8 February 2018

English only

Committee on the Peaceful Uses of Outer Space
Scientific and Technical Subcommittee
Fifty-fifth session
Vienna, 29 January–9 February 2018

Report on the United Nations/South Africa Symposium on Basic Space Technology: Small satellite missions for scientific and technological advancement

(Stellenbosch, South Africa, 11–15 December 2017)

Note by the Secretariat

I. Introduction

1. The United Nations/South Africa Symposium on Basic Space Technology on the theme "Small satellite missions for scientific and technological advancement" was the fourth in a series of international symposia on basic space technology development to be held in the regions that correspond to the Economic Commissions for Africa, Asia and the Pacific, Latin America and the Caribbean, and Western Asia. The symposia are part of the Basic Space Technology Initiative, which is carried out as part of 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 the peaceful uses of outer space and in support of sustainable development.

2. The Symposium was organized by the Office for Outer Space Affairs of the Secretariat and the Department of Science and Technology, the Department of Trade and Industry and the South African National Space Agency, on behalf of the Government of the Republic of South Africa. It was held in Stellenbosch, South Africa, hosted by Stellenbosch University.

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 is prepared pursuant to General Assembly resolution 72/79. It should be read in conjunction with the reports on the four United Nations/Austria/European Space Agency symposia on small-satellite programmes held between 2009 and 2011 (see A/AC.105/966, A/AC.105/983 and A/AC.105/1005), the report on the United Nations/Japan Nanosatellite Symposium (A/AC.105/1032), the report on the United Nations/United Arab Emirates Symposium on Basic Space Technology (A/AC.105/1052) and the

report on the United Nations/Mexico Symposium on Basic Space Technology (A/AC.105/1086).

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 capacity-building in space technology and its applications to all Member States of the United Nations, independent of their level of economic development. The initial focus of the Programme was on the applications of space technology in, for example, satellite communications, Earth observation and positioning and navigation services.

5. Advances in technology, as well as the adoption of philosophies of technology development that accept a higher but still reasonable level of mission risk, have resulted in increasingly capable small satellite missions that can be developed with an infrastructure and at a cost that make them feasible and affordable for organizations such as academic institutions and research centres that 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 in countries that had previously only been users of space applications.

6. In response to that interest, the Basic Space Technology Initiative was added as a new cornerstone to the United Nations Programme on Space Applications in 2009, pursuant to its mandate to 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, as set out in General Assembly resolution 37/90.

7. The Initiative focuses on the development of affordable, small-satellite platforms with a mass below 150 kg and on the associated technical, managerial, regulatory and legal issues. It supports capacity-building in basic space technology and its applications for the peaceful uses of outer space in support of sustainable development and, in particular, addresses their contribution to UNISPACE+50 and achieving Space2030 Agenda.

8. The Basic Space Technology Initiative began with the organization, in 2009, 2010 and 2011, of three United Nations/Austria/European Space Agency symposia on small-satellite programmes, followed by the current series of International Symposia, starting in 2012. The theme of the United Nations/Japan Nanosatellite Symposium held in 2012 was “Paradigm shift: changing architecture, technologies and players”, the theme of the United Nations/United Arab Emirates Symposium on Basic Space Technology held in 2013 was “Small-satellite missions for developing space nations”, and the theme of the United Nations/Mexico Symposium on Basic Space Technology held in 2014 was “Making Space Technology Accessible and Affordable”.

9. The United Nations/South Africa Symposium had the following main objectives:

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

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

(c) Review state-of-the-art scientific applications of small satellite programmes and their associated supporting technological developments, in

particular with focus on applications for agriculture, environment and city monitoring, and education to promote a sustainable growth, in line with the 2030 Agenda for Sustainable Development;

(d) Elaborate on regulatory issues of space technology development programmes, such as frequency allocation and space debris mitigation measures for enhancing the long-term sustainability of outer space activities as well as import/export controls;

(e) Elaborate on legal issues and responsibilities related to space technology development programmes, such as those that are raised from the relevant provisions in international space law; and

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

10. The Committee on the Peaceful Uses of Outer Space endorsed at its fifty-ninth session seven thematic priorities for UNISPACE+50 (see A/71/20, para. 296). The discussions at the Symposium will inform the preparations towards UNISPACE+50, which will be held in 2018 to mark the fiftieth anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space in 1968. The observations and recommendations of the Symposium will contribute to the UNISPACE+50 process and will be brought to the attention of relevant policy and decision making bodies.

