also reviewed the advantages of using the System of Differential Corrections and Monitoring with the support of the Global Navigation Satellite System (GLONASS) of the Russian Federation and GPS. The combined use of GLONASS and GPS signals (with Galileo and Compass signals in the future) increased the availability of navigation services, especially in difficult settings such as urban and industrial areas, mountains and rugged terrain. The session also featured case studies on the development of a high-precision GPS-based geodetic network in Latvia and Uzbekistan, and on applications of GNSS technology in surveying and mapping in the Philippines.

23. The second technical session continued consideration of GNSS technologies and services. In that context, the presentations demonstrated the use of satellite navigation in precision farming. It was recognized that the economic benefits of precision farming could be very high; however, for its successful implementation, in addition to the technology itself, a number of prerequisites should be met, including the availability of modern agricultural vehicles equipped with on-board computers, high-accuracy positioning tools (navigation signal receivers), field property detection systems (automatic soil samplers, various types of sensors, remote sensing equipment) and appropriate software for analysing data and optimizing agricultural operations. The participants were also shown examples of how GNSS data, when applied with remote sensing and geographic information system data, could be used for environmental monitoring and emergency response, as well as for effective water resource management.

24. The session also featured presentations on the use of high-accuracy GPS equipment and advanced software for estimating movements of buildings in coastal areas in Viet Nam and on the application of GPS data for monitoring the

Thai geodetic network after the 2004 Sumatra-Andaman earthquake and the 2005 Nias earthquake and monitoring tectonic plate movements in Guatemala. Other papers presented at the session demonstrated the effectiveness of using GNSS data and high-resolution satellite imagery for rural cadastre mapping, and discussed GNSS dependability assessments for systems related to the safety of land transportation.

25. The third technical session was on international and regional frameworks, initiatives and cooperation in the area of GNSS technology and service applications. It also covered issues related to capacity-building in developing countries. A number of papers presented at that session emphasized the need to fully realize regional reference frames (the African Geodetic Frame, the Geocentric Reference System for the Americas, the Reference Frame Sub-Commission for Europe, the European Position Determination System, and the Asia Pacific Regional Reference Frame).

26. Workshop participants were updated on the status of the Galileo User Forum workshops, which provided a platform for end-users to discuss existing and potential applications of Galileo and European Geostationary Navigation Overlay Service (EGNOS) systems with developers of the systems, as well as to discuss new projects and partnerships. Since 2008, Galileo User Forum workshops had considered issues such as the application of Galileo for railways, EGNOS and civil aviation; GNSS applications for agriculture; the use of GNSS for in-vehicle and cooperative systems and for enhancing road safety; and the benefits of satellite navigation for urban mobility.

27. The participants were also introduced to the activities of ICG, which had been established by the General Assembly as a forum to promote cooperation on matters of interest to its members related to civil satellite-based positioning, navigation, timing, and value-added services; to promote cooperation on the compatibility and interoperability of global navigation satellite systems; and to promote their use in supporting sustainable development, particularly in developing countries. The Office for Outer Space Affairs acts as the executive secretariat of ICG and the Providers' Forum and develops, in cooperation with international, regional and national agencies and institutions, a wide range of activities focusing on capacity-building, in particular deploying instruments for the International Space Weather Initiative, developing a GNSS education curriculum and utilizing regional reference frames.

28. Presentations at the session also reviewed ongoing or planned capacity-building efforts in Europe, Morocco, Nigeria and South Africa and discussed outreach and public awareness activities of the Space Generation Advisory Council to promote GNSS applications among youth.

29. All the papers delivered at the technical sessions of the workshop and presented at its poster session are available on the IAF website: www.iafastro.org/index.html?title=2010_UN-IAF_Workshop.

30. A concluding round-table discussion with the participation of top-level representatives of space agencies and other relevant national, regional and international institutions and organizations from both space-faring and non-space-faring countries was organized in order to establish a direct dialogue between Workshop participants on how GNSS technologies, applications and services could address social and economic issues.

31. The round-table discussion was moderated by Dorin Prunariu, Chair of the Committee on the Peaceful Uses of Outer Space, and the following six panellists took part: Jan Kolář, Head of the Czech Space Office and Chair of the IAC local organizing committee; Ken Hodgkins, Director of the Office of Space and Advanced Technology, Department of State, United States; Alexey Romanov, Deputy Director General of JSC Russian Space Systems, Russian Federation; Bernhard Hofmann-Wellenhof, Institute of Navigation and Satellite Geodesy, Graz University of Technology, Austria; Giorgio Solari, Directorate of Galileo and Satellite Navigation Related Activities, ESA; and Mustapha Amghar, Director of Galileo Morocco Group, Morocco.

32. Prior to the round table, two working groups were established to summarize the critical issues and focal themes identified in the presentations delivered at the technical sessions so that they could be addressed to the panellists. The first working group focused on issues related to capacity-building, institutional strengthening and international cooperation, and the second discussed practical aspects of GNSS applications for sustainable development.

33. Within the limited time available for discussion, the round-table panellists discussed the following issues that had been brought to their attention by the moderator, the chairs of the working groups and the audience:

- (a) Ways to fill the gap between providers and end users;
- (b) Capacity-building in access to and use of GNSS technologies, data and services;
- (c) Developing awareness among policymakers and decision makers;
- (d) International and regional cooperation;
- (e) Need for standardization of GNSS reference documents.

