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Committee on the Peaceful Uses of Outer Space

Report on the third United Nations/Austria/European Space Agency Symposium on Small Satellite Programmes for Sustainable Development: "Implementing small satellite programmes: technical, managerial, regulatory and legal issues"

(Graz, Austria, 13-16 September 2011)

I. Introduction

1. The third in a series of three United Nations/Austria/European Space Agency symposiums on small-satellite programmes for sustainable development was held in Graz, Austria, from 13 to 16 September 2011, focusing on the theme "Implementing small satellite programmes: technical, managerial, regulatory and legal issues". The series of symposiums is part of the Basic Space Technology Initiative, an initiative carried out in the framework of the United Nations Programme on Space Applications that is aimed at supporting capacity-building in basic space technology and promoting the use of space technology and its applications for the peaceful uses of outer space and in support of sustainable development (see www.unoosa.org/oosa/en/SAP/bsti/index.html).

2. The Office for Outer Space Affairs of the Secretariat, the Government of Austria and the European Space Agency (ESA) have jointly organized symposiums on space science and technology and their applications in Graz since 1994. The symposiums have addressed a broad range of themes, including the economic and social benefits of space activities for developing countries, the cooperation of the space industry with developing countries, enhancing the participation of youth in space activities and space applications for sustainable development. Information on all the symposiums is available on the website of the Office for Outer Space Affairs (www.unoosa.org/oosa/SAP/graz/index.html).

3. The most recent Symposium was the eighteenth held since 1994. It was hosted by the Government of Austria and co-sponsored by the Federal Ministry for

European and International Affairs of Austria, the State of Styria, the city of Graz and ESA. The International Academy of Astronautics (IAA) and the Austrian Academy of Sciences supported the Symposium.

4. The present report describes the background, objectives and programme of the Symposium, provides a summary of the thematic sessions and contains the recommendations and observations made by the participants. The report is prepared pursuant to General Assembly resolution 65/97. It should be read in conjunction with the reports on the first and second Symposiums in the series, held in September 2009 and 2010 (A/AC.105/966 and A/AC.105/983).

A. Background and objectives

5. Since the Third United Nations Conference on the Peaceful Uses of Outer Space (UNISPACE III), held in Vienna from 19 to 30 July 1999, considerable progress has been made in the operational use of space technology and its applications. Advances made in several technological fields in the past decade have led to the increased affordability and accessibility of space applications, thus enabling more and more users in a growing number of countries to benefit from space activities. Space-based assets such as telecommunications, Earth observation and navigation satellites support a broad range of applications and are increasingly integrated into public infrastructure, contributing to policy- and decision-making in support of sustainable development to improve people's lives.

6. Increasingly capable nano- and small satellites can now be developed with an infrastructure and at a cost that make them feasible and affordable for organizations such as academic institutions and research centres, which have a limited budget for space activities. The many benefits that can be derived from such activities have led to an increased interest in establishing basic capacities in space technology development, including in developing countries and countries that had previously been only users of space applications.

7. Small satellites, their development and their applications have been considered by the Committee on the Peaceful Uses of Outer Space in the framework of the United Nations Programme on Space Applications since the mid-1990s (see A/AC.105/611, A/AC.105/638 and A/AC.105/645). As part of the Technical Forum of UNISPACE III,[1] the United Nations, in cooperation with IAA, held a workshop on small satellites in the service of developing countries. In follow-up to that workshop, since 2000 the Office for Outer Space Affairs and IAA have organized half-day workshop sessions on the theme of small satellites in the service of developing countries as part of the annual International Astronautical Congress.

8. The accelerating pace of technological advances, in particular those related to the development of satellites in the 1 to 50 kg class, and the sharply rising number of players active in the field led to the establishment in 2009 of the Basic Space Technology Initiative, a new area of activity of the United Nations Programme on Space Applications, pursuant to its mandate to stimulate the growth of indigenous

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[1] See *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), annex III.

nuclei and an autonomous technological base, to the extent possible, in space technology in developing countries, with the cooperation of other United Nations entities and/or Member States, as set out in General Assembly resolution 37/90. The Initiative supports capacity-building in basic space technology, with an initial focus on the development of nano- and small satellites and their applications for the peaceful uses of outer space in support of sustainable development and, in particular, their contribution to achieving the internationally agreed development goals, including those set forth in the United Nations Millennium Declaration (General Assembly resolution 55/2), as well as the goals set out in the Plan of Implementation of the World Summit on Sustainable Development[2] and the Johannesburg Declaration on Sustainable Development.[3]

9. Among the first activities under the Basic Space Technology Initiative was the organization of the series of three symposiums on small-satellite programmes for sustainable development. The first Symposium, held in 2009, addressed general issues related to capacity-building in space technology development and small-satellite development activities. For the second Symposium, in 2010, the subtheme "Payloads for small satellite programmes" was chosen. The third Symposium focused on the subtheme "Implementing small satellite programmes: technical, managerial, regulatory and legal issues" and had the following objectives:

(a) To review the status of small-satellite activities worldwide, with a particular focus on international and regional cooperation;

(b) To examine issues relevant to the implementation of small-satellite programmes, such as integrating space technology development activities into a country's or an organization's science and technology strategy and programme and project management issues;

(c) To elaborate on the regulatory issues of small-satellite programmes, such as frequency coordination and space debris mitigation measures;

(d) To elaborate on the legal issues of small-satellite programmes, such as the registration of satellites with the United Nations and the question of responsibility for national space activities and liability for damages caused by space objects;

(e) To discuss the way forward for the Basic Space Technology Initiative, the organization of future international space technology development conferences and the preparation of an education curriculum for aerospace engineering.

B. Attendance

10. Participants in the Symposium were selected on the basis of their academic qualifications and on the basis of their professional working experience in space technology development or their involvement in the planning and implementation of small-satellite programmes of relevant governmental organizations, international or

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[2] *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 2, annex.

[3] Ibid., chap. I, resolution 1, annex.

national agencies, non-governmental organizations, research or academic institutions or private sector companies.

11. The Symposium was attended by 102 space professionals involved in nano- and small-satellite missions from governmental institutions, universities and other academic entities and the private sector from the following countries: Algeria, Austria, Azerbaijan, Belarus, Belgium, Brazil, Canada, China, Egypt, France, Germany, India, Iran (Islamic Republic of), Iraq, Israel, Italy, Japan, Kenya, Lithuania, Mexico, Nepal, Netherlands, Nigeria, Pakistan, Saudi Arabia, Slovakia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Thailand, Tunisia, Turkey, Ukraine, United Arab Emirates, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay, Venezuela (Bolivarian Republic of) and Viet Nam.

12. Representatives of the Office for Outer Space Affairs, International Telecommunication Union (ITU), ESA, EURISY and IAA were among those participating in the Symposium.

13. Funds allocated by the United Nations and the co-sponsors were used to defray the costs of the air travel, daily subsistence allowance and accommodation of 27 participants. The co-sponsors also provided funds for local organization, facilities and the transportation of participants.

C. Programme

14. The programme of the Symposium was developed by the Office for Outer Space Affairs in cooperation with the programme committee of the Symposium. The programme committee included representatives of national space agencies, international organizations and academic institutions. An honorary committee and a local organizing committee also contributed to the successful organization of the Symposium.

15. The programme consisted of a series of keynote speeches, technical presentations and workshop-style sessions, with time set aside for discussions and short presentations by participants on their relevant activities. Chairs and rapporteurs were assigned to each session and provided their comments and notes as input for the preparation of the present report. The detailed programme, list of participants and full documentation of the presentations made at the Symposium have been made available on the website of the Office for Outer Space Affairs (www.unoosa.org/oosa/en/SAP/act2011/graz/index.html).

16. Following welcoming remarks by representatives of the co-sponsoring organizations, two keynote addresses, entitled “Small satellites and the long-term sustainability of outer space activities” and “ESA’s small satellite activities”, were delivered by the representative of a successful pioneering small-satellite company from Europe and by the representative of ESA. A representative of the Office for Outer Space Affairs made a presentation on the status of the Basic Space Technology Initiative and reviewed the highlights, objectives, and expected outcome and follow-up activities of the Symposium. A press conference held on the first day with representatives of Austrian media promoted the work of the United Nations Programme on Space Applications.

17. The Symposium consisted of sessions on the following themes: review of small-satellite activities; programmatic and managerial issues; regulatory and legal issues; small satellites and the long-term sustainability of outer space activities; working groups on the Basic Space Technology Initiative; and discussion of recommendations and observations. At the closing session, statements were made by representatives of the co-sponsoring organizations.

II. Summary of thematic sessions

A. Review of small-satellite activities

18. The purpose of the first thematic session was to provide information on recent small-satellite activities in countries in Africa, Asia and the Pacific, Europe, Latin America and the Caribbean and Western Asia. It was noted that, as had been the case at the previous symposiums, the Basic Space Technology Initiative was not focusing on small satellites falling within a certain specified mass range. Instead, the spotlight was on small-satellite development activities that could be conducted with relatively modest resource requirements, such as with a small team of developers using commercial off-the-shelf components, with a limited development and test infrastructure and within a budget that was affordable for smaller organizations, including those that were new to space technology development activities.

19. The CubeSat pico-satellite platform (see www.cubesat.org) developed by California Polytechnic State University and Stanford University in 1999 had been widely accepted by the small-satellite community. Satellites based on that standard had been developed by governmental and non-governmental organizations, including commercial industries and academic institutions. More than 100 universities were involved in CubeSat development activities. In South Africa the Cape Peninsula University of Technology (CPUT) had established a satellite-engineering programme at its French South African Institute of Technology. Students attending the programme came from all over Africa and beyond. A pico-satellite based on the CubeSat standard (ZACUBE-1) had been completed, and plans were under way to construct a second one. CPUT was seeking cooperation with other African countries on satellite technology. It had organized the First International African CubeSat Workshop, which was to be held from 30 September to 2 October 2011 and would focus on the benefits and business opportunities related to small satellites.

