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Report on the United Nations/Brazil Symposium on Basic Space Technology: Creating Novel Opportunities with Small-Satellite Space Missions

(Natal, Brazil, 11–14 September 2018)

I. Introduction

1. The United Nations/Brazil Symposium on Basic Space Technology on the theme "Creating novel opportunities with small-satellite space missions" was the fifth in a series of international symposiums on basic space technology development to be held in the regions served by the Economic Commission for Africa, the Economic and Social Commission for Asia and the Pacific, the Economic Commission for Latin America and the Caribbean and the Economic and Social Commission for Western Asia. The symposiums are part of the Basic Space Technology Initiative, which comes under the United Nations Programme on Space Applications. The Initiative is aimed at supporting capacity-building in basic space technology and promoting the use of space technology and its applications for peaceful purposes and in support of sustainable development.

2. The Symposium was organized in Natal, Brazil, by the Office for Outer Space Affairs of the Secretariat and the National Institute for Space Research (INPE), the Federal Institute of Education, Science and Technology of Rio Grande do Norte (IFRN), the Federal University of Rio Grande do Norte (UFRN) and the Brazilian Space Agency (AEB), on behalf of the Government of Brazil. The Symposium and its side events were hosted by IFRN and AEB.

3. The present report contains a description of the background, objectives and programme of the Symposium, summaries of the presentations made during its technical sessions and panel discussions, and the recommendations and observations made by the participants. The report has been prepared pursuant to General Assembly resolution 72/77. It should be read in conjunction with the reports on the three United Nations/Austria/European Space Agency symposiums on small-satellite programmes held between 2009 and 2011 (A/AC.105/966, A/AC.105/983 and A/AC.105/1005) and the reports of the previous four symposiums in the series of international symposiums on basic space technology development (A/AC.105/1032, A/AC.105/1052, A/AC.105/1086 and A/AC.105/1180).

A. Background and objectives

4. The United Nations Programme on Space Applications was launched as a result of discussions at the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE), held in Vienna in 1968. The Programme is implemented by the Office for Outer Space Affairs and provides support to all States Members of the United Nations that aim to build capacity in space technology, regardless of their level of economic development.

5. Advances in technology and the acceptance of a higher but still reasonable level of mission risk have resulted in increasingly capable small satellites that can be developed by academic institutions, research centres and similar organizations that have limited infrastructure and budget for space activities. The variety of benefits that can be derived from small-satellite development has increased interest in establishing basic capacities in space technology development, including in developing countries and in countries that have, to date, been using space applications developed by others.

6. In response to that interest, the Basic Space Technology Initiative was added to the United Nations Programme on Space Applications in 2009. Pursuant to General Assembly resolution 37/90, the Programme should stimulate the growth of indigenous 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.

7. The Initiative focuses on the development of affordable small satellites with a mass less than 150 kg and the technical, managerial, regulatory and legal issues associated with such satellites. It supports capacity-building in basic space technology and its applications for the peaceful uses of outer space in support of sustainable development. Furthermore, the Initiative addresses the contribution of basic space technology to the process associated with the fiftieth anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE+50) and the implementation of a “Space2030” agenda, to be developed by the Committee on the Peaceful Uses of Outer Space.

8. The United Nations/Brazil Symposium had the following main objectives:

(a) Reviewing the status of capacity-building in basic space technology for small satellites, including lessons learned from past and ongoing development activities with focus on regional and international collaboration opportunities, in particular for countries in Latin America and Caribbean;

(b) Examining issues relevant to the implementation of small-satellite programmes, such as organizational capacity-building, development and testing infrastructure and launch opportunities;

(c) Reviewing the evolving capabilities and state-of-the-art applications of small-satellite programmes and the technological developments associated with them, with a particular focus on applications for agricultural, environmental and urban monitoring and for education that support sustainable growth, in line with the 2030 Agenda for Sustainable Development;

(d) Discussing regulatory issues related to space technology development programmes, such as frequency allocation, space debris mitigation measures and other issues that could arise with the newly emerging trend of small-satellite constellations;

(e) Discussing legal issues and responsibilities related to space technology development programmes, such as those that arise from the sources of international space law;

(f) Discussing the way forward for the Basic Space Technology Initiative and its capacity-building and international cooperation activities in support of UNISPACE+50.

9. The fiftieth anniversary of UNISPACE, the first United Nations space summit of the twenty-first century, was celebrated in June 2018. The Symposium was one of the first activities organized by the Office for Outer Space Affairs after that celebration and, as such, was particularly important in defining long-term opportunities in basic space technology.