11. With the aim of BSTI and the associated series of events related to “Capacity-building for the 21st century” (Thematic Priority 7), the Symposium objectives reflect this approach, while focusing on capacity-building, it encompasses also activities supporting other thematic priorities such as:

(a) Thematic Priority 1 by promoting international collaboration and cooperation activities;

(b) Thematic Priorities 2 and 3, by supporting and raising awareness on regulatory issues affecting as well small satellite missions involving frequency allocation, registry of space objects, space debris mitigation measures, import/export control and other legal responsibilities;

(c) Thematic Priority 6, reviewing the role of small satellites in sustainable and resilient cities and societies, assessing their potential for Earth observation.

B. Attendance

12. The Symposium was attended by 126 space professionals involved in nanosatellite and small-satellite missions from governmental and intergovernmental institutions, universities and other academic entities, and the private sector from the following 33 countries: Brazil, China, Costa Rica, Egypt, Ethiopia, France, Germany, Ghana, India, Indonesia, Japan, Kenya, Malawi, Mauritius, Morocco, Namibia, the Netherlands, New Zealand, Nigeria, Pakistan, Peru, the Russian Federation, Singapore, Slovakia, South Africa, Spain, Sudan, Tunisia, Turkey, Uganda, the United Arab Emirates, the United Kingdom of Great Britain and Northern Ireland, and the United States of America.

13. The Symposium was co-sponsored by the Department of Science and Technology, the Department of Trade and Industry, the South African National Space Agency and the Stellenbosch University, on behalf of the Government of the Republic of South Africa, as well as the European Space Agency. Funds allocated by the United Nations and the co-sponsors were used to sponsor 31 funded participants. The sponsors also provided funds for the organization and facilities of the Symposium and for the local transportation of all participants.

C. Pre-symposium hands-on workshop

14. As a pilot project, a two-day workshop on assembling pico-satellites was organized with Nihon University and UNISEC-Global in order to enhance understanding of basic satellite system architecture and experiencing the pico-satellite development process, led by Mr. Masahiko Yamazaki, Nihon University, Japan.

15. The goal of the workshop was to provide participants with space systems engineering experience by assembly, integration and test of a HEPTA-Sat pico-satellites kit and to train potential trainers to lead such workshops in the future.

16. The workshop was attended by 18 space researchers and students involved in nanosatellite and small-satellite missions from governmental institutions, universities and other academic entities from the following 11 countries: Brazil, Egypt, Ghana, Kenya, Mauritius, the Netherlands, Namibia, Nigeria, South Africa, Sudan and Uganda, and assembled 6 pico-satellites in total.

17. The workshop was hosted and sponsored by Stellenbosch University. Nine international participants and two experts were sponsored by the United Nations.

II. Programme

18. The programme of the Symposium was developed by the Office for Outer Space Affairs, the Government of the Republic of South Africa and Stellenbosch University, 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.

19. The programme consisted of an opening session, keynote addresses, seven technical sessions, a panel discussion, a poster session and discussions on observations and recommendations, followed by closing remarks by the co-organizers.

A. Opening session

20. At the opening session, welcoming remarks were made by a representative of Stellenbosch University, the CEO of South African National Space Agency, a representative of the Mayor’s Office of Stellenbosch, the Deputy Director General of the Department of Science and Technology and a representative of the Office for Outer Space Affairs.

21. In the first keynote address, a representative of the Department of Science Technology provided an overview of space science and technology in South Africa. He reviewed the history of space activities in South Africa, including the establishment of the South African Nation Space Agency in December 2010, and introduced the current policy and strategy.

22. The second keynote address from a representative of California Polytechnic State University explained the role of small satellites in workforce development including their contribution in the private sector and serving as a training tool for students.