20. It was reported that various universities in Japan had been very active in the development of small satellites. Wakayama University was the lead university for the University International Formation Mission (UNIFORM) project, aimed at developing and deploying within four years a forest fire-monitoring constellation of satellites in the 50 kg class. The UNIFORM project was promoted by the Ministry of Education, Culture, Sports, Science and Technology of Japan and sought international cooperation in the fields of satellite development, ground system development and satellite data platform development. It was also linked to the Micro-STAR project of the Satellite Technology for the Asia-Pacific Region (STAR) programme in the framework of the Asia-Pacific Regional Space Agency Forum. The universities in Japan involved in space technology development had established

the University Space Engineering Consortium (UNISEC), a non-profit organization to facilitate practical space activities at the university level. UNISEC involved more than 50 institutes and laboratories from 35 universities in Japan and almost 500 student members. To the international community it offered the CanSat Leader Training Programme (CLTP) and a "mission idea contest". Participants from all over the world had participated in the first CLTP, held in February and March 2011. The first mission idea contest, with participants from 24 countries, had been concluded in March 2011, and a second such contest was planned for 2012. The establishment of an international UNISEC was also being considered to transfer the positive experiences gained in space technology development activities to universities in other countries.

21. A presentation on the Humanitarian Satellite (HUMSAT) Network project, an international educational initiative led by the University of Vigo in Spain to develop a constellation of small satellites, had been made at the first United Nations/Austria/European Space Agency Symposium, in 2009 (see www.humsat.org). Tied to the Global Educational Network for Satellite Operations (GENSO) project, a worldwide network of radio amateur and university ground stations to support the operations of university satellites (see www.genso.org), the HUMSAT Network would provide data relays based on a store- and forward-data transfer system. The project coordinator provided an update on the status of the HUMSAT project. The University of Vigo was preparing the first satellite in the constellation for its launch in 2012.

22. In Latin America and the Caribbean, Argentina, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Ecuador, Mexico, Peru and Venezuela (Bolivarian Republic of) had established national space offices or agencies. Argentina, Brazil, Chile and Mexico had started pursuing local capabilities to develop satellites in the 1990s. More recently, Chile, Colombia, Peru and Uruguay had begun space technology development activities. Several small and medium-sized enterprises developing space technology components had been established. Capacity-building in space technology development in the Latin American and Caribbean region was progressing well, as shown by the growing number of small-satellite projects.

23. An example of space technology and applications programmes in Western Asia was provided by the representative of the Emirates Institute for Advanced Science and Technology (EIAST), founded in the United Arab Emirates in 2006 to support scientific innovation and technology advancement. EIAST jointly developed the DubaiSat-1 Earth observation satellite in cooperation with Satrec Initiative of the Republic of Korea. DubaiSat-1 had been successfully launched in 2009 and provided imagery with a ground resolution of better than 10 m. It was to be followed by the more advanced DubaiSat-2, currently under development. EIAST was also considering collaborating with local universities to begin the joint development of CubeSat-based pico-satellites to support the establishment of indigenous space technology capacities.

B. Programmatic and managerial issues

24. The second and third sessions of the Symposium dealt with programmatic and managerial issues for small-satellite programmes. This included the management

and operation of the ground station network, the fielding of launch opportunities, technology transfer considerations, the standardization of test procedures, best practices for capacity-building, strategies for advancing from educational projects to applications and collaboration in small-satellite development programmes.

25. It was reported that for a small satellite in low-Earth orbit the daily contact time with a single ground station could be as little as 20 minutes per day. In the past each satellite project had established its own dedicated ground station. The GENSO project pursued the idea of a shared ground-station network that would allow a small satellite to connect to several ground stations in the network and thus multiply the contact time per day. GENSO ground stations could both downlink data from and uplink data to the satellite. Small-satellite projects, primarily those in the educational sector using radio frequencies assigned to the amateur satellite service, could make their ground stations available to GENSO by following GENSO standards and using GENSO software. GENSO was coordinated by the Education Office of ESA. The University of Vigo in Spain hosted the European Operations Node and coordinated access to the network.

26. A major bottleneck for small-satellite missions was the availability of affordable launch opportunities. Launch providers were increasingly making available piggyback launch opportunities for secondary payloads. Often available at a low cost that was affordable for educational institutions, piggyback launch opportunities were confined to those in which the secondary payload would be inserted into the delivery orbit required by the primary payload. The Polar Satellite Launch Vehicle (PSLV) of the Indian Space Research Organisation was launched three or four times a year and continued to provide piggyback launch opportunities. Many recent small-satellite missions had been launched on PSLV. In this context, participants noted the initiative of the CANEUS Small Satellite Sector Consortium, which proposed to create a web-based global launch portal (see www.launchportal.org) that would bring together launch vehicle providers with small-satellite developers seeking a launch opportunity.

