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Basic Space Technology Initiative (BSTI)

Activities in 2009-2011 and plans for 2012 and beyond

I. Introduction

1. 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 1968.¹ The Programme is implemented by the United Nations Office for Outer Space Affairs (OOSA) 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.^{2,3}
2. The initial focus of the Programme was on the applications of space technology, such as in satellite communications, Earth observations and positioning and navigation services. In the 1990s space science-related activities were added to the Programme through the launch of the Basic Space Science Initiative (BSSI).⁴ The International Space Weather Initiative (ISWI) is presently being implemented under the BSSI.
3. Beginning with the mid 1980s the international space community took note of the growing role of small satellites¹ with masses smaller than 100-250 kg. Such satellites can be developed by small teams in university-like environments and offer opportunities for countries and organizations with limited space budgets to engage in space technology development activities. In response to the increasing interest in this field the Programme on Space Applications in 1995 and 1996 organized several events related to small satellites.^{5,6,7} A background paper on small satellite missions was prepared for the Third United Nations Conference on the Exploration and

¹ This paper uses the general term “small satellites” to designate all categories of satellite platforms with masses ranging from sub 1 kg to approx. 250 kg (including femto-, pico-, nano-, micro-, mini- satellites).



Peaceful Uses of Outer Space (UNISPACE III), which was held in Vienna in July 1999.⁸ Within the framework of the Technical Forum of UNISPACE III the United Nations, in cooperation with the International Academy of Astronautics (IAA), held a workshop on small satellites at the service of developing countries.^{9,10} As a result of this workshop, OOSA and IAA, since 2000, are organizing workshop sessions on the theme small satellites at the service of developing countries as part of the annual International Astronautical Congress.

4. The operationalization of space applications has accelerated in the years following UNISPACE III and barriers preventing countries from accessing and using space applications have gradually been lowered or removed. Countries and organizations that have previously only been users of space applications or that in the past did not have the resources required to engage in space technology development activities are now increasingly interested in building capacity in space technology development. The definition and successful promulgation of standards for nano-, micro- and mini satellite platforms with masses as small as 1 kg, such as the CubeSat standard, and the use of affordable miniaturized consumer-electronic components that are increasingly replacing more costly and sometimes less capable space-qualified components, have also contributed to this trend. Together these trends have resulted in a reduction of the entry cost for the development of space technology. Consequently satellite development activities are now also in the realm of countries and organizations that had been excluded from such activities in the past due to their limited budgets for space activities.

5. In response to this growing interest in small-satellite platforms and in-line with the mandate of the Programme on Space Applications, OOSA has launched the Basic Space Technology Initiative (BSTI) in 2009.^{11,12,13} BSTI, BSSI and the recently launched Human Space Technology Initiative (HSTI) represent new cornerstones of the Programme on Space Applications.

II. Basic Space Technology Initiative

6. BSTI encompasses a range of activities in support of capacity building in space technology development. Its overall mission is to enhance access to and use of space applications in support of policy- and decision making for sustainable development through building capacity in basic space technology development. The Initiative, implemented under the framework of the United Nations Programme on Space Applications, has the following underlying objectives:

(a) Respond to the interest in many countries to establish indigenous capacities in basic space technology development;

(b) Address the growing role of small satellites for education, basic space science and for operational applications;

(c) Assist countries with their efforts to ensure compliance with the relevant legal and regulatory frameworks and promote the use of appropriate standards where applicable; and

(d) Promote international cooperation and information exchange in capacity building in basic space technology.

7. A particular focus of the capacity building activities of BSTI is related to the development and operation of small satellites. It has been found that the benefits that can potentially be derived from the implementation of programmes dedicated to the development of small satellites can go far beyond the benefits of the actual applications enabled by those satellites:^{14,15}

(a) The conceptual design, detailed development, manufacturing, launch and operation of a small satellite can be conducted within a time frame that is much shorter compared to the common programme or project duration involving larger-sized satellite platforms. Small satellites have gone from conceptual design to launch in time-periods as short as six months. Such projects are extremely flexible and allow graduate students to follow a satellite project from its conceptualization through to its operational phase;