10. The observations and recommendations related to building indigenous capacity in space technology and its applications, and therefore reducing the "space divide", that were made at the Symposium directly contribute to the achievement of Sustainable Development Goals 4, on quality education, and 10, on reducing inequalities. Moreover, in the context of the 2030 Agenda of Sustainable Development, the development of entry-level space technologies, through providing an affordable entry point, also supports the acquisition of technical capabilities and know-how, which in turn paves the way for potential spin-offs to other industrial sectors, the establishment of commercial businesses (which comes under Goal 9, on industries, innovation and infrastructure) and new opportunities for international cooperation (which comes under Goal 17, on partnerships).

B. Attendance

11. The Symposium was attended by 209 participants involved in nanosatellite and small-satellite missions from governmental and intergovernmental institutions, universities and other academic entities and the private sector from 27 countries, namely Argentina, Bolivia (Plurinational State of), Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Germany, Guatemala, India, Italy, Japan, Kenya, Mexico, Nigeria, Paraguay, Peru, the Republic of Korea, South Africa, Spain, the Sudan, Tunisia, Turkey, Ukraine, the United Kingdom of Great Britain and Northern Ireland and the United States of America.

12. The Symposium was sponsored, on behalf of the Government of Brazil, by INPE, AEB, UFRN and IFRN. Funds allocated by the United Nations and the sponsors were used to sponsor 28 participants from 22 countries.

C. Hands-on workshop preceding the Symposium

13. Prior to the main Symposium, a two-day, hands-on CubeSat development workshop was held by INPE in the facilities of AEB. The main objective was to equip participants with the knowledge necessary for them to lead similar workshops in their own countries. Participants took courses on the architecture of basic satellite systems, developed a CubeSat ground kit and gained experience with space systems engineering processes, encompassing assembly, integration and testing.

14. The workshop was attended by 25 researchers and students involved in nanosatellite and small-satellite missions. The attendees represented governmental institutions, universities and other academic institutions from 11 countries, namely Argentina, Bolivia (Plurinational State of), Brazil, Bulgaria, Chile, Colombia, Costa Rica, Guatemala, Italy, Mexico and Peru.

II. Programme

15. The programme of the Symposium was developed by the Office for Outer Space Affairs in cooperation with the programme committee, which 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. An industry exhibition, held in conjunction with the Symposium, was organized by the local organizers.

16. The programme consisted of an opening and introductory sessions, keynote addresses, four technical sessions, two panel discussions, six poster sessions and a final

session for discussions on observations and recommendations, followed by closing remarks by the co-organizers. The oral and poster presentations delivered during the Symposium are available on the website of the event (www.unoosa.org/oosa/en/ourwork/psa/schedule/2018/symposium_brazil_bsti.html).

A. Opening session

17. At the opening session, welcoming remarks were made by a representative of the Director of IFRN, a representative of the Director General of the IFRN Campus Natal Central, a representative of the Rector of UFRN, the President of AEB and a representative of the Office for Outer Space Affairs.

18. In the first keynote address, the Director of INPE provided an overview of the current role and future plans of the Institute in small-satellite research and development. He presented the Institute's capacity-building, infrastructure development and outreach activities, and provided examples of the applications of small satellites for scientific and technological research.

19. The second keynote address was delivered by a representative of Utah State University, who illustrated the role of small satellites in space science through a Brazil/United States joint space weather research mission named Scintillation Prediction Observations Research Task (SPORT). The joint CubeSat-based mission was designed to improve understanding of the preconditions leading to equatorial plasma bubbles causing radio scintillation.

20. Two introductory presentations were given by representatives of the Office for Outer Space Affairs. In the presentations, an overview of the mission of the Office to bring the benefits of space to humankind was given and the potential of space in supporting the achievement of the 2030 Agenda for Sustainable Development was emphasized. Moreover, the challenges facing countries during the initial phases of their access to space technologies, and the potential of small-satellite-based space technology development in responding to such challenges by providing an affordable solution, were highlighted.

21. In the final presentation of the introductory session, a representative of AEB provided a summary of Brazilian small-satellite missions and gave an overview of the Agency's small-satellite initiatives.

B. Technical sessions

22. Technical sessions were held on the following topics: (a) small satellites and capacity-building in basic space technology, with a focus on Latin America and the Caribbean; (b) evolving capabilities and operational applications of small-satellite missions; (c) legal and regulatory issues related to small satellites; and (d) evolution of a local data-collection system into an international CubeSat constellation-based environmental data-collection initiative. Each technical session was followed by a poster session.