23. Two introductory presentations were provided by the representatives of the Office focusing on UNISPACE+50, the Basic Space Technology Initiative and the Objectives of the Symposium. This was followed by an introduction of the representative of the Stellenbosch University, focusing on a historical overview of the university’s satellite projects over the past 25 years.

B. Technical sessions

24. Technical sessions were held on the following topics: (a) space technology development and capacity-building with a focus on Africa; (b) small satellite missions in support of key scientific projects and questions; (c) applications of small satellite missions; (d) small satellite projects for engineering education; (e) regulatory and legal issues and long-term sustainability of outer space activities; (f) other aspects of small satellites; and (g) international experiences and opportunities, followed by a poster session. Highlights and major discussion points raised during the sessions are summarized below.

1. Space technology development and capacity-building with a focus on Africa

25. The historical perspective of the Nigerian space programme was presented by a representative from NASRDA. NASRDA has been focusing on three satellite projects, NigeriaSat 1 (2003), NigeriaSat X (2011) and NigeriaSat 2 (2011) and has also developed a Geo-stationary satellite that was built in partnership with China. The Nigerian space programme has a strong focus in capacity-building and know-how transfer. NASRDA understands that this vision can only be achieved through an intense capacity-building programme, research and international cooperation.

26. The second presentation introduced inputs from the African Regional Centre for Space Science and Technology Education in French Language (CRASTE-LF), affiliated to the United Nations. The objectives of the Centre are to develop educational material, to increase knowledge in space sciences and technologies by organizing postgraduate as well as short courses such as seminars, workshops, conferences at the Regional level, to improve the technical competences of the experts, teachers, and decision-makers, to assist the countries of the region on the development of endogens capacities in space tools, to strengthen the local and regional capacities, to promote cooperation between the developed countries and Member States and to develop expertise in space sciences and technologies.

27. A representative from the Kenya Space Agency argued that CubeSats are a pathway for developing countries to access space, illustrated by the development of 1KUNS-PF, the first Kenyan University NanoSatellite-Precursor Flight, a 1U CubeSat, which is being developed by Kenyan and Italian students. The CubeSat is part of a collaborative International Master's program between the University of Nairobi, Kenya, and the University of Rome, La Sapienza, Italy with the support of the Kenya Space Agency and sponsorship from the Italian Space Agency. The 1KUNS-PF Cubesat was selected to be the first beneficiary of the KiboCUBE programme, which is a collaboration between the Office and the Japan Aerospace Exploration Agency.

28. A representative of the South Africa National Space Agency presented on space technology development in South Africa introducing the opportunities for embarking on a space programme. The representative also focussed on the question of the use of satellite information for socioeconomic development.

2. Small Satellite Missions in Support of Key Scientific Projects and Questions

29. The CEO of New Space Systems introduced the stellar gyro, which is a new sensor that allows a virtually driftless gyro function by using image processing technology from a simple low cost camera. This is an enabling technology for low cost communications constellations which has been developed with support from the Government of the Republic of South Africa through the Department of Trade and Industry and the Council for Scientific and Industrial Research supported Aerospace Industry Support Initiative programme.

30. A representative of Space Advisory Company focused on South Africa’s contribution to the Netherlands China lunar explorer (NCLE) which will be China's second lunar lander and the first ever spacecraft to land on the far side of the Moon. The goal of NCLE is to perform astrophysical studies in the unexplored radio regime

of 80 kHz to 80 MHz from translunar locations. NCLE is considered a pathfinder mission for a future low-frequency space-based or moon-based radio interferometer.

31. A representative of Japan Aerospace Exploration Agency introduced the two lunar CubeSats developed in his organization, OMOTENASHI and EQUULEUS which have been selected as secondary payloads to NASA's EM-1 mission. These CubeSats pave the way for future deep-space CubeSats, as well as cargo vehicles to the cis-lunar region by demonstrating novel trajectory control techniques with limited delta-V budget.

32. A representative of the National Institute for Space Research presented the results obtained with NanosatC-Br1, launched in June 2014 and still operational, the development of NanosatC-Br2, to be launched next year, and the strategy to develop their nano-satellite programme, starting with payload assembly integration and testing, through on-board software development, until operations and data distribution.

