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Thematic priority 1. Global partnership in space exploration and innovation

Note by the Secretariat

I. Introduction

1. At its fifty-ninth session, in 2016, the Committee on the Peaceful Uses of Outer Space endorsed the seven thematic priorities of the fiftieth anniversary of the United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE+50), as well as their objectives and mechanisms (A/71/20, para. 296).

2. The Action Team on Exploration and Innovation was established as the mechanism under thematic priority 1: Global partnership in space exploration and innovation. The Action Team's terms of reference were made available to the Committee at its sixtieth session, in 2017, in conference room paper A/AC.105/2017/CRP.21. The present document resulted from the work of the Action Team: the content was developed and discussed at meetings of the Action Team, as well as through electronic channels, with substantive and secretariat support provided by the Office for Outer Space Affairs of the Secretariat. (Conference room paper A/AC.105/C.1/2018/CRP.3 provides further procedural details on the Action Team's work.)

3. The present document is an updated version of document A/AC.105/C.1/114, which delegations had before them at the fifty-fifth session of the Scientific and Technical Subcommittee, and includes information on the second International Space Exploration Forum, held in Tokyo on 3 March 2018.

II. Background

A. The human quest to explore

4. Human desire to know what is beyond Earth dates back to antiquity. The myths and legends from the various regions of the world show that exploring the vast cosmos has been a common dream of humanity since ancient times.

5. Humanity's interest in the heavens has been universal and enduring. Humans are driven to explore the unknown, discover new worlds, push the boundaries of science and technology and then push even further. The desire to explore and

challenge the boundaries of what humans know and where humans have been has undoubtedly benefited society.

6. Space exploration represents a substantial challenge in the quest to explore new frontiers and expand humanity's collective sense of its place in the universe. Knowledge acquired from space exploration has also introduced new perspectives on the place of humans, individually and collectively, in the universe. Curiosity and exploration are vital to the human spirit. The challenge of going deeper into space is an invitation to the citizens of the world today, and the generations of tomorrow, to join that exciting journey.

B. Scientific exploration

7. Major milestones in the early years of space exploration included the 1957 launch of Sputnik 1, the first artificial satellite, into space, as well as Yuri Gagarin's first human flight to orbit Earth four years later, in 1961. During the 1960s, unmanned spacecraft photographed and probed the Moon, and in 1969 Neil Armstrong and Buzz Aldrin successfully completed the first Moon walk.

8. There is now once again a renewed interest in space exploration. This is exemplified by exciting recent initiatives, including but not limited to: the New Horizons explorer launched by the National Aeronautics and Space Administration of the United States of America, which flew to Pluto; the Rosetta spacecraft of the European Space Agency (ESA), which updated and expanded human knowledge of comets; the data on Saturn retrieved from the Cassini spacecraft; China's Chang'e series of explorers leaving new marks on the Moon; the Mangalyaan space probe sent into Mars orbit by the Indian Space Research Organization on behalf of Asia; the Japanese mission Hayabusa 2 and its second trip to an asteroid; the development by the United Arab Emirates of its own spacecraft to explore Mars; the ExoMars missions of ESA and the State Space Corporation "Roscosmos" of the Russian Federation; and the exoplanet discoveries around the TRAPPIST-1 star. At the same time, humans have continuously lived and worked aboard space stations in orbit, while further human spaceflight capabilities for Earth orbit and beyond have matured.

9. Astronomy has always played an important role in driving humankind's passion for space exploration. The Hubble Space Telescope, for instance, has been and remains a large, versatile and well-known research tool. Major astronomical discoveries made in recent centuries have readjusted humankind's view of the universe. From Copernicus' heliocentric model to understanding the Big Bang, astronomical science and space exploration have cemented humanity's desire to explore.

10. For example, according to the Committee on Human Spaceflight of the National Research Council of the United States, rationales for space exploration can be divided into two sets: pragmatic rationales, which involve economic benefits, contributions to national security, contributions to national stature and international relations, inspiration for students and citizens to further their science and engineering education, and contributions to science; and aspirational rationales, which involve the eventual survival of the human species (through off-Earth settlement) and shared human destiny and the aspiration to explore.

11. There are a variety of exploration activities that may be prioritized according to States' preferences, with investments in science and technology needed to extend human presence in the solar system. Employing the complementary capabilities of both humans and robotic systems will enable humankind to meet those ambitious space exploration challenges and increase the benefits for societies.

12. Exploration destinations, in the medium term, are generally agreed to include the Moon, near-Earth asteroids and Mars, while robotic missions continue to explore the entire solar system and beyond.