1. Small satellites and capacity-building in basic space technology, with a focus on Latin America and the Caribbean

23. Speakers from Utah State University, Sergio Arboleda University, the Technical Institute of Aeronautics (Brazil), the School of Astronautics of Beihang University, the Central American Association for Aeronautics and Space, Istanbul Technical University, San Pablo Catholic University (Peru), the Aerospace Corporation, the Directorate General for Research and Development of the Air Force of Argentina, the Mexican Space Agency (AEM), the Centre for Research on Microelectronics and Nanotechnology, Berlin Space Technologies, the University of Chile and the Massachusetts Institute of Technology presented completed, ongoing and future capacity-building activities.

24. The primary mechanism for capacity-building was the use of small-satellite development programmes such as the Libertad-2, SPORT, IRAZÚ, µSAT-3, AztechSat-1, SUCHAI, ITUpSAT 1, FACT, USUSat and AeroCube projects, with the involvement of local educational institutions. It was stated that providing suitable real project opportunities greatly facilitated capacity-building in the space technology domain, and that small-satellite missions represented an affordable means of accessing those opportunities.

25. The participants demonstrated their use of a combination of CubeSat components purchased from international suppliers coupled with indigenously fabricated components or subsystems of the spacecraft. They underlined the importance of that approach for capacity-building and training programmes. It was also highlighted that paradigm changes in space capacity-building and use, such as the widespread use of commercial off-the-shelf components, signalled a new era and were triggering further changes in the policy, strategy, workforce and infrastructure aspects of space missions.

26. Some speakers illustrated the importance of multilateral cooperation at the national level to raise support and funding for small-satellite projects from academia, private companies and the public sector, and emphasized the need to raise awareness about the uses of space technology for solving real-life problems on Earth. The 2030 Agenda for Sustainable Development was highlighted as a prominent source of information on areas in which the use of space technology would be essential.

27. Alternative funding mechanisms for raising the necessary funds for small-satellite projects were also presented. Such mechanisms included space sector-related financial instruments in the European Union and regional and international collaboration opportunities. The importance of regional and international cooperation was emphasized for basic space technology-related capacity-building. It was stated that South-South cooperation would be beneficial for countries developing capacity as it would allow the sharing of the risks and costs associated with space missions.

28. Finding a mutually beneficial set of mission objectives was highlighted as a potential way of enabling collaboration between countries with significantly different levels of space capacity; the examples of the AztechSat-1 and SPORT missions were given in that regard. It was noted that educational institutions in spacefaring countries were not subject to the same legal restrictions as private businesses when it came to the export of basic space technology. It was also highlighted that some European countries were offering specific training in basic space technology to developing countries to extend their business opportunities to those emerging markets.

29. The participants emphasized the importance of affordable launch opportunities to realizing capacity-building projects. Some participants indicated that North-South cooperation projects provided the important advantage of easy access to launch opportunities. The participants also commended the Office for Outer Space Affairs and the Japan Aerospace Exploration Agency (JAXA) for the KiboCUBE initiative, which was a unique example of triangular cooperation in that area.

30. The session was concluded with a panel discussion that served to review and highlight the most important aspects of space technology capacity-building. Representatives from Utah State University, the Aerospace Corporation, INPE, Space BD Inc., Airvantis and Berlin Space Technologies addressed the elements that were most likely to lead to success in small-satellite missions.

31. During the discussion, three standards were highlighted as providing guidance on increasing the chance of mission success: (a) International Organization for Standardization (ISO) standard ISO 17770:2017 (Space systems — cube satellites (CubeSats)); (b) ISO 19683:2017 (Space systems — design qualification and acceptance tests of small spacecraft and units); and (c) tailored European Cooperation for Space Standardization engineering standards for in-orbit demonstration CubeSat projects (TEC-SY/128/2013/SPD/RW Rev.3). In addition, two recent publications

were recommended as reference documents: (a) *Improving Mission Success of CubeSats* (Catherine C. Venturini, Aerospace Report No. TOR-2017-01689); and (b) "Reliving 24 years in the next 12 minutes: a statistical and personal history of university-class satellites" (Michael Swartwout, document SSC18-WKVIII-03, Saint Louis University, Missouri, 2018).