33. A representative of University of Cape Town explained the importance of synthetic aperture radar on small satellites, which is a mature field and has a diverse range of potential applications with advantages over other electromagnetic wave spectrum frequencies, including access to the whole surface of the Earth through cloud cover.

34. A representative of Theia Space made a presentation on their hands-on training satellite kit named ESAT, which serves to enhance understanding on how different subsystems and architectures work, as well as the process of integration and validation.

3. Applications of Small Satellites Missions

35. A representative of the University of Erlangen-Nuremberg gave an overview of satellite-powered data analytics to empower the lives of farmers. While satellite data has been used to monitor the agricultural sector for the last 3 decades, the complex relationships between parameters governing crop growth and soil health had limited its scope to research. The representative proposed going beyond the traditional Geographic Information Systems techniques, and use machine learning and parallel computing techniques to resolve these complex relationships and get insights into crop phenology. He argued that there is a strong case for creating a disruptive technology solution for finance and governance.

36. A representative of the Mauritius Research Council introduced the MIRT-SAT1 proposal. He explained that CubeSats can be used in Mauritius as a solution to current socioeconomic issues. MIRT-SAT1 is seen as a short to medium-term solution as it will be the first Mauritian Infrared and Telecommunication Satellite to address various challenges. Additionally, it was mentioned that the KiboCUBE programme was a factor contributing to the development of the MIRT-SAT1 mission proposal.

37. A representative of Clyde Space LTD highlighted the international partnership programme between Africa and the United Kingdom for enhanced detection of fires using nanosatellite technology. The project includes a masters' programme that is used for knowledge transfer: the courses address some of the United Nations Sustainable Development Goals and illustrate the application of satellite applications. Earth Observation, Navigation and Communications, Data Science, Entrepreneurship & Space Systems are optional. The main aim is to encourage students towards creating new services and developing companies. It will be available from September 2019. A joint PhD Programme is also available.

38. A representative from Head Aerospace China presented the HEAD-1 Satellite, which provides in-orbit operational data for maritime surveillance. She indicated that the company is planning a constellation of 30 small satellites that will have Automatic Identification System receivers and Hyperspectral sensors. The applications for the constellation will include real-time maritime surveillance services.

39. The last presentation for the session focused on enabling the blue economy through spatial information systems, which was introduced by a representative of the Council for Scientific and Industrial research of South Africa. The Operation Phakisa project aims at improving the use of our oceans for socioeconomic development.

4. Small-satellite projects for engineering education

40. A representative of the Department of Science and Technology of South Africa introduced the objectives of the Pan African University, including their thematic principles and partners. The University is a continental network for academic, research and innovation institutions composed of five hubs located in different regions of the African continent. It seeks to develop institutions of excellence in science and technology, enhance the postgraduate education and promote the integration and cooperation in the continent through the mobility of talented and qualified applicants.

41. A representative of the Nanyang Technological University gave a general overview of the small satellite missions developed in Singapore at the Satellite Research Center (SaRC), including their past missions, future projects and their international collaboration programs. This Satellite Research Center has developed seven satellites. The most noted is the 1st Singapore built satellite XSAT, which was developed and launched in 2011. SaRC has established strategic collaboration programs with local and international organizations that provide potential training opportunities for undergraduate, graduate, middle and high school students.

42. A representative of the Cape Peninsula University of Technology in Cape Town gave a general description of the University's Satellite Programme, including their national and regional perspectives. This programme developed Africa's first CubeSat, launched in 2013, and is currently developing its second nanosatellite, which will be launched in 2018. They also have established local, regional and global cooperation programmes and propose the design and implementation of an indigenous constellation of nanosatellites.

43. A representative of the University of Auckland presented New Zealand's CubeSat Programme, including the results obtained and their future perspectives. Their CubeSat program is oriented to undergraduate students of all the faculties of the university, with multidisciplinary teams creating a potential synergy. Auckland Program for Space Systems will have a CubeSat ready for launch at the end of 2018, the first satellite built in New Zealand to go into space. Furthermore, this programme attempts to create opportunities for students, encourage leadership and become an incubator for start-ups.

