United Nations A/AC.105/1032

General Assembly

Distr.: General
21 November 2012

Original: English

Committee on the Peaceful Uses of Outer Space

Report on the United Nations/Japan Nanosatellite Symposium: "Paradigm shift — changing architecture, technologies and players"

(Nagoya, Japan, 10-13 October 2012)

I. Introduction

1. The United Nations/Japan Nanosatellite Symposium on the theme "Paradigm shift — changing architecture, technologies and players" was the first in a series of international symposiums 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. It was the continuation of a series of three United Nations/Austria/European Space Agency (ESA) symposiums on small satellite programmes held in Graz, Austria, from 2009 to 2011. The symposiums are 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 Symposium was organized by the Office for Outer Space Affairs of the Secretariat and by the University of Tokyo, on behalf of the Government of Japan. Its organization was supported by the University Space Engineering Consortium (UNISEC); the Cabinet Office, Ministry of Internal Affairs and Communications, Ministry of Foreign Affairs, Ministry of Education, Culture, Sports, Science and Technology, and Ministry of Economy, Trade and Industry of the Government of Japan; the Aichi Prefectural Government; the city of Nagoya; and the Nagoya Convention and Visitors Bureau. The Symposium also benefited from contributions made by the International Academy of Astronautics (IAA), Mitsubishi Heavy Industries Ltd., Suntory Holdings Limited and the Next Generation Space System Technology Research Association.

3. The present report describes the background, objectives and programme of the Symposium, summarizes the presentations made during the thematic sessions, special lectures and panel discussions, and documents the recommendations and observations made by the participants. The report is prepared pursuant to General Assembly resolution 66/71. It should be read in conjunction with the reports on the three United Nations/Austria/ESA symposiums on small satellite programmes held from 2009 to 2011 (A/AC.105/966, A/AC.105/983 and A/AC.105/1005).

A. Background and objectives

4. 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.

5. Increasingly capable nanosatellites 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.

6. 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 under the United Nations Programme on Space Applications, 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. The Initiative supports capacity-building in basic space technology, with an initial focus on the development of nanosatellites 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[1] and the Johannesburg Declaration on Sustainable Development.[2]

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[1] *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.

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

7. The Basic Space Technology Initiative began with the organization of three United Nations/Austria/ESA Symposiums on Small Satellite Programmes held in 2009, 2010 and 2011. The first Symposium addressed general issues related to capacity-building in space technology development and small-satellite development activities. For the second Symposium, 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”. The objectives of the Symposium that is the subject of the present report were:

(a) To discuss the latest technical developments, programme management and systems engineering approaches;

(b) To address the role of nanosatellites for space education and to launch the development of a United Nations education curriculum on space engineering;

(c) To provide information about the status of recent discussions on legal and regulatory aspects applicable to nanosatellite activities;

(d) To provide a forum for discussion and exchange so as to encourage cooperation among the Symposium participants.

B. Attendance

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

9. The Symposium was attended by 290 space professionals involved in nanosatellite and small-satellite missions from governmental institutions, universities and other academic entities and the private sector from the following 43 countries: Angola, Armenia, Australia, Austria, Brazil, Bulgaria, Canada, Chile, China, Czech Republic, Ecuador, Egypt, Finland, France, Germany, Ghana, Greece, India, Indonesia, Italy, Japan, Kenya, Lithuania, Mexico, Mongolia, Netherlands, Nigeria, Oman, Pakistan, Philippines, Republic of Korea, Singapore, South Africa, Sudan, Sweden, Switzerland, Thailand, Tunisia, Turkey, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay and Viet Nam.

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

11. Funds allocated by the United Nations and the sponsors were used to defray the costs of the air travel, daily subsistence allowance and accommodation of 33 participants. To demonstrate their qualifications, all participants applying for full or partial sponsorship were required to submit an abstract in accordance with the requirements for the call for papers of the Symposium. The sponsors also provided funds for local organization, facilities and the transportation of participants.

C. Programme

12. The programme of the Symposium was developed by the Office for Outer Space Affairs and the University of Tokyo 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.