(b) Small satellite programmes open the door for developing countries and countries with limited space budgets to participate in space activities, enabling them to establish basic capacities for the development of space technology tailored to their specific needs and objectives. The necessary investment required for the infrastructure and for the development of the actual hardware is relatively modest and — as has been demonstrated in many cases — affordable for organizational units such as university institutes;

(c) System engineers, mission designers, industrial engineers and programme and project management specialists can be trained and educated in methods of space mission design. The skills of these experts are easily transferable and required by many other industries, thus benefiting industrial sectors other than the aerospace sector;

(d) Technical capabilities can be acquired in the areas of miniaturization, microelectronics and micro-manufacturing, with potential spin-offs for other industrial sectors such as the medical, consumer electronics, robotics and entertainment sectors;

(e) The services and technologies developed for small satellite programmes create opportunities for the establishment of commercial businesses. There are several examples of space technology companies that have been set up as a result of the experience gained in small satellite programmes, including in developing countries. Small satellites are becoming tools for commerce, as their capabilities have increased and their cost has been reduced, yielding a return on investment. This is significant in so far as it may motivate countries to subsidize the development of space technology and encourage the establishment of companies that could support a local high technology industry;

(f) Small satellite programmes create new opportunities for international space cooperation. For cooperation to be equal and fully beneficial to all parties, each partner has to offer capabilities and knowledge of interest to the others. Owing to the comparatively quick technology innovation cycles of small satellite programmes, such programmes offer a relatively level playing field for both new entrants and established players. While it could take years or even decades to establish the capabilities required for developing larger satellites, new players can catch up relatively quickly with the developments in the field of small satellites. The experiences gained and lessons learned in the development of small satellites are in many cases also directly applicable to the development of larger satellites.

This is also the case with infrastructures required for the development of small satellites, which in can often be adapted or upgraded for the purpose of developing larger satellites;

(g) Small satellite programmes provide a reference frame to generate short-, mid- and long-term plans and perspectives for space technology development and serve as a stepping stone in enhancing a country's space capacity. They are also ideally suited to be a starting point for bringing together a country's academic, administrative and industrial sectors and for making use of their synergies in defining and implementing the initial phases of a space programme and a national space policy;

(h) Space technology development activities demonstrate the benefits of space technology and its applications, focus the attention of government and industry and serve to rally and encourage the people uniting behind a programme and project;

(i) Benefits can be derived from the actual operational use of small satellites, in many application fields, as well as in space science and research and technology development.

III. BSTI Work Programme

8. The BSTI Work Programme has been developed in consultation with space technology development experts from around the world. It is based on five activity categories: I. Basic activities, II. International space technology conferences, III. Space technology education curriculum, IV. Establishment of long-term fellowship programmes, and V. Basic Space Technology Initiative projects. These work programme lines provide sufficient flexibility to adapt and modify the programme if the need arises:

I. Basic activities

The basic activities encompass the following:

(a) Organize a series of three annual symposiums on basic space technology in 2009-2011 to launch BSTI and to bring together small satellite experts from around the world to define and refine the objectives of the Initiative;

(b) Support small satellite developers by providing answers to questions related to legal and regulatory aspects of space technology development activities, such as the registration of satellites with the United Nations, the implementation of the voluntary space debris mitigation guidelines of the Committee on the Peaceful Uses of Outer Space and — in cooperation with the International Telecommunication Union (ITU) — assuring compliance with the established procedures required for the use of radio-frequency spectrum and satellite orbits;

(c) Promote the use of open standards, such as for ground stations, satellite platforms and communication protocols, as well as open-source and non-proprietary development methods and software tools for design, development, manufacturing and simulations;

(d) Work with launch providers — in cooperation with the International Astronautical Federation (IAF) — to encourage them providing preferential conditions for launch opportunities for small satellite projects that promote international cooperation or pursue humanitarian goals;

(e) Disseminate information on BSTI through a dedicated website (<http://www.unoosa.org/oosa/en/SAP/bsti/index.html>) and mailing list. Parties interested in joining the mailing list are invited to contact the Office for Outer Space Affairs.