44. A representative of All Nations University (ANU) in Ghana gave a comprehensive description of the most important projects developed in the Space Science Technology Laboratory (ANU-SSTL), including their CubeSat program and their future perspectives. ANU-SSTL has developed different educational programs. The most highlighted project is the GhanaSat-1 satellite, which is a 1U CubeSat successfully launched from the ISS in July of 2017. It is the first Ghanaian satellite launched into space. Their future goals are to develop the GhanaSat-2 satellite to monitor illegal mining activities and the water pollution that affects Ghana.

45. A representative of the Nihon University in Japan gave an overview of the training course with the HEPTA-Sat, including the main parts of the tool and the importance of training for space systems engineering. The Hepta-Sat kit allows students to understand the basic concepts of assembly, integration and testing. The hands-on training gives the opportunity to experiment, solve problems, design missions, and have feedback of specialists.

46. A representative of the University of Carthage in Tunisia provided the context of the development of the Tunisian SUPCOM spatial program, including the strategies and the challenges of the program. SUPCOM has established regional and international cooperation with space technology institutions and universities.

47. A representative of the Pakistan Space and Upper Atomsphere Research Commission introduced the Pakistan National Student Satellite Program for Space Engineering Education, including their objectives, the current development status of the student satellite project and the lessons learned. The Pakistan National Student Satellite Program seeks to establish a collaboration program between the Pakistan Space and Upper Atomsphere Research Commission and academia. The program started in 2012 with the hands-on training for students and among its achievements is the development of a functional micro satellite PNSS-1, where each university is in charge of a different module. The integration and test is the next step.

5. Regulatory and legal issues and long-term sustainability of outer space activities

48. The Chief of the Committee, Policy and Legal Affairs Section of the United Nations Office for Outer Space Affairs presented the international legal regime and governance aspects of outer space activities. During the presentation, an overview of the number of ratifications of the five United Nations space treaties was shared, with a focus on African countries and their participation in international governance of space. New agenda items on the Agenda of the Legal Subcommittee of United Nations Committee of Peaceful Uses in Outer Space were also highlighted.

49. A representative of the United Nations Office for Outer Space Affairs introduced the questionnaire on small satellites, following its adoption in the Legal Subcommittee in 2017. Building upon 6 questions, it comprises an overview of small satellite activities, licensing, responsibility and liability, launching state concept, registration and space debris. Additionally, frequently observed legal and regulatory issues related to small satellite activities were illustrated.

50. A representative of the African Regional Centre for Space Science and Technology Education in English Language, affiliated to the United Nations, discussed legal issues and responsibilities related to space technology development programs and the need for creating more national space policies and laws in African countries. He provided participants of the Symposium with a detailed overview of some of pressing legal and regulatory matters associated with space activities, such as radio frequency management, national legislation or authorization.

51. Small satellites related regulations in South Africa were discussed by the Chief Director of Space Affairs in the Department of Trade and Industry. Relevant South African space-related legislations, starting from South African Space Affairs Act of 1993 up to a current new draft bill, were described and analysed from the perspective of small satellite missions, in order to provide an overview of the legal and regulatory framework governing small satellite activities in South Africa and its currently proposed future amendments.

52. The Chair of the Working Group on the Long-term Sustainability of Outer Space Activities summarized the status quo of discussion at the Committee regarding the long-term sustainability agenda. Following the acceptance of an initial set of long-term sustainability guidelines in 2016, the progress achieved in 2017 is mainly the preparation of the preambular text. Several guidelines still remain under consideration as of December 2017, including one proposed guideline focusing directly at small satellite activities.

53. Radio frequency spectrum issues related to small satellites constituted the topic of the presentation made by a representative of the Department of Telecommunications and Postal Services of the Republic of South Africa. He addressed primarily the existing international regulatory framework for frequency spectrum management and gave a general overview of existing regulations within the International Telecommunication Union (ITU) regime applicable to small satellite missions. Emphasis was given to the need for actors to go through the national authorities, as the ITU only accepts applications from appointed state representatives.