13. The programme consisted of an opening session, the final presentations of the second Mission Idea Contest, five technical sessions, three panel discussions, two special lectures, a poster session, a session dedicated to launching the development of an education curriculum on space engineering, and discussions on observations and recommendations, followed by closing remarks by the co-organizers.

14. During the poster session a total of 61 posters covering a wide range of topics related to the development of nanosatellites were presented.

15. The chairs and co-chairs assigned to each of the five technical sessions and three panel discussions provided their comments and notes as input for the preparation of the present report. The detailed programme, background information and full documentation of the presentations made at the Symposium have been made available on a dedicated Symposium website (www.nanosat.jp).

16. The Symposium participants were also invited to attend the Japan International Aerospace Exhibition 2012, which was held in Nagoya from 9 to 14 October 2012 (www.japanaerospace.jp).

II. Summary of Symposium programme

A. Opening session

17. At the opening session welcoming remarks were made by representatives of the University of Tokyo and the Ministry of Education, Culture, Sports, Science and Technology of Japan, as well as by the Chair of the Committee on the Peaceful Uses of Outer Space. 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.

B. Mission Idea Contest

18. The Mission Idea Contest is a series of competitions organized by UNISEC with sponsorship from the University of Tokyo. Its objectives are to encourage innovative exploitation of microsatellites and nanosatellites to provide useful capabilities, services or data and to contribute to capacity-building in space science, applications and engineering. The first Mission Idea Contest, with participants from 24 countries, was concluded in March 2011. The second Mission Idea Contest was launched with an international call for papers in August 2011. Mission ideas for

nanosatellites weighing less than 50 kg were considered in the two categories "Mission idea and satellite design" and "Mission idea and business model".

19. The contest was held in collaboration with the Office for Outer Space Affairs and IAA and was supported by the Gesellschaft zur Förderung des akademischen Nachwuchses, Analytical Graphics Inc., Princeton Satellite Systems, Teaching Science and Technology Inc., an international review team and individual regional coordinators in 33 countries. Regional seminars to promote the contest were held from November 2011 to April 2012 in the following countries: Belgium, Brazil, Bulgaria, Germany, Ghana, Guatemala, Japan, Kenya, Lithuania, Mexico, Namibia, Nigeria, Peru, Saudi Arabia, Singapore, Spain, Tunisia, Turkey and Venezuela (Bolivarian Republic of). A total of 72 mission idea submissions from 31 countries were received.

20. During the session devoted to the contest, the finalists and semi-finalists presented their mission ideas. After evaluating each presentation on the basis of established criteria, the international review team selected the winners in each category. Further details about the mission ideas and the results of the contest are available from the Mission Idea Contest website (www.spacemic.net). A third Mission Idea Contest is expected to be held in the near future.

C. Technical sessions

21. Technical sessions were held on the following topics: (a) satellite architecture and technologies, (b) innovation in the satellite development process, (c) utilization and applications of micro- and nanosatellites, (d) standardization and regulatory issues and (e) strategies for capacity-building. The presentations made in the sessions were selected on the basis of a review of all abstracts submitted in response to the Symposium's call for papers. Highlights of and major discussion points raised during the sessions are summarized in the paragraphs below.

1. Satellite architecture and technologies

22. The session on satellite architecture and technologies considered research activities related to small-satellite technologies and mission plans. Most of the more than 30 papers submitted focused on architecture and software development technology, both of which are considered of great importance for reducing mission development costs while also maintaining a high level of mission reliability.

23. Open-source on-board flight-control software components and plug-and-play architectures consisting of separate modules connected through standard interfaces are increasingly being researched and implemented by the small-satellite community. Relevant concepts were presented by Tokyo University of Science and the OpenCube Initiative of Germany.

24. A software verification strategy (model-in-the-loop, software-in-the-loop and hardware-in-the-loop simulation) for the attitude-control software of small satellites was presented by Wakayama University of Japan.