27. The Berlin Space Industry Association had conducted a study of technology transfer in small-satellite programmes. The study had also addressed the inherent conflict of interest in capacity-building programmes where a client organization purchased services and know-how from an experienced host organization. The client usually had the objective of establishing independent space technology development capabilities, whereas it would run counter to the objective of the host organization to make the client completely independent. This conflict of interest could be overcome if the host organization were transparent about what could realistically be achieved, if it did not sell overly complex missions in the guise of technology transfer programmes and if it developed a business model that supported technology transfer success. At the same time, the client organization needed to define a feasible road map for its plans to build space technology development capacity that balanced all stakeholder interests and that was tailored to its needs and capabilities. It also needed to pay attention to building infrastructure, such as laboratories, facilities, mission control and operations centres, in parallel to the development of the satellite.

28. It was noted that the recent boom in small-satellite development had been caused, inter alia, by the wide acceptance of standards for satellite platforms and components, as demonstrated by the wide acceptance of the CubeSat platform.

Efforts were under way to define standardized testing procedures for small satellites, similar to those that had already been established for medium-sized and large satellites. The Ministry of Economy, Trade and Industry of Japan was sponsoring a project on the standardization of methods of evaluation for nanosatellites, the goal of which was to contribute to the establishment of the standards of the International Organization for Standardization (ISO) by 2015. A first workshop on this matter would be held in December 2011 at Kyushu Institute of Technology in Japan.

29. A representative of the Centre for Satellite Technology Development of the National Space Research and Development Agency (NASRDA) provided information on efforts to build indigenous space technology capacity in Nigeria. The country had procured or co-developed and subsequently launched several satellites through international cooperation. NASRDA was also pursuing plans to develop small satellites entirely within the country.

30. FPT University, a private information technology university in Viet Nam, was conducting the F-1 pico-satellite project with the aim of learning about aerospace engineering, and the design and manufacture of a small satellite. The project objectives were in accordance with the Vietnamese National Strategy for Space Research and Applications, and the project was supported by the Ministry of Science and Technology. The University was also engaged in collaborative projects with international partners and aspired to move on eventually to application-driven small-satellite missions.

31. An example of international university collaboration in the small-satellite field was presented by the representative of the Universidad Politécnica de Madrid. In cooperation with the Universidad Nacional Autónoma de México and the Universidad Nacional de Ingeniería of Peru, it was promoting small-satellite projects as a means of innovative education and research. Together they were studying the development of an experimental nanosatellite mission to evaluate inter-satellite links. The Universidad Politécnica de Madrid was also offering a master's degree programme in space technology, open to international students (see www.mst-upm.es).

32. The representative of the Massachusetts Institute of Technology presented key concepts in technological capability-building and learning. Building technological capability can advance in two ways, by increasing either technological autonomy or technological complexity. An analysis of collaborative satellite projects pursued with foreign partners by many countries showed the different possible project approaches. To reach desired capability-building goals, satellite development programmes needed to be planned and implemented. Lessons learned from past collaborative satellite development programmes could provide useful insights.

33. The SENSAT project was aimed at researching, designing, developing and constructing high-performance educational nanosatellites and at supporting the enhancement of the teaching and training processes needed to build high-level human resources in the area of aerospace technology in the north-west of Mexico, mainly in the States of Baja California and Sonora. Four Mexican universities were involved in that project, using a software-based management tool as well as various web-based applications for coordinating the project among the geographically

dispersed partners. The project team was working on several small satellites and would also cooperate with the newly established Mexican Space Agency.

34. The Office for Outer Space Affairs, under its Basic Space Technology Initiative, and the Government of Japan, in cooperation with the Kyushu Institute of Technology (KIT), had established a United Nations/Japan long-term fellowship programme on nanosatellite technologies. The doctorate programme in nanosatellite technologies entailed participation in a three-year programme, concluding with the award of a doctor of engineering degree in nanosatellite technologies after successful thesis defence. The first two fellows had begun their studies at KIT in November 2011. The next round of applications for fellowships would be opened before the end of 2011. For further information see www.unoosa.org/oosa/en/SAP/bsti/fellowship.html.

35. The managerial aspects of the Undergraduate University Orbital Student Satellite small-satellite development project were highlighted by the representative of São Paulo University. The Student Satellite was to be launched on the maiden flight of the Brazilian satellite launch vehicle, which had suffered a tragic pad explosion in 2003. The initial challenge was to find sponsors for the project. Once that had been accomplished, the project had to face strict time constraints to meet the launch date. In addition to resolving budget and schedule issues, team motivation and sponsor relations were identified as important considerations in the project.