54. A representative of ITU conducted a workshop on frequency registration for small-satellite missions explaining the regulatory procedure for submitting frequency

registration through ITU SpaceCap and stressed the importance to notify and record the use of frequency bands by small-satellite systems, in accordance with ITU Radio Regulations.

6. Other aspects of small satellites

55. A representative of the National Institute for Space Research discussed the growing concern about the accumulation of objects in orbit. He illustrated a new concept of de-orbiting techniques that use solar radiation pressure and atmospheric drag to force the decay of a body in orbit. The technology presented uses variable area, such as an inflatable balloon, and variable coefficient of reflectivity and can accelerate the decay time in different types of orbits.

56. A representative from Ghana Space Science and Technology Institute addressed the CubeSat development program in Ghana, devoted to monitor illegal gold mining activities using hyperspectral imagery. The project includes the design of a Ground Control Segment for CubeSats by converting an existing antenna. Additionally, the program is expected to aid in resolving other country's issues related to the environment and risk management, as well as developing technical capacities in space technology.

57. A representative of the Space Advisory Company, shared details of the nSight-1 ground station. He addressed hardware and software design from the project perspective. Using readily available off-the-shelf components, the experience may benefit other institutions that are interested in establishing their own satellite tracking capabilities

58. A representative from the DFH Satellite Co. Ltd discussed integration technology on micro-nano satellites for high performance remote sensing. He addressed the need of higher space and time resolution at a lower cost, and illustrated how innovation in optical design could be achieved through miniaturization and integration. The presenter concluded that a revolution in big data from satellites, accessible and at a low cost, can benefit emerging countries.

59. A representative of the Federal Institute of Education, Science and Technology introduced a system of data collection based on automated weather stations located all across Brazil and linked via satellite to ground stations. The system currently covers 10% of the country and is scheduled to scale up into a global community based on data sharing. The success of the project relied in the support of different institutions which resulted in a successful spin-off company. A Brazilian satellite data transmitter was developed to work with satellite constellations and the data can be accessed through a platform specifically developed for this purpose. He also took the opportunity to introduce the next United Nations/Brazil Symposium on Basic Space Technology and Nanosats to be held in Natal, Rio Grande do Norte, Brazil, in 2018.

7. International experiences and opportunities

60. A representative of the Japan Aerospace Exploration Agency reported on the KiboCUBE programme in cooperation with the Office for Outer Space Affairs, with a second CubeSat recently selected for deployment. The Japan Aerospace Exploration Agency has deployed over 200 satellites from the public and private sector using the Kibo module. The deployment is done in a down-backward fashion to avoid collision with ISS. He mentioned that capacity-building and providing support to educational institutions have been the main goals of the KiboCUBE programme. Under the cooperation with the Office, Japan Aerospace Exploration Agency is providing opportunities for entities in developing countries to deploy their satellites from the ISS. Additionally, he invited applications for the third round of the KiboCUBE programme, with a deadline of March 31, 2018.

61. A representative of UNISEC-Global explained its structure as an NGO having 15 local country chapters worldwide and being accepted as a permanent observer to the Committee of Peaceful Uses of Outer Space in 2017. The representative also

illustrated UNISEC Global's CanSat Leader Training Program, which has benefited 73 participants from 34 countries since its inception in October 2010. The speaker reported their goal to promote practical space projects in each country in the world by 2030 as part of the solutions to achieve the Sustainable Development Goals.

62. A representative of SCS Aerospace Group provided an overview of the SUNSAT programme from South Africa. SUNSAT was launched in 1999 and led to exchanges with NASA (battery supply), provided opportunities for visiting students from Europe and formed the basis for the development of the Imager of Kitsat 3 from South Korea. SUNSAT was followed by SumbandilaSat launched in collaboration with Russia. The presenter also explained that the African resource management constellation (ARMC) promotes capacity-building and international collaboration between African countries and expressed his view on the willingness to follow up with nSight-2 and -3 for international collaboration and capacity-building.

63. A representative from Kyutech reported that the BIRDS satellite project aims to provide students from developing countries training on satellite design and manufacturing towards creating a sustainable space programme within their countries. The BIRDS satellites are fostering a human network of trained students from developing non-space faring countries and has won the 2017 GEDC-Airbus Diversity Award for this mission.