III. Findings and conclusions of the Workshop

34. The major findings and conclusions of the Workshop's working groups and panellists of the round table may be summarized as follows:

- (a) GNSS is increasingly robust and diverse in its developed applications, which vary from simple and widely used applications, such as personal GPS services, to complex, value-added systems aimed at specialist groups in such areas as transportation, agriculture, geophysical dynamics and disaster management;
- (b) Climate change is a global problem with local effects;
- (c) Many organizations exist that specifically address capacity-building for GNSS throughout the world, such as ICG, the regional centres for space science and technology education affiliated to the United Nations, and various national and system developer programmes aimed at the communities associated with the provision of services and use of GNSS applications. These organizations actively build capacity through information, education, training programmes and workshops. The academic sector is increasingly adding GNSS to curricula;

(d) Despite a substantial capacity-building infrastructure, several applications still have significant gaps that need to be bridged between potential end-users and the GNSS capabilities that have been developed for their use;

(e) Institutions involved in GNSS applications in the countries developing GNSS systems are strong, and their orientation is towards the widespread application of GNSS. At the same time, institutions involved in GNSS applications in many other countries are often inadequate to ensure the widespread application of GNSS;

(f) There is a strong infrastructure in place to enable international cooperation in the application of GNSS. However, further workshops may be needed to better identify ways to cooperate, and collaborate and improve the dissemination of information;

(g) Bilateral or multilateral cooperation (between countries, establishments, etc.) on GNSS-based projects may be the most effective approach;

(h) Combining GNSS data with other sources of data can be beneficial for many applications;

(i) One of the important issues to be considered by ICG is building the capacity of countries to address radio frequency interference problems.

35. The Workshop reached the following conclusions:

(a) Efforts should be increased to accomplish the final step of bringing GNSS applications to the end-user by developing and making available turnkey operations (including value-added service providers) that bridge the gap between GNSS providers and end-users and by further developing various training programmes and their delivery, including online;

(b) The primary focus should be on establishing a long-term investment environment and identifying and developing applications that will have the greatest immediate benefit for the development of sustainable societies, in such areas as the provision of food and potable water and disaster management;

(c) ICG and the regional centres for space science and technology education affiliated to the United Nations could help identify regional weaknesses and increase awareness of the benefits of GNSS applications through international forums and organizations in countries where significant gaps between specific potential applications and end-users exist;

(d) Outreach activities should be continued through ICG, especially in countries where the benefits of GNSS applications have not yet resulted in the systematic application of GNSS for the advancement of their societies, particularly in the areas of sustainable food and potable water supplies and disaster management. Awareness-raising activities should be continued through workshops and training courses that focus on specific areas of interest to end-users;

(e) Collaboration with existing international and regional institutions and mechanisms should be continued;

(f) A comprehensive database of existing capacities and infrastructures and information on best practices in GNSS applications should be established and made available in each region;

- (g) The need to standardize GNSS reference documents should be addressed by ICG in the future.

IV. On-site evaluation of the Workshop

36. In order to receive feedback from participants and to assess the Workshop, a questionnaire survey was conducted among participants on the last day of the event. A total of 40 completed questionnaires were returned to the organizers, of which 28 (70 per cent) were from participants who had received financial support from the co-sponsors and 12 (30 per cent) were from self-funded participants. Some of the results of the survey are presented below.

37. All respondents except one felt that the theme of the Workshop was relevant to their current work and that the programme had met their professional needs and expectations. All respondents would recommend participation in future United Nations/IAF workshops to their colleagues.

38. With regard to the overall level and quality of presentations at the Workshop, 47.5 per cent of respondents believed it to be very good, 50 per cent considered it good, and 2.5 per cent (one person) found it not so good. In terms of the overall organization of the Workshop, 63 per cent of respondents considered it very good and 37 per cent considered it good.

39. Participants indicated that the Workshop had helped them to:

- (a) Enhance their knowledge of space technology and applications (34 replies);
- (b) Confirm ideas and concepts in space technology and applications (27 replies);
- (c) Generate new application project ideas (28 replies);
- (d) Seek potential cooperation with other groups (31 replies);
- (e) Seek possible partnerships (26 replies).

40. In answering the question on the actions or projects they would initiate as a follow-up to the Workshop, respondents indicated that they would:

- (a) Contact experts and/or network (35 replies);
- (b) Define new projects (23 replies);
- (c) Undertake additional education or training (18 replies);
- (d) Procure equipment or technologies (17 replies);
- (e) Seek funding support for projects (19 replies).

41. Assessing the Workshop's round-table discussion, 45 per cent of respondents considered it very interesting, 50 per cent said it was interesting and 5 per cent thought it was not so interesting. Of the participants who responded, 95 per cent believed that issues of particular interest to them and their agencies had been addressed by the round-table panellists, and 95 per cent also felt that they had had a chance to bring their questions to the attention of the panellists.

42. In response to the question on the level of interaction between panellists and the audience, 42.5 per cent considered it very interactive, 50 per cent thought it had been interactive and 7.5 per cent believed that the discussion had not been so interactive.

43. The survey also showed that none of the respondents who had received funding would have been able to attend the Workshop and IAC without the financial support provided by the organizers.

V. Follow-up actions

44. At the meeting of the IAF Committee for Liaison with International Organisations and Developing Nations, which was held during IAC and was attended by representatives of the Office for Outer Space Affairs, it was decided that the twenty-first United Nations/IAF workshop should be held in Cape Town, South Africa, from 30 September to 1 October 2011, as an associated event of and in conjunction with the 62nd IAC, which would be held in Cape Town from 3 to 7 October 2011.

45. The suggested theme of the twenty-first United Nations/IAF workshop was "Space for human and environmental security". Discussion on the objectives and programme of that workshop would be continued at a planning meeting, to be held during the forty-eighth session of the Scientific and Technical Subcommittee, in 2011.

46. It was also reconfirmed at the meeting of the Committee for Liaison with International Organisations and Developing Nations that further round-table discussions between participants and heads or senior managers of space agencies and relevant institutions or organizations should be held during future United Nations/IAF workshops.