2. Evolving capabilities and operational applications of small-satellite missions

32. The session featured speakers from the public, private and academic sectors in Bolivia (Plurinational State of), Brazil, China, Costa Rica, Denmark, Germany, Guatemala, India, the Netherlands, Ukraine and the United States. They represented the University of Wuerzburg, SatSure, the National Aeronautics and Space Administration (NASA), the University of Sciences and Humanities (Peru), the University del Valle (Guatemala), the University of Brasilia, Shenzhen Aerospace Dongfanghong HIT Satellite Ltd., Innovative Solutions in Space B.V., Noosfera Projects, INPE, the Costa Rica Institute of Technology, Yuzhnoye State Design Office, GomSpace and the Vel Tech Rangarajan Dr. Sagunthala Research and Design Institute of Science and Technology.

33. The striking increase in demand for small satellites and their constellations was highlighted. It was noted that the most dominant factor in that trend was the increase in commercial operators, explained by the appealing features of small satellites, namely faster innovation cycles, the distribution of risk to multiple assets instead of a traditional large satellite and the possibility of using high-performance commercial components. It was underlined that rapid growth in the small-satellite market had been impacting the small launch-vehicle market, leading to investment for research into developing reusable, small launch vehicles with the potential to significantly increase the frequency of launches at lower costs.

34. The main challenges for small satellites were recognized as high-bandwidth communications, precision attitude control, propulsion and miniaturization of instruments; however, it was also noted that, as a result of intensive technological research, the capabilities of small satellites were constantly improving. Speakers presented examples of technology validation missions in those key areas, including UWE, GOMX, Serpens and IMS-1.

35. The increasing capabilities of small satellites were emphasized by the speakers, and applications derived from those capabilities were described in the presentations. MV-1, TIM, IRAZÚ, Quetzal-1, N-Sight, Discoverer, SICH-2, CloudCT, BrightSkies, IONOSAT, AEROSOL-UA and other Earth and meteorological observation missions that were linked to applications such as agriculture monitoring, soil moisture monitoring, forest monitoring, glacier monitoring, volcano ash cloud observation, lightning monitoring, water monitoring, maritime monitoring, disaster evaluation, air pollution monitoring, atmospheric aerosol analysis and ionospheric measurements were explained.

36. Speakers underlined the importance of new observational techniques, especially small-satellite-based sensors, to the advancement of space science, space weather and astrophysics, and gave examples of current missions serving that purpose.

37. The Internet of Things was highlighted as another area of application that was expected to be the next driver for small satellites and their constellations. Existing uses for it, namely agricultural monitoring and mobile system connectivity, for improving life on Earth were given. One of the most important future challenges for small-satellite capabilities was highlighted as formation flying, which was defined as decentralized autonomous control and coordination of satellite groups, in contrast to constellations individually controlled from the ground.

38. The session concluded with a panel discussion that involved the participation of representatives from NASA, the University of Wuerzburg, Visiona Space Technologies, GomSpace, Innovative Solutions in Space and the Massachusetts

Institute of Technology. Stimulating discussions were held on the ever-growing and improving capabilities and applications of CubeSats and other small satellites.

3. Legal and regulatory issues related to small satellites

39. The session featured speakers from the public, private and academic sectors in Brazil, Canada and Italy, as well as representatives of international organizations. The speakers, from McGill University (Canada), INPE, Dipteron, the International Telecommunication Union (ITU) Radiocommunication Bureau, the Office for Outer Space Affairs, the Attorney General's Office in São José dos Campos, Sapienza University of Rome and the University of Brasilia, discussed issues such as space object registration, frequency allocation, space debris mitigation and national space legislation in the light of the latest developments.

40. Participants highlighted the slow pace of regulatory activities in contrast to the rapid growth in the number of small-satellite launches and the financial worth of the sector and expressed their growing concern regarding the proliferation of space debris and the resulting threat to the safety of space assets. One point that was raised was that the current typical duration of the frequency allocation process did not take into account the relatively short development time and lifespan of small satellites.

41. Speakers underlined the necessity of increased coordination between private and/or public and legislative and/or technical authorities in developing legislation at the national level, taking into account interdisciplinary considerations such as the international legal regime defining liability issues, technical models related to the generation of the debris and state-of-the-art technical methods of slowing down debris generation. In addition, participants emphasized the importance of paying special attention to small satellites, given the trend of using them for non-commercial purposes and the absence of a definition of small satellites in existing legal frameworks.

42. Two areas of research were highlighted, namely in-orbit satellite manufacturing using material that had already been launched into space and the manufacturing of satellites that could be recycled or reconfigured upon completion of their missions.