36. Space mission management for nano- and small-satellite programmes was also highlighted by the representative of Israel Aerospace Industries (IAI). After having successfully launched 13 small satellites in the over-100 kg class, IAI had decided to support the development of the Inklajn-1 CubeSat and the IMPS-150 small spacecraft bus, able to support a payload of up to 50 kg, with the aim of acquiring useful management experience in small space missions that might also be applicable to the development of its larger satellite projects. Some of the conclusions reached in those two projects were the need to have small teams with multidisciplinary abilities, to use concurrent engineering practices as long as possible during the design phase, to adhere to requirements using minimal redundancies, to introduce innovative technologies and techniques for reducing mass, volume and cost, to use nanosatellite and commercial off-the-shelf components and to reduce costs by spreading non-recurring engineering costs over several identical satellites.

37. The Institute of Communication Networks and Satellite Communications of the Graz University of Technology reported that, in cooperation with the Institute of Astronomy of the University of Vienna and the University of Toronto Institute for Aerospace Studies, it was developing the Bright-Star Target Explorer nanosatellite constellation. The presentation focused on the management and operational aspects of the satellite mission, in particular the administrative procedures for the coordination of frequency allocations in the amateur satellite service and science S-band through the International Amateur Radio Union and the Austrian regulatory office with ITU. Other aspects involved the procurement of the launch on an Indian PSLV and the management of the network of ground stations in Graz, Vienna, Warsaw and Toronto. The presentation was followed by a visit to the small-satellite ground station of the Graz University of Technology.

C. Regulatory and legal issues

38. It was noted that international treaties and other binding and non-binding legal and regulatory norms should be complied with when engaging in space activities. Small-satellite developers and operators were sometimes unaware of the need to adhere to certain legal obligations. Under its Basic Space Technology Initiative, the Office for Outer Space Affairs was providing advice on the relevant legal and regulatory issues and assistance to ensure compliance.

39. The first presentation in the session provided an overview of regulatory and legal issues relating to small satellites. According to article VI of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty), a State was internationally responsible for its national activities, whether such activities were carried out by governmental agencies or by non-governmental entities.

40. State liability for space activities was further defined by the Convention on International Liability for Damage Caused by Space Objects (Liability Convention). According to the Liability Convention, the launching State was absolutely liable during the launch phase and liable for damage caused during the in-orbit phase, on the condition that fault could be established. Piggyback launches often involved several actors that could be identified as launching States. In such a situation, General Assembly resolution 59/115, on the application of the concept of “launching State”, provided helpful guidance.

41. State authorization and supervision for national space activities, including the launch and operation of small satellites, were required under the Outer Space Treaty. National space legislation, adopted by a small but growing number of States, could further define the conditions and requirements for the conduct of space activities.

42. Following the successful launch of a space object, launching States were required to register the satellite with the United Nations in line with General Assembly resolution 1721 B (XVI) of 20 December 1961 or, if they were party to it, in line with the Convention on Registration of Objects Launched into Outer Space, adopted by the Assembly in its resolution 3235 (XXIX) of 12 November 1974. A representative of the Office for Outer Space Affairs made a presentation on the registration procedures. The Office had prepared a background paper on the practice of States and international organizations in registering space objects.[4] Recommendations on enhancing the practice of States and international intergovernmental organizations in registering space objects were contained in Assembly resolution 62/101.

43. Satellite missions required the use of the radio frequency spectrum for communications between the satellite and the ground-station network. As the bandwidth and capacity of the natural frequency spectrum were limited, coordination was necessary to prevent the harmful interference of signals. ITU was the United Nations body responsible for the allocation and coordination of the global use of the radio frequency spectrum. The frequency coordination was administered through national authorities in accordance with the International Telecommunication Convention. The annex to the Convention contained the

[4] A/AC.105/C.2/L.255, and Corr.1 and 2.

relevant administrative Radio Regulations, which had treaty status and were binding on all ITU member States.

44. A representative of the ITU Radiocommunication Bureau conducted a workshop on frequency registration for small-satellite missions. The conditions and procedures for the use of the amateur satellite service were explained. The International Amateur Radio Union was also involved in coordinating the use of the amateur satellite service. As coordination could take up to several years, the necessary procedures should be started as early as possible in the development phase of a satellite mission. ITU made available a workshop CD-ROM with helpful information and supporting software to help with data capture and validation of the notification filing. Relevant information was also available at www.unoosa.org/oosa/en/SAP/bsti/fundamentals.html.

D. Small satellites and the long-term sustainability of outer space activities

45. It was recalled that space debris was created by launches or in-orbit collisions of space objects. According to recent model calculations, the accumulation of space debris in certain low-Earth orbit regions could already have reached a tipping point, whereby the rate of debris creation caused by cascading in-orbit collisions of existing space objects would outweigh the natural decay of space debris. As a consequence, some orbit regions would become unusable for space activities.