25. A high-speed adaptive optics technology called High-Speed, Multispectral, Adaptive-resolution Stereographic CubeSat Imaging Constellation, which will be implemented on a forthcoming three-unit CubeSat mission, was presented by

Stanford University. In ground-based tests, image angular resolution improvements of an order of magnitude beyond the diffraction limits of the optics used were achieved.

26. The Space Science and Technology Institute of Lithuania presented a unique attitude-control method using piezo gears for reaction control in a one-unit CubeSat. A remaining technical challenge is its high power requirements. The development of a high-precision attitude determination and control system for the 35 kg astrometry satellite Nano-JASMINE was reported by the University of Tokyo of Japan.

27. The status of the QB50 mission was presented by Innovative Solutions in Space of the Netherlands.

2. Innovation in the satellite development process

28. Presentations in the session on innovation in the satellite development process focused on process design and analysis and on the space environment and ground testing.

29. A software model for estimating nanosatellite project costs, schedules and reliability based on demand-side management techniques and Monte Carlo simulation was presented by Kyushu Institute of Technology of Japan.

30. The University of Strathclyde, United Kingdom, presented an integrated system-operations-based approach for the optimal design of small-scale satellites.

31. The presentation by Manipal Institute of Technology of India on structural reliability of nanosatellites looked at the extent to which standards established for larger satellite projects might be applicable to small satellite missions.

32. The California Polytechnic State University of the United States stressed the role of the CubeSat standard in making nanosatellite development activities more accessible and affordable, as an example of constraint-driven innovation.

33. The following common themes were identified in the presentations made in the session:

(a) The use of appropriate cost and reliability analysis and estimation techniques is useful for the practical development of nanosatellites;

(b) Existing standards appropriately tailored to the needs of nanosatellite development may contribute to greater mission reliability;

(c) Enforcing adherence to existing standards, such as the CubeSat standard, has often forced mission designers to come up with creative solutions resulting in mission capabilities that previously would not have been considered possible, given volume and mass constraints;

(d) The growing capabilities and reliability of mass-produced consumer electronics are allowing mission designers to create increasingly capable nanosatellite missions, including operational applications.

3. Utilization and applications of microsatellites and nanosatellites

34. The presentation of the Babu Banarasi Das National Institute of Technology and Management of India on smart and cost-effective applications of micro- and

nanosatellites in developing countries summarized the wide range of benefits that could be derived from small-satellite programmes, in particular for the needs of developing countries.

35. Focusing on a specific application, Anyang Normal University of China presented research activities and applications of rapid fusion of images derived from Chinese microsatellite missions.

36. The Universidad Nacional Autónoma of Mexico made a presentation on the status of the HUMSAT/DEMO mission, the first satellite of the HUMSAT constellation, which will be launched in early 2013.

37. Tohoku University of Japan made a presentation on the development status of the Rapid International Scientific Experiment Satellite (RISESat) (Hodoyoshi-2) microsatellite.

4. Standardization and regulatory issues

38. With the growing number of nanosatellite missions in the planning, implementation or operations phase, considerations of standardizing satellite platforms and components, mission engineering approaches, and development and testing procedures and practices, as well as compliance with relevant regulatory issues, are becoming increasingly important.

39. The representative of ITU discussed the radio regulatory framework for small-satellite design and operation. He stressed that the framework encompasses rights as well as obligations. Frequency block allocations (article 5 of the ITU Radio Regulations) have been made for defined radio services. Their use is recorded in the Master International Frequency Register. The amateur satellite service is defined in article 25 of the Radio Regulations. Symposium participants were also made aware of resolution 757 (COM6/10) of the World Radio Communication Conference 2012 on regulatory aspects for pico- and nanosatellites. ITU made available to participants an updated workshop CD-ROM with helpful information and supporting software to help with data capture and validation of the notification filing.

40. The status of the micro- and nanosatellite environmental tests standardization project was presented by Kyushu Institute of Technology. Historically, nanosatellites have a relatively high failure rate of 52 per cent. The Nanosatellite Environment Test Standardization (NETS) project has been launched to help improve the reliability of nanosatellites while keeping their advantages, low cost and fast delivery. For this, a new way of thinking about environmental tests is necessary. Further details about the NETS project are available on the project website (http://cent.ele.kyutech.ac.jp/nets_web/nets_web.html).