43. The need for a platform for dialogue between the Office for Outer Space Affairs and the International Institute for the Unification of Private Law (Unidroit) to facilitate coordination and collaboration on the governance of space assets at the international level, taking into account potential linkages between the sustainability of the use of outer space and the 2030 Agenda for Sustainable Development, was mentioned.

44. The presentations delivered by the representatives of ITU and the Office for Outer Space Affairs provided information to the participants on frequency registration procedures and the requirements for small satellites and on responsibilities with respect to the registration of space objects with the United Nations.

4. Evolution of a local data-collection system into an international CubeSat constellation-based environmental data-collection initiative

45. During the session, different technical aspects of an international cooperation opportunity proposed by a consortium of Brazilian entities, Global Open CoLlecting Data System (GOLDS), were presented. It was emphasized that the aim of the initiative was to form an international constellation of CubeSats, data-collection platforms and ground stations that would operate collaboratively to ensure a seamless flow of basic environmental data to States.

5. Poster sessions

46. Poster presentations were made by 61 participants, from Argentina, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Costa Rica, Italy, Japan, Kenya, Mexico, Nigeria, Paraguay, the Republic of Korea, South Africa, Spain and the Sudan. The posters were presented during six poster sessions over four days. They covered

capacity-building, scientific and technological research, technology applications and policy analysis related to basic space technology and small-satellite activities.

III. Observations and recommendations

47. The participants at the Symposium expressed their appreciation for the fruitful information exchange over the course of the Symposium on a range of subjects that were important for the advancement of basic space technology and its applications. In the final session of the Symposium, the participants agreed on the observations and recommendations set out below, which would pave the way for further activities.

A. Space technology development and sustainable development

48. The participants recognized the importance of space science and technology, particularly small-satellite technology, as a means for ensuring the sustainable use of natural resources, fostering entrepreneurship, creating high-technology industrial sectors and therefore contributing to the achievement of the Sustainable Development Goals. It was highlighted that the design of space applications that accurately addressed development needs required collaboration between people with knowledge of space systems with people with knowledge of societal challenges.

49. Given the paradigm change in the nature of the space activities, given the increasing involvement of the private sector, the Office for Outer Space Affairs was encouraged to expand the focus of future symposiums to foster entrepreneurship by bridging the gap between the technical and investment communities.

50. It was recognized that small-satellite technology had improved significantly, to the extent that it could complement and/or even adapt the capabilities of large satellites, and that it was able to contribute to Earth observation, telecommunications, weather and climate, space science, astrophysics and planetary science missions.

51. Participation in small-satellite missions was regarded as a means of improving the technological and scientific capabilities of nations, since the skills developed in that context could permeate to other innovative industrial sectors.

52. Greater cooperation to support small-satellite capabilities and capacity-building at the university level, ensuring the participation of undergraduate students in the projects, was considered essential, as hands-on experience in real projects contributed to the training of student engineers.

53. “Train-the-trainer” activities, such as the one preceding the Brazil Symposium, should be continued. Furthermore, implementation of similar hands-on workshops on CanSat and CubeSat development at the regional level should be considered. Opportunities for the regional centres for space science and technology education, affiliated to the United Nations, to provide similar hands-on training as part of their education programmes, preferably with the addition of basic space law and policy concepts, should be explored.

54. Considering the needs of developing countries, ground-based training kits designed to utilize commercial off-the-shelf components to keep overall cost to affordable levels, while following a stacked approach to simulate the modularity in the satellite systems, was recommended. In order to ensure the successful replication of the training course by the trainees, contact points responsible for post-training follow-up and guidance should also be provided.

55. The promotion of gender equality in space activities should be sought, and avenues for increasing the number of women in capacity-building activities should be pursued as a fundamental factor in stimulating societal growth.

B. Cooperation in basic space technology capacity-building

56. Continued efforts to raise awareness of the potential of small-satellite technology programmes and to establish synergies between governmental entities, the private sector, research institutions and academia to develop joint initiatives to contribute to the implementation of the Sustainable Development Goals were recommended.

57. As a means of overcoming constraints such as a lack of technical know-how, funding and launch capability, collaboration opportunities through missions based on a common set of mutually beneficial objectives should be explored between entities from spacefaring countries and entities from countries seeking to build capacity in space technology.