46. A representative of the Office for Outer Space Affairs made a presentation on the issue of space debris, which had been considered by the Committee on the Peaceful Uses of Outer Space since its inception. Since 1994 it had been a regular item on the agenda of the Committee. There was consensus within the space community that appropriate measures for debris mitigation, and in the future possibly active debris removal, would have to be implemented to preserve the space environment for future generations.

47. The Inter-Agency Space Debris Coordination Committee (IADC), an international forum of governmental bodies for the coordination of activities related to the issues of man-made and natural space debris, had developed consensus guidelines for debris reduction.[5] The participating space organizations were encouraged to use those guidelines in identifying the standards that they would apply when establishing the mission requirements for planned space systems. Operators of space systems were encouraged to apply the guidelines to the greatest extent possible. Specifically, the IADC guidelines considered 25 years to be a reasonable lifetime limit within which a space object, after the end of its operational phase, should be de-orbited or removed to a designated graveyard orbit.

48. On the basis of the IADC mitigation guidelines, the Committee on the Peaceful Uses of Outer Space had endorsed its set of basic Space Debris Mitigation Guidelines to be considered for the mission planning, design, manufacture and operational phases of spacecraft and launch vehicle orbital stages.[6]

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[5] A/AC.105/C.1/L.260, annex.

[6] See A/62/20, paras. 118-119 and annex.

49. Some specific considerations were necessary for small-satellite missions to ensure compliance with the voluntary Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space and of IADC. For example, small satellites were frequently launched as secondary payloads, and therefore the constraints of being delivered to a destination orbit determined by the primary payload, which can be located at high altitude, were accepted. Without the help of a propulsion system or a braking device, such as magnetic and solar sails, drag-augmentation devices and tethers, it might not be possible for the satellite to adhere to the 25-year in-orbit lifetime limit. In particular, it might not be possible to integrate a propulsion system or other de-orbit device into a small satellite, because of its size and mass limitations.

50. A representative of Surrey Satellite Technology Ltd. reported on the status of its ongoing research and development activities on technical measures for space-debris mitigation in small-satellite missions. While small-satellite activities were under close scrutiny by the space community, the experiences gained through those activities could also benefit the wider satellite development community in the future.

51. Since 2010 the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space had been considering a new agenda item entitled "Long-term sustainability of outer space activities". The Working Group created under that agenda item would also examine technical standards, established practices and acquired experience for the successful development and operation of space systems throughout all the phases of the mission life cycle for all classes of space objects, including microsatellites and smaller satellites. On the basis of the report of the Working Group, voluntary guidelines for the space community might be drafted. In the framework of the Basic Space Technology Initiative, the drafting of voluntary guidelines for the conduct of small-satellite activities was beginning to be considered and could be submitted for consideration by the Working Group.[7]

52. The session concluded with a presentation on the establishment of national space law by the representative of the University of Vienna. Austria was in the process of adopting a national space law, which was made necessary by the anticipated launch of the first Austrian satellite, TUGSAT-1/BRITE. The space law would, inter alia, establish administrative responsibilities for the creation and maintenance of a national launch registry, define administrative measures for the authorization and supervision of space activities and regulate liability and requirements for insuring space activities. As demonstrated by the case of Austria, small-satellite activities could encourage countries to establish national space laws.

E. Basic Space Technology Initiative and the way forward

53. Part of the final session was devoted to the discussion of ongoing and future activities to be conducted under the Basic Space Technology Initiative. Following the summaries delivered by the rapporteurs of the thematic sessions, the participants considered the observations and recommendations emanating from the discussions at the Symposium.

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[7] See A/AC.105/983, para. 52.

54. The session began with a presentation by participants in the nine-week space studies programme of the International Space University held in Graz, Austria, from 11 July to 9 September 2011. Under the Basic Space Technology Initiative, several of the space studies programme participants had formed a project team to create a guidebook on small-satellite programmes. Further details about the team project can be found at www.unoosa.org/oosa/en/SAP/bsti/isu-ssp2011.html. The team project website, containing the final project report and its executive summary, can be accessed at http://gossp.isunet.edu. The project team was considering updating the project report with the aim of creating a comprehensive guidebook for all those interested in engaging in small-satellite development activities.

55. The symposium participants then proceeded to discuss and approve the workplan of the Basic Space Technology Initiative (see sect. III below), and then discussed general observations and recommendations (see sect. IV below).

56. The session concluded with a presentation by the representative of the local organizing committee of the fourth African Leadership Conference on Space Science and Technology for Sustainable Development, held in Mombasa, Kenya, from 26 to 29 September 2011, drawing the attention of the symposium participants to the sessions on capacity-building in space technology development and space law co-organized by the Office for Outer Space Affairs under the Basic Space Technology Initiative. Details about the sessions and the Mombasa Declaration resulting from that Conference can be found at www.unoosa.org/oosa/en/SAP/bsti/alc2011.html.