13. The emphasis and priority for each destination may be different, depending on the States' preferences, but the technical challenges that need to be addressed provide many synergies. Exploration of all destinations follows similar scientific themes: to answer fundamental questions about the origin and co-evolution of life and to understand the future of humankind in the universe. Various destinations then each add their own specific parts to the scientific puzzle.

14. Thus, cooperation will amplify accomplishments in space while opening new venues of scientific and technological innovation, as well as bringing together States, international intergovernmental organizations, space agencies, the public, industry and the private sector, non-governmental organizations, academia and civil society to explore space for the benefit of humankind.

15. The experience gained until now clearly indicates that science and exploration are mutually beneficial, enable technological innovation and support economic development and human welfare.

16. There is a rich potential for space exploration to deliver benefits to people on Earth. The development of scientific knowledge, including its technical spin-offs, have already contributed to the areas of health, medicine, public safety, the environment, computer technology and transportation.

17. Activities in low-Earth orbit (LEO) will continue to be important in space exploration, providing continuity for research and technology advancement in the space environment and delivering important benefits to societies.

18. Human activities beyond LEO are considered as the next evolution in human space exploration.

C. Innovation

19. Innovation translates scientific and technical knowledge into successful applications of processes, products and services and helps move the boundaries of human exploration and uses of outer space.

20. Innovation derived from space exploration endeavours is also a key driver of socioeconomic development and technical progress on Earth for the benefit of all humankind, providing growth, jobs and long-term returns.

21. Innovation is not limited to technical fields. New opportunities for creating socioeconomic value call for new business models and legal instruments, guidelines, clarifications or rules of operation for meeting challenges and embracing opportunities.

22. Exploration of new space frontiers and innovative applications of new scientific and technical knowledge will require substantial and sustained investment efforts. Such investment could be carried out by international intergovernmental organizations and national agencies and could increasingly originate from private sources and businesses.

23. Significant investment in innovation will also be indispensable in translating knowledge provided by space-based science into applications of socioeconomic relevance and for achieving Sustainable Development Goals in areas such as education, health, agriculture and environment, benefiting the general population and generating new opportunities for creating jobs and improving social welfare.

24. Innovation in the area of space applications lends itself to a broad range of cooperation among States, international intergovernmental organizations, space agencies, the public, industry and the private sector, non-governmental organizations, academia and civil society. In particular, cooperation in innovation and disseminating knowledge between developed and developing countries are ideal conduits for promoting the overall goals of sustainable development and the peaceful exploration and uses of outer space.

25. Non-governmental organizations and the private sector could contribute to the work of international intergovernmental organizations, Governments and space agencies in order to ensure that entrepreneurial and innovation capabilities are fully leveraged to maximize the benefits for development to be derived from space exploration and utilization endeavours.

D. Partnership

26. Space exploration continues to be a multifaceted endeavour also in the twenty-first century. The political agendas of a growing number of countries include space exploration as a goal and frame it as an international cooperative adventure.

27. A shared scientific vision of space exploration can unite space exploration stakeholders, challenge scientists and capture the public imagination. Those addressing the challenges related to space exploration foster the development of new technology, create new industries and help to foster a peaceful connection between countries. Collaboration is essential for space exploration and for addressing scientific challenges that are inherently global and interrelated.

28. Building a basic space technology capacity within a wider range of countries and increasing public awareness and engagement are concrete steps that can attract new actors in space exploration worldwide. By engaging non-spacefaring countries in international space exploration programmes, it will be possible to create a critical support structure to ensure programme continuity and sustainability in the development and execution of future international space exploration frameworks.

III. Raising awareness of space exploration and innovation as essential drivers for opening up new domains in space science and technology, triggering new partnerships and developing capabilities that create new opportunities for addressing global challenges

A. Global vision

29. The international community envisions space exploration as the exploration of outer space for peaceful purposes, in particular for the purposes of enhancing the understanding of Earth and the cosmos, and promoting human civilization and social progress for the benefit of all humankind.

30. With continuous exploration, humankind will make new discoveries, extend its knowledge and be able to answer some fundamental scientific and philosophical questions: “How did the planet Earth and its solar system form?”, “Does life exist beyond the planet Earth?”, “What are the potential opportunities for humanity in the local space environment?”, “Where did humans come from?”, “What is humanity?”, and “What is the destiny of humankind?”.

31. Space exploration is in the common interest of all humankind. Space exploration generates new knowledge in science and technology for all humankind. Space exploration can trigger new partnerships, foster dialogue with the space industry and the private sector and promote cooperation among all countries.

32. Robotic systems not only have flown by Pluto and landed on comets, but have also been leaving the solar system. Humans have already left their footprints on the Moon and in the future will step on Mars. Through space exploration, humans are continuing to move the boundaries of their space activities, and they could find other habitable environments and locations for sustainable living in the cosmos.