41. Network architectures and interfaces suitable for international cooperation in the field of ground-station networks and their operation for small-satellite missions was the topic of the presentation by the University of Tokyo on the study of micro- and nanosatellite operation models for building operational networks. Reliable and stable ground-station networks are especially important for operational and commercial small-satellite missions.

42. The presentation by the Center for Space Standards and Innovation of the United States addressed the issue of space debris mitigation in small-satellite

missions. It was argued that operationally safe orbit regimes for small satellites that satisfy most mission needs were accessible and available and that small satellites and their operations should not be distinguished from large satellites for space debris mitigation purposes.

5. Strategies for capacity-building

43. The final technical session addressed activities related to capacity-building in space engineering and small-satellite projects and programmes.

44. Improving and enhancing the space-industry workforce of Thailand was the topic of the presentation by the representative of the Geo-Informatics and Space Technology Development Agency of Thailand. Thailand is planning to inaugurate the Space Krenovation Park, the aim of which is to contribute to space industry capacity-building. The Park is expected to incorporate a satellite operation centre, a space and Geographic Information System training centre, a space museum, assembly, integration and test facilities and a business incubator.

45. Competitions have been used in several countries to involve the younger generation in space-related activities. The Canadian Satellite Design Challenge Management Society presented lessons learned from a Canadian university's nanosatellite design competition.

46. UNISEC reported on the outcome of the third CanSat Leader Training Program, which had been concluded recently. More than 30 participants from 21 countries have participated since the first such Program, in 2011. The fourth CanSat Leader Training Program will be held in autumn 2013 (see www.cltp.info).

47. Representatives of Cairo University and Istanbul Technical University made presentations on research and application-based space education in Egypt and Turkey. The activities have benefited from international programmes, such as the Mission Idea Contest and the CanSat Leader Training Program, as well as from educational activities of the American Institute of Aeronautics and Astronautics. It was concluded that practical project work and design studies were important elements of space education.

48. The importance of building space science and technology capacity to drive national innovation and economic growth was stressed in the presentation of the representative of the Indonesian National Institute of Aeronautics and Space (LAPAN). LAPAN is involved in international cooperation efforts with spacefaring countries to acquire the capability for indigenous development of space technology.

D. Panel discussions

49. Panel discussions were held on the following topics: (a) how to ensure high mission reliability without increasing cost and development time, (b) international space education using nanosatellites and (c) small satellites and space debris.

1. How to ensure high mission reliability without increasing cost and development time

50. The panellists talked about their experiences with developing satellite mission architectures. They agreed that nanosatellites opened up new application possibilities that were driven by the end user and limited only by physics. New technologies made it possible to constantly improve system performance.

51. Good development practices included designing with appropriate margins to help ensure reliability and using flight-proven components to reduce the risk of component failure in critical subsystems. With new technologies, random component failures had been vastly reduced. However, rapid changes in technologies also meant that it was difficult to build statistical reliability models; thus, risk analysis was becoming difficult. Failure tree analysis should, however, be maintained to prepare for mitigation measures. Other mitigation measures included duplication of components or capabilities, such as within constellations. Ideally, different hardware implementations should be used to duplicate functions to take account of systematic hardware failures.

52. Collaboration with universities for research and development activities was considered fruitful. Limiting subcontractors and keeping more than 75 per cent of the implementation of a mission within the team can considerably simplify programme mission complexity. It was recommended to work with small, tightly knit and experienced teams.

53. Optimal communication and constant interaction among team members was considered essential. Decisions should be taken at the lowest possible organizational levels and shared efficiently. For this an appropriate document-tracking and management system needed to be implemented, while making every effort to optimize overheads and management structures as much as possible.

54. It was noted that the pressure to deliver reliable services was growing, especially for commercial nanosatellite missions. It was therefore necessary to apply commercial rigour in the design of a mission; student labour might not be suitable for that purpose.