57. Finally, a representative of the local organizing committee of the United Nations/Japan workshop on capacity-building in space technology development, to be held in Nagoya, Japan, from 10 to 13 October 2012, made a presentation on the arrangements planned for the workshop and encouraged all symposium participants to consider participating in the event. That workshop would be the first in a series of annual conferences, carrying forward the activities launched during the series of three United Nations/Austria/ESA Symposiums.

F. Presentations by participants

58. In addition to those described above, participants were given the opportunity to make short presentations on their small-satellite activities. The presentations made by the representatives of Austria, Belgium, Canada, China, Egypt, France, Germany, Italy, Kenya, Mexico, Nepal, Nigeria, Pakistan, Slovakia, the Sudan, Thailand, Tunisia, Ukraine, the United Kingdom of Great Britain and Northern Ireland, the United States of America, Uruguay and Viet Nam were an integral component of the Symposium and provided a wealth of information on ongoing small-satellite programmes and projects worldwide.[8]

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[8] Documentation relating to those presentations has been made available on the website of the Office for Outer Space Affairs.

III. Basic Space Technology Initiative

59. Participants in the Symposium discussed and approved the updated work programme of the Basic Space Technology Initiative, structured in five areas of activity, as set out below:

1. Basic activities

(a) To organize a series of United Nations workshops, symposiums and expert meetings on basic space technology, including the now-concluded series of three United Nations/Austria/ESA symposiums on small-satellite programmes for sustainable development from 2009 to 2011. Those workshops and symposiums will also have the purpose of guiding and reviewing the activities to be conducted in the framework of the Initiative;

(b) To maintain and update the web pages of the Office for Outer Space Affairs dedicated to the Initiative and a mailing list to disseminate relevant information on topics related to space technology development. This may also include the creation of an online forum and the hosting of databases containing information on matters such as opportunities for the sharing of manufacturing and testing infrastructures and equipment for the development of small satellites;

(c) To increase the awareness of small-satellite developers with respect to relevant regulatory aspects, such as the registration of satellites with the United Nations and the voluntary space debris mitigation guidelines of the Committee on the Peaceful Uses of Outer Space and, in cooperation with ITU, assistance to ensure compliance with the established procedures required for the notification of the allocation and use of frequencies;

(d) To promote the promulgation and use of open standards as well as open-source and non-proprietary development methods and software tools for design, development, manufacturing and simulations.

2. International space technology conferences

To conduct international space technology conferences between 2012 and 2015 in the regions that correspond to the United Nations economic commissions for Africa, Asia and the Pacific, Latin America and the Caribbean, and Western Asia. Those conferences shall, inter alia, consider regional aspects of capacity-building in space technology development as well as opportunities for interregional cooperation.

3. Space technology education curriculum

(a) To conduct a comprehensive survey of worldwide academic programmes in aerospace engineering and small-satellite development offering scholarship opportunities. The results of the survey have been published in the document entitled "Educational opportunities in aerospace engineering and small satellite development" (ST/SPACE/53), which shall be updated as needed;

(b) To develop an educational curriculum for aerospace engineering, following the model of earlier education curricula developed by the United Nations for use at the regional centres for space science and technology education, affiliated to the United Nations, as well as at other interested academic institutions. It is planned that this activity will commence at the first international space technology conference, to be held in 2012.

4. Long-term fellowship programmes

To continue establishing and offering long-term fellowship programmes in aerospace engineering and small-satellite development at the graduate and postgraduate levels in cooperation with interested academic institutions worldwide.

5. Basic Space Technology Initiative projects

To use the Basic Space Technology Initiative as a framework to implement regional and international projects related to capacity-building in space technology development. At present, two projects are being implemented:

(i) Support for the HUMSAT project, an effort led by the University of Vigo, Spain, with the participation of institutions in many other countries;

(ii) Continuation of efforts to develop a best-practice handbook for the implementation of small-satellite programmes, an effort launched in cooperation with the International Space University (ISU), as the output of one of the team projects conducted during the ISU space studies programme held in Graz, Austria, in summer 2011.

60. Other activities under consideration under the Basic Space Technology Initiative are the development of a nanosatellite code of conduct, as a self-policing initiative of the small-satellite community and as a possible contribution to the discussions under the agenda item on the long-term sustainability of outer space activities in the Committee on the Peaceful Uses of Outer Space, and the initiation of discussions with launch providers to consider making available free or low-cost launch opportunities for international nano- and small-satellite projects. It is anticipated that those activities will be conducted in cooperation with the International Astronautical Federation.