II. International space technology conferences

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

III. Space technology education curriculum

Develop an education curriculum for aerospace engineering by convening expert meetings of space technology educators during the international space technology conferences. The Office for Outer Space Affairs, in cooperation with the Regional Centres for Space Science and Technology Education, affiliated to the United Nations, has developed a range of applications-oriented education curriculums on topics such as meteorology, communications, remote sensing, space science and space law for use in the Centres and in educational institutions worldwide.¹⁶ The development of the education curriculum for aerospace engineering will follow the same model.

IV. Establishment of long-term fellowship programmes

Establish, in cooperation with academic institutions, long-term fellowship programmes in aerospace engineering and small satellite development at the graduate and postgraduate levels.

V. Basic Space Technology Initiative projects

Offer BSTI as a framework to support the implementation of regional and international projects related to capacity building in space technology development.

IV. Activities in 2009-2011 and plans for 2012 and beyond

9. BSTI activities are implemented by staff in the Space Applications Section of the Office for Outer Space Affairs (85% time of one P-staff and 20-25% time of one G-staff). Basic funding is made available from the Trust Fund of the Programme on Space Applications. In 2009-2010 these resources were complemented by contributions from various co-sponsors at a ratio of three to one. Travel and subsistence support to OOSA staff implementing BSTI-related activities were provided by Lithuania (Lithuanian Space Association), Japan (Tokyo University),

Mexico (Government of Mexico), Spain (Vigo University) and the International Space University.

10. The following paragraphs describe the activities conducted in 2009-2011 and plans for 2012 and beyond under the five activity categories of the BSTI Work Programme:

I. Basic activities

11. From 2009 to 2011 the Office for Outer Space Affairs, in cooperation with the Government of Austria and the European Space Agency, is organizing a series of three United Nations/Austria/European Space Agency symposiums on small satellite programmes for sustainable development.^{17,18,19} Participants in these symposiums are space technology experts from all over the World who are involved in small satellite projects. The discussions at the symposiums in 2009 and 2010 provided opportunities to refine the BSTI objectives and the work programme and to define the future activities that could be conducted under the framework of the Initiative. The first symposium dealt with general issues of small satellite programmes, the second symposium focused on the theme “Payloads for Small Satellite Programmes” and the third and final symposium in the series to be held in September 2011 will consider technical, managerial, legal and regulatory issues.

12. BSTI is working in close cooperation with the International Telecommunications Union Radiocommunication Sector (ITU-R) to make available information on radio-frequency allocation and registration procedures.²⁰

13. Space debris mitigation is a major concern for the deployment of small satellites. BSTI will act as a forum for the small satellite community to exchange information on legal, technical and operational considerations for space debris mitigation.

14. Upon request, the Office for Outer Space Affairs provides technical advisory services to Member States seeking to build capacities in space technology development. In 2010 the Office was invited to participate in international space technology conferences and meetings held in Lithuania, Mexico, Spain and Japan. At the 1st Nano-satellite Symposium held on 10 and 11 June 2010, organized by the University of Tokyo, Next System Technology Research Association (NESTRA), University Space Engineering Consortium (UNISEC) and AXELSPACE Corporation and co-sponsored by the Ministry of Education, Culture, Sports, Science and Technology and Ministry of Economy, Trade and Industry Cabinet Office of Japan, OOSA presented its plans for BSTI and provided advice and support for the organization of the first Nano-satellite Constellation Mission Idea Contest. The Initiative was also presented at a conference organized by the Universidad de Vigo, Fundacion Caixagalicia and the Ministerio de Ciencia e Innovacion of the Government of Spain and held in Vigo, Spain, on 29 June 2010. At the “Space Economy in the Multipolar World (SEMW2010) 1st International Space Conference” held in Vilnius, Lithuania from 6 to 9 October 2010, OOSA presented BSTI and provided information on the procedures for the registration of space objects. A regional meeting of small satellite experts from the Latin American and Caribbean region was organized and held together with the 6th Space Conference of the Americas (VI CEA) in Pachuca, Mexico, from 15 to 19 November 2010. Further information on these and other activities is

provided in the news section of the BSTI webpages at www.unoosa.org/oosa/en/SAP/bsti/news.html.

15. BSTI was also presented to the “Second International Cluster Forum — Nanosatellite Event” organized by the International Astronautical Federation at the 61st International Astronautical Congress held in Prague, Czech Republic, on 29 September 2010, to the CANEUS-Shared Small Satellites CSSP International Workshop held in Marina di Carrara, Tuscany, Italy from 20 to 22 October 2010 and to Nanyang Technological University in Singapore in December 2010.