2. International space education using nanosatellites

55. The panellists considered the role of student satellites as hands-on education tools and for systems engineering training. Small satellites can be developed, built and flown within the duration of a student programme, which typically lasts two to three years.

56. The representative of UNISEC introduced UNISEC International, a proposal to apply the experiences and lessons learned by UNISEC in Japan to other countries and organizations interested in space engineering activities at the university level.

57. Panellists noted that several universities that had developed components as part of their small-satellite activities were now distributing them commercially.

58. It was suggested that governments could establish and support long-term programmes to provide a high level of stability to educational capacity-building activities. In situations where such support was not being provided by the

government, it was found to be helpful for educational programmes to be aligned with existing government objectives.

3. Small satellites and space debris

59. The panel discussions began with a thorough review of space debris-related activities in the framework of the Committee on the Peaceful Uses of Outer Space, presented by the Chair of the Committee.

60. It was noted that the space debris risk was real and that several collisions and a large number of close encounters had been well documented. It was also noted that the real risk stemmed not from the still limited number of satellites in orbit but from the fragmentation of satellites, which was most often caused by pressurized or energized satellite components. A key issue to mitigate space debris was therefore to passivize satellites when they reached the end of their lifetimes.

61. Statistical analysis showed that the current number of small satellites launched annually did not significantly increase the risk of in-orbit collisions; however, conservative mitigation measures, as recommended by the Inter-Agency Space Debris Coordination Committee,[3] and the voluntary Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space should be adhered to.[4]

62. Without specific deorbiting mechanisms, it was safe to deorbit a small satellite from an orbital altitude of lower than 400 km within 25 years following the end of its lifetime. For an orbital altitude between 400 km and 800 km, various deorbiting mechanisms were under development. For missions going to orbit altitudes higher than 800 km, it would be difficult to deorbit the satellite within a reasonable time frame.

63. While all space debris mitigation guidelines were currently of a voluntary nature, it was noted that several countries required satellite builders to demonstrate adherence to space debris mitigation guidelines in order to obtain an export licence for the transport of the satellite to a launching site in another country.

E. Special lectures

1. Pushing the capabilities of small satellites

64. Recent advances in manufacturing processes, coupled with dramatically reduced component failure rates of miniaturized commercial off-the-shelf parts, which have become the new standard for high reliability, and their low unit cost thanks to high production volume, was changing the economics of space. Statistical analysis demonstrated that Moore’s Law was also applicable to the growth factor in the capabilities of small satellites, such as in the ground resolution of small Earth-observation satellites or in their data volume transmission rate. The technical developments would soon be constrained only by the limits of physics.

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

[4] *Official Records of the General Assembly, Sixty-second Session, Supplement No. 20* (A/62/20), annex.

65. The presentation recalled the success story of Surrey Space Centre and its commercial arm, Surrey Satellite Technology Ltd. (SSTL), which had 30 years of experience with the development of small-satellite missions, involving 25 launches on 9 different launch vehicles. During that time the capabilities of the satellite missions developed by the Surrey Space Centre and SSTL had vastly increased. Starting from simple store-and-forward microsatellites in the early 1980s, to various low Earth orbit (LEO) and medium Earth orbit application missions, SSTL was now trying to apply its small-satellite experience to geostationary Earth orbit satellites, to LEO synthetic aperture radar satellites and to lunar and Mars science and exploration missions.

66. The limited availability of launch opportunities and their cost continued to seriously constrain the development and exploitation of small satellites, and new launcher solutions were at least a decade away.

2. The art and science of space systems engineering

67. A special lecture dealt with the art and science of space systems engineering, which encompassed technical leadership (the art) and systems management (the science). Systems engineers acted as the interface between architects, designers, developers and operators. The role of the systems engineer was compared with that of a musical maestro who knows what the music should sound like and who has the skills to lead a team in achieving the desired sound. The systems engineer was also ultimately responsible for delivering a successful project.