IV. Observations and recommendations

61. The Symposium participants made the following observations:

(a) Small-satellite development activities were thriving worldwide. There was a growing number of satellite developers who were driven by a wide range of diverse motivations, such as the desire to establish a capacity in space technology development with the required human resources and infrastructure, to provide exciting technology projects to educate and motivate staff and students, to develop application- or science-driven missions, to engage in regional or international cooperation or to create the foundation for space technology businesses and industry;

(b) A particular advantage of small-satellite development projects was that they could be sized and adapted to an organization's existing budgets and capacities. Small-satellite projects had been successfully conducted by universities, research and development organizations and industry, including in developing countries and countries that previously did not have any space technology development activities;

(c) Small-satellite programmes could be implemented using various types of management philosophies, ranging from less formal but more flexible student-run projects to projects strictly applying systems engineering standards developed for large space projects. In the latter case, a small satellite project could be used as a learning tool for larger and more complex missions. Many small satellite projects also used web-based management tools to coordinate the work of a geographically dispersed project team;

(d) There were many opportunities for cooperation open to the small-satellite community, whether through individual projects such as HUMSAT, QB50 and GENSO, through journals such as the Journal of Small Satellites (see www.JoSSonline.org), through participation in international conferences, such as those organized in the framework of the Basic Space Technology Initiative, or through initiatives such as the mission idea contest organized by UNISEC of Japan. Regional capacity-building programmes included UNIFORM, STAR and the proposed Middle East and North Africa space technology education programme. Cooperation could also include the sharing of testing facilities, such as in the case of the BRITE nanosatellite constellation, or the sharing of ground stations, such as in the GENSO project. Even within a country, universities, non-governmental and governmental organizations and industry could cooperate in small-satellite projects. Several universities were also offering fellowship opportunities, including the United Nations/Japan long-term fellowship programme on nanosatellite technologies and programmes listed in the publication "Educational opportunities in aerospace engineering and small satellite development" (ST/SPACE/53);

(e) Several informal quasi-standards, such as the CubeSat standard, had been widely accepted by parts of the small-satellite community over the last few years. Further efforts for the standardization of environmental testing procedures were under way. Standardization created opportunities for cooperation between small-satellite development teams, allowing for the interchange of components and subsystems, thus also contributing to shorter development and innovation cycles;

(f) Several binding and non-binding legal and regulatory norms were applicable to small-satellite programmes. In countries that had adapted a national space law, that might may have to be considered as well. Small-satellite developers were required to adhere to any binding norms and regulations, including the requirement to register space objects with the United Nations and to coordinate the allocation and use of frequencies through ITU. Every effort should be made to be compliant with relevant voluntary guidelines, such as the voluntary Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space and IADC.

62. The Symposium participants made the following recommendations:

(a) The small-satellite community needed to be aware of and address the concerns of those who considered small satellites to be a threat to the long-term sustainability of outer space activities. The small-satellite community should make use of any opportunity to demonstrate exemplary behaviour. Full compliance with binding legal and regulatory norms and adherence, to the largest extent possible, to non-binding norms and guidelines, were therefore essential. It was important to educate small-satellite developers about those aspects to avoid difficulties at the late stage of projects. Such efforts should continue through the Basic Space Technology Initiative;

(b) There was a definite increase in interest in small-satellite activities and their applications. However, access to funding for non-governmental organizations was often difficult to obtain. The conditions and requirements for funding from governmental sources could also be difficult to manage for small organizations. To promote small-satellite activities it was therefore proposed that Member States assess the opportunity for innovative funding and procurement mechanisms;

(c) Given the increasing crowding of the amateur satellite service band owing to the growing number of small-satellite missions, the members of the small-satellite community should coordinate among themselves and work with their governments to submit proposals at future World Radiocommunication Conferences to make additional frequency bands available for small-satellite activities, including with regard to the possibility of widening the scope of purposes, which was currently limited by the definition of the amateur service;

(d) The small-satellite community should be actively involved in and provide input to the discussions relevant for small-satellite activities in the Working Group established in the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space under the agenda item on the long-term sustainability of outer space activities. The views of the small-satellite community could be channelled through the Basic Space Technology Initiative.

V. Conclusions

63. The Symposium in September 2011 concluded the series of three United Nations/Austria/ESA Symposiums. The series demonstrated the growing worldwide interest among governmental and non-governmental organizations in establishing space technology development capabilities. It brought together more than 250 representatives from more than 50 Member States who were actively involved in small-satellite development projects. Together they contributed to the launch of the Basic Space Technology Initiative of the United Nations Programme on Space Applications by discussing and agreeing on a work programme in support of capacity-building and the promotion of international cooperation in small-satellite programmes.

64. Starting in 2012, a new series of workshops on capacity-building in space technology development will be launched with the United Nations/Japan workshop, to be hosted by the University of Tokyo. It will be followed by a workshop organized in cooperation with the Government of the United Arab Emirates, planned to be held in 2013. For the period 2014-2015, representatives of institutions of the following countries participating in the three United Nations/Austria/ESA Symposiums have expressed an interest in hosting a future regional workshop on basic space technology development: Canada, India, Mexico, South Africa, Thailand, Tunisia and Venezuela (Bolivarian Republic of).