16. A regional meeting on capacity building in space technology development will be organized in connection with the 4th African Leadership Conference on Space Science and Technology for Sustainable Development to be held in Mombasa, Kenya, from 26 to 28 September 2011.

II. International space technology conferences

17. Expressions of interest to host international space technology conferences in the period 2012-2015 under the framework of the Basic Space Technology Initiative have been received from the following countries: Canada, India, Japan, Mexico, South Africa, Thailand, Tunisia, United Arab Emirates and Venezuela (Bolivarian Republic of).

18. It is anticipated that the 2012 conference will be held in Japan, followed by a conference in the United Arab Emirates. Members States interested in hosting a BSTI conference are invited to contact OOSA.

III. Space technology education curriculum

19. Work on the space technology education curriculum is expected to begin in 2012 with a meeting of selected aerospace engineering education experts in connection with the first international space technology conference.

20. In preparation for this activity the Office for Outer Space Affairs has conducted a comprehensive, worldwide survey of educational opportunities in aerospace engineering and small satellite development which is available as document ST/SPACE/53 from the OOSA website. The document will be updated on a regular basis.²¹

IV. Establishment of long-term fellowship programmes

21. In cooperation with the Kyushu Institute of Technology (KIT) and the Government of Japan, BSTI established the United Nations/Japan Long-term Fellowship Programme on Nano-Satellite Technologies in 2010.^{22, 23} The “Doctorate in Nano-Satellite Technologies (DNST)” Fellowship Programme is a three-year PhD programme. Successful participants will be awarded a doctorate degree in Nano-Satellite Technologies (Doctor of Engineering). It is the first PhD-level Fellowship Programme under the United Nations Programme on Space Applications. Every year two successful candidates will be offered the opportunity to join the Programme. Applications from 38 qualified candidates from all over the World have been received during the first round of the Fellowship Programme in 2011. OOSA and KIT are now in the process of selecting two successful candidates who are expected to begin the Programme in October 2011.

22. The Office for Outer Space Affairs is continuing discussions with educational institutions to identify education opportunities for future space technology experts.

V. Basic Space Technology Initiative projects

23. Presently, two project-type activities are being pursued under the framework of the BSTI.

24. As part of the first activity BSTI is providing support to HUMSAT, a nano satellite constellation project led by the University of Vigo, Spain.²⁴ HUMSAT aims to develop a constellation of satellites to collect data from globally distributed sensor networks. Several organizations have indicated their interest to contribute satellites to the constellation. HUMSAT will make use of the GENSO distributed network of groundstations and is also pursuing various educational objectives.²⁵

25. The second activity aims to develop a best practices guidebook for small satellite programmes for organizations and institutions considering space technology development activities. This effort is conducted in cooperation with the International Space University (ISU) which has permanent observer status with the Committee on the Peaceful Uses of Outer Space and offers a range of academic programmes for space professionals. Participants at the ISU Space Studies Programme to be held in Graz, Austria, in summer 2011 will be tasked to help with the development of such a guidebook.²⁶

V. Conclusions

26. Establishing a capacity in space technology development will not only contribute to improving the operational use of space applications, but will also enable countries to transition from being passive space users to becoming more active players in international space cooperation. This can be achieved, for example, through the development and operation of small satellites and through actively contributing to the collection and sharing of space-based data and information in support of research activities and sustainable development.

27. The Basic Space Technology Initiative implemented by the Office for Outer Space Affairs under the framework of the United Nations Programme on Space Applications aims to contribute to these efforts by complementing the Programme's other activities in the basic space sciences and space applications.

28. Member States are invited to make full use of the activities offered under the BSTI. The Office for Outer Space Affairs welcomes comments on the Initiative as well as expressions of interest for cooperation on activities related to capacity building in space technology development.

29. For the latest information on the Basic Space Technology please consult the BSTI website at <http://www.unoosa.org/oosa/en/SAP/bsti/index.html>.