33. Space exploration will lead to new space technologies and applications, which can create opportunities to address global challenges, and will promote and provide

practical support for sustainable development, in line with the 2030 Agenda for Sustainable Development. The quality of life on Earth will improve with the contributions of space exploration and innovation.

B. Advancing space science and technology through space exploration activities

34. Space exploration is a powerful driver for advancing science and technology. Space exploration allows for great discoveries, but there is also limitless potential for advancements in science and technology, advancements that will increase the quality of life for all humankind.

35. Scientific objectives for space exploration activities include: (a) extending human knowledge of the origins and evolution of the solar system and other planetary systems around other stars; (b) deepening the understanding of the origin, evolution and destination of the planet Earth; (c) advancing fundamental research goals in space science; and (d) searching for signatures of life outside of Earth and understanding the conditions that support the evolution of life together with the planetary environment.

36. Developing the knowledge, capabilities and infrastructure necessary for robotic activities and for humans to live and work beyond LEO requires the development and testing of advanced technologies, reliable systems and efficient operation concepts. This may require human presence beyond LEO for achieving particular scientific objectives. Depending on the specific mission target, increasing the number of individuals that can be supported at a destination, the amount of time they can remain at the destination and their level of self-sufficiency while at the destination will require detailed analysis.

37. LEO programmes and infrastructures provide opportunities to conduct research and are valuable test beds for technologies, products and services to be utilized in future missions of long duration (missions to cislunar space, the Moon, Mars and beyond).

38. Increasing scientific knowledge and technical capability will reduce the risks and increase the productivity of future missions, for instance by enabling the effects of the space environment on human health and exploration systems to be examined more closely. While searching for the means to live beyond LEO, research on the effects of the space environment on human health will lead to advances in the treatment of health issues on Earth.

39. The Earth’s safety and social welfare are enhanced by the collaborative pursuit of planetary defence against possible impacts of minor bodies of the solar system.

40. Developing synergies between human and robotic missions maximizes the contributions made by each, as well as their collaborative contribution to common goals. It is envisioned that robotic missions will provide new discoveries and serve also as precursors of human exploration, making subsequent human missions safer and more productive.

41. Space exploration requires the development and advancement of key enabling technologies, including in the areas of electric propulsion, radiation protection, tele-robotics and virtual reality, autonomy in operations, and optical telecommunications, and, in the long-term, will also require in situ resource utilization.

42. Exploration requires flexible and modular technologies that can be applied in multiple scenarios.

43. Those technologies and applications should be used in accordance with relevant national and international legislation.

C. Triggering new partnerships

44. In line with Sustainable Development Goal 17 (Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development), the benefits of partnerships between Governments, the private sector and civil society are recognized. Inclusive multi-stakeholder partnerships for space exploration, built upon principles and values, a shared vision and shared goals provide unique and creative opportunities for the international community to move forward towards a better future for all.

45. No single space agency can invest heavily in all the areas of technology that are needed. That poses a key challenge for space exploration missions. By developing partnerships with common goals, entities with an interest in space exploration will be able to coordinate their investments and work together in ways that maximize returns on investments and enable earlier realization of common goals and objectives.

D. Developing capabilities

46. As more States become involved in space exploration and embrace the study and use of outer space in its totality, they may fully participate in and benefit from all related research areas and the wealth of knowledge about the universe.

47. Opportunities of integrated human and robotic space exploration missions in the near future may, in the long term, result in a gradual build-up of capabilities for more complex missions. This approach, along with human capital development, technology transfer, the transfer of skills and knowledge, and exchange programmes or joint development initiatives, may offer opportunities for including in space exploration activities more developing countries with emerging capabilities in space exploration.

48. Apart from space science and technology, efforts to build space capabilities should focus more on space applications, especially in countries with emerging capabilities in space exploration. Emphasis should be placed on the dissemination of knowledge about space science, through training, exhibitions, publications, the media and international exchanges, as well as through outreach activities.

49. The Office for Outer Space Affairs and the regional centres for space science and technology education, affiliated to the United Nations, should play key roles in capacity-building. Awareness-raising efforts should put emphasis on youth all over the world, encouraging them to study and have careers in science, technology, engineering and mathematics (STEM).

IV. Fostering dialogue with the space industry and the private sector

50. Ensuring the peaceful exploration and use of outer space and the safe, secure and sustainable development of outer space activities for the benefit of all humankind requires a holistic approach to collaboration between all stakeholders in outer space activities, including Governments and government agencies, non-governmental entities, academic institutions, industry and the private sector. As an example, in some countries, significant parts of the national space programme rely on the private sector for launching and transportation services for space exploration.