58. Other recommended means of achieving and/or enhancing collaboration at the international level were the implementation of training programmes involving exchanges of human resources and the provision of international mentors and subject matter experts to new and inexperienced project teams. The Office for Outer Space Affairs was recognized as a potential facilitator for the establishment of such partnerships, through a triangular approach.

59. Regional and international cooperation initiatives such as those for the joint development and launching of multiple small satellites were recommended to foster information-sharing and to enable more complex projects. The GOLDS environmental data-collection mission was welcomed as an example of such an initiative for Latin America and the Caribbean.

60. The development and adoption of common standards for electrical and mechanical subsystem interfaces (bus interfaces) were encouraged to facilitate cooperation among development teams and reusability.

C. Mission and programme planning-related recommendations

61. Defining an important and compelling purpose or objective for a space mission, other than capacity-building, which would ensure the commitment of the team and justify the mission cost, was recognized as a critical factor for programme success and continuity. It was noted that programmes that produced valuable data or provided needed capabilities for a country had proved to be more useful than programmes that lacked a clear objective and were only educational in nature.

62. The participants agreed that all space missions must have a clearly defined scope and clearly defined goals and success criteria at the start of the programme. It was strongly recommended that those objectives be set out in writing and protected against “scope creep” as the programme moved forward, in order to avoid negative effects on schedule and cost.

63. It was noted that regulatory aspects (such as frequency registration) and launcher-based constraints and requirements should be taken into account during the mission-planning phase. The creation of a schedule and budget of resources for a mission was recommended; confirmation that the mission could be completed within the available time using the available budget and resources should also be provided.

64. The allocation of ample resources for testing was considered critical for the success of missions. The typical time allocated for testing during the whole development process was roughly estimated as up to half and at least one third of the available time in a space project. Day-in-the-life testing, communication-link testing with the ground station, power system charge and discharge testing and thermal testing (in a vacuum if possible) were mentioned as a minimum subset of the required tests. Given the increasing frequency of small-satellite launch opportunities, the practice of sacrificing tests to preserve launch schedules should be avoided.

65. The composition of the project team was also recognized as an important factor in mission success. Inexperienced team members should be supported by more experienced members so that effective, informal peer reviews could take place. Subject matter experts should be involved in discussions.

66. Programme continuity was considered necessary for mission success; therefore, it was recommended that staff turnover risk management was built into the mission plan to secure the required professionals and formal documentation for know-how preservation and transfer. The definition of long-term goals spanning at least 10 years was considered necessary to achieve sustainability.

67. It was recommended that countries, especially those at the early stages of the capacity-building phase, should invest in infrastructure development to ensure that a space industry that would be able to accommodate experienced graduates and professionals could flourish.

D. Concerns related to sustainability

68. It was acknowledged that the joint support of legislative and technical authorities from the public, private and academic sectors of the small-satellite community was necessary for the establishment of appropriate regulatory frameworks that would not constrain innovation and would ensure the sustainability of future space activities. It was recommended that scientists and engineers engaged and coordinated with their delegates and representatives to be involved in the studies conducted by international organizations, such as ITU studies on small satellites and mega-constellations.

69. Participants expressed their concerns about the proliferation of small-satellite constellations and the risk of exacerbating space debris and called for firm adherence to existing guidelines on avoiding those constellations becoming a threat to the long-term sustainability of low Earth orbit.

70. Participants noted that there was a need to extend a priori allotment of radio frequency and orbital slots in orbits other than the geostationary orbit for developing countries. Participants also noted that commercial activity in space should be regulated by drawing upon its critical role for the achievement of the Sustainable Development Goals and its status as a global commons.

IV. Conclusions

71. The participants expressed their appreciation to the organizers of the Symposium for the multidisciplinary and cross-sectoral nature of the programme, which had addressed the subject of small satellites in a holistic manner.

72. Participants noted the progress made in the regions served by the Economic Commission for Africa, the Economic and Social Commission for Asia and the Pacific, the Economic Commission for Latin America and the Caribbean and the Economic and Social Commission for Western Asia in establishing domestic small-satellite capacity in government institutions and industry since the beginning of the series of Basic Space Technology Initiative symposiums, in 2009.

73. Noting the significant number of countries in each region that could still benefit from capacity-building activities to strengthen their capabilities, participants recommended that the Office for Outer Space Affairs continue to organize symposiums in the context of the Basic Space Technology Initiative, in addition to the legal and regulatory support and opportunities it offered to facilitate the participation by States in space technology development and applications. Furthermore, the participants recommended the organization of more hands-on training activities on CanSat and CubeSat development at the regional level.