Notes

- ¹ United Nations, General Assembly, Official Records Twenty-Third Session, Agenda item 24, Report of the Committee on the Peaceful Uses of Outer Space, Annex II "Documentation on the United Nations Conference on the Exploration and Peaceful Uses of Outer Space", New York 1968.
- ² United Nations Office for Outer Space Affairs, "United Nations Programme on Space Applications", United Nations, ST/SPACE/52, February 2010.
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- ⁴ Haubold, H., Gadimova, S., "Progress in basic space science education and research: The UNBSSI", Space Policy 26, Elsevier, February 2010, pp. 61-63.
- ⁵ United Nations General Assembly, "Microsatellites and Small Satellites: Current Projects and Future Perspectives for International Cooperation", A/AC.105/611, 2 November 1995.
- ⁶ United Nations General Assembly, "Symposium on Utilization of Micro- and Small Satellites for the Expansion of Low-cost Space Activities, Taking into Account the Special Needs of Developing Countries", A/AC.105/638, 7 May 1996.
- ⁷ United Nations General Assembly, "Report on the United Nations/Instituto Nacional de Técnica Aeroespacial/European Space Agency International Conference on Small Satellites: Missions and Technology", A/AC.105/645, 5 November 1996.
- ⁸ United Nations, "Small Satellite Missions", UNISPACE III Background Paper 9, A/CONF.184/BP/9, 26 May 1998.
- ⁹ United Nations, UNISPACE III, "Report of the Technical Forum", A/CONF.184/L.13, 28 July 1999.
- ¹⁰ United Nations, UNISPACE III, Technical Forum, "Conclusions and proposals of the Workshop on Small Satellites at the Service of Developing Countries", A/CONF.184/C.2/L.7, 27 July 1999.
- ¹¹ Balogh, W., Haubold, H., "Proposal for a United Nations Basic Space Technology Initiative", Advances in Space Research 43, Elsevier, 15 June 2009, pp. 1847-1853.
- ¹² Balogh, W., Haubold, H., "Capacity Building in Basic Space Technology Development in the United Nations Programme on Space Applications", 27th International Symposium on Space Technology and Science, Paper 2009-r-3-02, Tsukuba, Japan, 5-12 July 2009.
- ¹³ Basic Space Technology Initiative website:
<http://www.unoosa.org/oosa/en/SAP/bsti/index.html>.
- ¹⁴ United Nations, UNISPACE III Technical Forum, "Conclusions and proposals of the Workshop on Small Satellites at the Service of Developing Countries", A/CONF.184/C.2/L.727, July 1999.
- ¹⁵ United Nations, Report on the second United Nations/Austria/European Space Agency Symposium on Small Satellite Programmes for Sustainable Development: Payloads for Small Satellite Programmes, A/AC.105/983, 29 November 2010.
- ¹⁶ Regional Centres for Space Science and Technology Education website:
<http://www.unoosa.org/oosa/en/SAP/centres/index.html>.
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- Development 2009 website <http://www.unoosa.org/oosa/SAP/act2009/graz/index.html>.
- ¹⁸ United Nations/Austria/ESA Symposium on Small Satellite Programmes for Sustainable Development 2010 website <http://www.unoosa.org/oosa/SAP/act2010/graz/index.html>.
- ¹⁹ United Nations/Austria/ESA Symposium on Small Satellite Programmes for Sustainable Development 2011 website <http://www.unoosa.org/oosa/SAP/act2011/graz/index.html>.
- ²⁰ Basic Space Technology Initiative — Basic Activities:
<http://www.unoosa.org/oosa/en/SAP/bsti/fundamentals.html>.
- ²¹ United Nations Office for Outer Space Affairs: Educational Opportunities in Aerospace Engineering and Small Satellite Development, United Nations, New York, ST/SPACE/53, September 2010. Available from <http://www.unoosa.org/oosa/en/SAP/bsti/bsti-education/index.html>.
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- ²³ Basic Space Technology Initiative — Fellowship Programme website:
<http://www.unoosa.org/oosa/en/SAP/bsti/fellowship.html>.
- ²⁴ Humanitary Satellite Network project (HUMSAT) website: <http://www.humsat.org/>.
- ²⁵ Global Educational Network for Satellite Operations (GENSO) website:
<http://www.genso.org>.
- ²⁶ International Space University Space Studies Programme website:
<http://www.isunet.edu/index.php/spp>.
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