F. Space education curriculum session

68. Since 1988 the United Nations, through its Programme on Space Applications, has supported the establishment of regional centres for space science and technology education, affiliated to the United Nations, in Africa, Asia and the Pacific, Latin America and the Caribbean, and Western Asia (see www.unoosa.org/oosa/en/SAP/centres/index.html). In setting up the centres it was noted that education between nations and even between institutions within the same country varied significantly, which resulted in considerable differences in space science and technology education curricula in terms of content and modes of presentation.[5, 6]

69. To ensure an acceptable common standard of teaching, education curricula have been developed in various space application disciplines (see www.unoosa.org/oosa/en/SAP/centres/education-curriculum.html). Additional education curricula are currently under development. The education curricula are also used by academic institutions other than the regional centres.

70. Under the Basic Space Technology Initiative, the Office for Outer Space Affairs intends to develop an education curriculum related to space technology engineering. The curriculum will include a model syllabus and suggested teaching

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[5] Hans J. Haubold, "Education curricula of the UN-affiliated regional centres for space science and technology education", *Space Policy*, vol. 19, No. 1 (2003), pp. 67-69.

[6] Hans J. Haubold, "Education curricula in space science and technology: the approach of the UN-affiliated regional centres", *Space Policy*, vol. 19, No. 3 (2003), pp. 221-223.

materials for a postgraduate-level course, covering such disciplines as systems engineering, mission design, project management, satellite bus and subsystems, as well as relevant legal issues.

71. An international panel of experts composed of space-engineering educators will help to develop the curriculum, which should be completed by February 2015. A summary of the discussions about the curriculum-development process, as well as further information, is available from www.unoosa.org/oosa/en/SAP/bsti/index.html.

III. Observations and recommendations

72. Participants in the United Nations/Japan Nanosatellite Symposium:

(a) Stressed the importance of small-satellite missions and their need for access to bandwidth in the frequency spectrum;

(b) Took note of the need for timely notification to ITU about planned satellite projects to ensure that harmful interference was avoided;

(c) Took note of resolution 757 (COM6/10) of the World Radiocommunication Conference 2012 on regulatory aspects for nano- and picosatellites;

(d) Recommended that the international small- and nanosatellite community establish a mechanism through the creation of a working group to coordinate their input to the studies to be prepared in response to resolution 757 (WRC-12) through their respective administrations or by joining ITU as an academia member.

73. Participants also:

(a) Took note of the discussions in the Committee on the Peaceful Uses of Outer Space under the agenda item on the long-term sustainability of outer space activities and of the establishment of a Working Group under that agenda item;

(b) Took note of the establishment of expert groups to address particular aspects of the long-term sustainability of outer space activities under that Working Group;

(c) Recommended that those involved in small-satellite activities should establish contact with their Member States' representatives in the Working Group and the expert groups to ensure that the interests and inputs of the small-satellite community were being adequately taken into account.

74. Participants further recommended that a working group should be established with the aim of considering existing regulatory and legal obligations for small-satellite missions (micro-, nano- and picosatellites with a dry mass of less than 50 kg), such as the registration of space objects, frequency coordination and space debris mitigation guidelines, and facilitate their dissemination and contribute through other appropriate measures to ensure that members of the small-satellite community complied with those obligations.

75. Finally, the participants:

(a) Confirmed the updated work programme of the Basic Space Technology Initiative, as contained in A/AC.105/1005, paras. 59-60;

(b) Endorsed the approach and schedule of work for the development of the education curriculum on space technology engineering.

IV. Conclusions

76. The United Nations/Japan Nanosatellite Symposium, the first in a series of symposiums under the Basic Space Technology Initiative 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, will be followed by a Symposium organized in cooperation with the Government of the United Arab Emirates, to be held in 2013, and a Symposium organized in cooperation with the Government of Mexico, to be held in 2014. For the period 2015-2016, representatives of institutions of the following countries have expressed an interest in hosting a regional workshop on basic space technology development: Canada, Egypt, India, South Africa, Thailand, Tunisia and Venezuela (Bolivarian Republic of).