8. Poster session

64. Poster presentations were made by 20 participants from Brazil, China, Costa Rica, Egypt, Ethiopia, Ghana, Japan, Kenya, Malawi, Namibia, the Netherlands, Nigeria, Peru, Slovakia, South Africa, Sudan, Uganda and the United Arab Emirates. Their posters covered topics of scientific research, political analysis, economical growth and applications related to small satellite activities.

C. Panel discussions

65. A panel discussion on the Young Africa Space Engineers in the global space arena was organized focusing on the available opportunities and main challenges.

66. In their discussions, the moderator and panellists from Egypt, Ghana, Kenya, Nigeria and South Africa discussed the opportunities and challenges for the Young Africa Space Engineers, covering the areas of industry, education, satellite mission cost as well as African collaborative satellite projects. The remarks and questions to the panellists engaged the young African experts and policy makers present at the symposium.

III. Observations and recommendations

67. With regard to capacity-building and international cooperation in space technology development:

(a) The participants of the Symposium noted that the African continent has a high potential for growth in the field of small satellites and can significantly benefit from an increase in the local development of satellites and use of satellite applications for social and economic development;

(b) The participants noted that space science and technology is an important tool for ensuring the sustainable use of natural resources, fostering entrepreneurship and the creation of high-technology industrial sectors. Furthermore, it makes a considerable contribution to the creation of enabling environments for addressing a wide range of pressing challenges, including the need to create jobs, reduce poverty, manage resources sustainably, and develop rural areas. A formal space sector will assist Africa to realise the vision of a peaceful, united, and prosperous continent;

(c) Recognizing these needs, the participants recommended that the Office for Outer Space Affairs create platforms for partnerships and capacity-building specifically dedicated to Africa, following hands-on models such as HEPTA-Sat, KiboCUBE, and UNISEC Africa;

(d) The participants welcomed the information that the United Nations/Japan Long-term Fellowship Programme for Post-graduate study on Nano-Satellite Technologies (PNST), in collaboration with the Kyushu Institute of Technology, was extended for the period 2018-2020. This was seen as an important opportunity for African academic institutions to further develop their capabilities in basic space technology and its applications;

(e) Further, participants acknowledged that African Research Councils and academia are collaborating on, for example, the reception and dissemination of fire monitoring data, and maritime domain applications;

(f) The participants recommended to increase efforts to raise awareness on the potential of small satellite programmes for capacity-building, education, provision of Earth observations data and telecommunication services, and technological development. The participants also recommended further consideration by African universities of a coordination mechanism for the development and operation of a constellation of CubeSats;

(g) In this regard, the participants acknowledged the necessity for increased opportunities for women in STEM education, in particular in space science and technology;

(h) The importance of stronger cooperation between governments, inter-governmental and non-governmental organizations, private sector, academia and research institutions, was noted. The development of a Pan African University network for space science and technology was encouraged. It is also recommended that a Young African Space Dialogue be established, to be recognised in/by decision making bodies such as the Pan African Parliament and the African Union Commission;

(i) To further enhance long-term space capabilities at the national and regional level, the educational programmes of the African Regional Centres on Space Science and Technology Education, affiliated to the United Nations, should be strengthened and fully utilized. The African Regional Centres were also encouraged to take a proactive role in the building up of an Alliance of all Regional Centres;

(j) The participants of the Symposium acknowledged the efforts of the Office for Outer Space Affairs to promote better access to space, in bridging the space divide, by enhancing the access to space-based data and information, future opportunities for ground, launch and in-orbit experiments and research as well as through design, manufacturing and operation of small satellites;

(k) It was noted, in this regard, the importance of facilitating access to orbit for developing countries and emerging space nations, through for example the KiboCUBE programme in cooperation with JAXA. The participants of the Symposium encouraged the Office and potential partners to extend these opportunities to larger CubeSats, or to more than one CubeSat per year;

(l) The participants of the Symposium considered that in an effort to strengthen African contribution to global governance of outer space activities, more African countries should become active members of the Committee on the Peaceful Uses of Outer Space. There should also be increased active participation of the African Group in the work of the Committee. In this regard, the participants of the Symposium noted the progress made in the preparations for UNISPACE+50 under its thematic priority areas, and the opportunity for supporting the objectives of the African Space Policy and Strategy;

(m) In this context, the participants of the Symposium noted with satisfaction that the General Assembly in its resolution 72/79 of 14 December 2017 on

"international cooperation in the peaceful uses of outer space" welcomed the adoption of the African Space policy by the Assembly of the African Union at its twenty-sixth ordinary session held in Addis Ababa on 30 and 31 January 2016, and noted that this achievement marks the first step towards the realization of an African outer space programme within the framework of the African Union Agenda 2063;

(n) It was suggested that the African Union should consider seeking permanent observer status with the Committee on the Peaceful Uses of Outer Space to foster African common interest in international cooperation in the peaceful uses of outer space;

(o) The participants of the Symposium welcomed the Legal Subcommittee questionnaire on the application of international law to small-satellite activities, covering the licensing and authorization, responsibility and liability, launching State and liability, registration and space debris mitigation, and recognized its importance in raising awareness among States and the potential for sharing good practice related to small satellite activities. Responses to the questionnaire were highly encouraged;

(p) Participants encouraged African countries to develop their own space policies and strategies. This policy framework will guide and inform the ratification of United Nations treaties on outer space, in particular promoting the universality of the Outer Space Treaty;

(q) The participants of the Symposium noted with appreciation the explanation on the regulatory procedure for submitting frequency registration through the International Telecommunication Union (ITU) SpaceCap tool and recognized the importance to notify and record the use of frequency bands by small-satellite systems, in accordance with ITU Radio Regulations. The participants noted that the Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites, published by the Office for Outer Space Affairs and ITU, will serve as a useful guideline for governments and small-satellite operators;

(r) The participants noted the importance of facilitating access to orbit for developing countries and emerging space nations. Small satellites with short duration missions are becoming the means for such countries to become involved in space activities. A simplified regulatory regime for the co-ordination, notification and recording procedures for frequency assignments pertaining to small satellite networks with short duration missions is required, taking into account the short development cycle, the short lifetimes and the typical missions of such satellites;

(s) The participants of the Symposium suggested having in future symposia a dedicated session focusing on space debris mitigation and end of life disposal, in observance of the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space;

(t) The participants noted that the guidelines for the longer-term sustainability of outer space activities being developed by the Committee on the Peaceful Uses of Outer Space would provide helpful guidance for governmental and non-governmental entities involved in the development and operation of small satellites. The participants further noted that the implementation of these voluntary guidelines would strengthen governance and enhance the safety, security and sustainability of outer space activities;

(u) The participants of the Symposium and of the pilot back-to-back HEPTA-Sat workshop expressed their appreciation for hands-on activities connected with the present Symposium. A hands-on workshop for a limited number of participants should, in the future, become an integral part of the Symposia, which could cover educational satellite kits, flatsats, software platforms, data analysis or others;

(v) The participants of the Symposium recommended that the Office of Outer Space Affairs should actively be involved in and keep abreast of the developments in the small satellite community, by participating and when possible sponsoring

cooperation projects and activities, and by attending relevant events, such as the Annual Small Satellite Conference or the Annual CubeSat Developers Workshop;

(w) The participants of the Symposium expressed their appreciation to the organizers of the Symposium for the multi-disciplinary and cross-sectorial nature of the Symposium programme, which addressed the discipline of small satellites in a holistic manner; and

(x) The participants of the Symposium recognized the significance of the Basic Space Technology Initiative of the Office for Outer Space Affairs and recommended that the series of Symposia on BSTI be continued, covering the regions of the United Nations Economic and Social Commissions. In that regard, the participants welcomed and endorsed the proposal of Brazil to host the next Symposium in 2018, with a focus on Latin America and the Caribbean.

IV. Conclusions

68. The next Symposium on Basic Space Technology will focus on capacity-building in space technology development for Latin America and the Caribbean. For the period 2019-2020, representatives of institutions of the following countries have expressed an interest in hosting a future regional workshop on basic space technology development: Lebanon, Pakistan, the Russian Federation and the United States of America.