51. While space exploration activities were for a long time the domain of international and national government agencies, more recently non-governmental organizations, including industry and the private sector and academic institutions, have been increasingly participating in those activities, as suppliers of technology, as subcontractors in the implementation of international and national space programmes or even as entrepreneurial innovators in commercial space ventures.

52. In addition, more and more non-governmental organizations dealing with issues relating to space exploration are participating in discussions of national and international forums.

53. This increasing participation of industry, the private sector and non-governmental organizations in space exploration means that States need to pay close attention to the proper implementation of new technological and commercial activities to ensure that they are in line with international law.

54. Policymakers, space agencies, non-governmental organizations, academia, the space industry and the private sector should use existing forums, such as the Committee on the Peaceful Uses of Outer Space and its subcommittees or other relevant international forums, to foster a constructive dialogue about broader issues and perspectives involving the space industry and the exploration and use of outer space. In particular, such a dialogue could lead to a better understanding of the implications of new technological and commercial activities and ensure that their implementation is in accordance with the principle of the rule of international law, with a view to reviewing concepts to address specific aspects of public and private activities in outer space.

55. Dialogue between States, non-governmental organizations and private industry is particularly relevant to putting new space technologies to the best possible use in addressing issues on Earth in areas such as agriculture, the environment, climate change and their socioeconomic consequences.

56. The Committee on the Peaceful Uses of Outer Space and the Office for Outer Space Affairs play a central role in fostering such a global dialogue, involving all participants, on the entire spectrum of issues related to space activities, including the exploration of outer space. UNISPACE+50 and the “Space2030” agenda can be used as catalysts to increase cooperation and partnerships in outer space activities.

V. Promoting cooperation between spacefaring nations and emerging space nations

A. Importance of international cooperation

57. Most of the achievements in the exploration of outer space of the past five decades would not have been possible without international cooperation.

58. It is now widely recognized that the magnitude of the human, technical and financial resources required for missions to explore outer space is such that no single country can undertake such a mission. International cooperation is not only a necessity for realizing such missions but is also more cost-effective, as it enables the participating countries to pool their resources, complement each other’s capabilities and share the resulting benefits.

59. International collaboration is today an integral part of every country’s policy on outer space. Objectives of international space exploration are achieved primarily through various bilateral or multilateral partnerships.

60. A good example of the shift from competition to cooperation in space exploration is the International Space Station (ISS). The first component of ISS was launched into orbit in 1998, and ISS has been occupied by a crew since 2000. By June 2017, more than 90 countries had become involved in the utilization of ISS, and the international space community will benefit from its continued exploitation, as well as from lessons learned from the ISS project.

61. Space exploration, with its global dimension requiring enhanced mutual trust and respectful and peaceful behaviour, can and should serve as an instrument for fostering cooperation and the maintenance of international peace and security.

62. There are numerous benefits of space exploration, such as increasing scientific knowledge, inspiring people and improving technical competence. Many of those benefits can be enhanced and, where appropriate, more widely distributed through international collaboration.

63. By serving as a catalyst to build mutual understanding and trust between countries, space exploration also supports new means of and solutions for addressing global challenges in international partnerships.

64. There is value in a step-by-step approach to exploration, enabling States to develop space exploration capabilities through cooperative international missions. Such an approach allows States to meet national priorities while also achieving shared long-term goals. International collaboration therefore ensures that all States have an opportunity to explore outer space.

B. Current cooperation framework

65. The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, provides the basic framework of international cooperation in space exploration and innovation for Member States willing to contribute to broad international cooperation in scientific areas, as well as to study and report on legal problems that may arise from the exploration and use of outer space.

66. In line with Sustainable Development Goal 17 (Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development), it is important to enhance cooperation between spacefaring countries and countries with emerging capabilities in space exploration, particularly in the area of space exploration and innovation. Coordination within the United Nations is indispensable for the sustainable development of activities in space exploration and innovation. In addition, there are different kinds of established processes, bilateral or multilateral, at the regional or global level that have proved useful in promoting cooperation between spacefaring countries and countries with emerging capabilities in space exploration.

67. The Committee on the Peaceful Uses of Outer Space, whose activities are effectively supported by the Office for Outer Space Affairs, represents a unique international forum for decision-making, guidance, coordination, information-sharing and opening up collaboration on a global scale.

68. The Committee is an important body for international cooperation and the coordination of outer space affairs among States, at the policy level and at the technical level. It is a natural platform for identifying coordination mechanisms to ensure that all countries, both developed and developing, at the governmental level and at the non-governmental level (i.e. industry, the private sector, civil society and younger generations), can participate in and benefit from space exploration and innovation.

69. The Committee on the Peaceful Uses of Outer Space and its subcommittees have, in the past, dealt with the topic of space exploration and innovation. For instance, States have frequently provided information and updates on related national and collaborative initiatives in the sessions of the Committee under the agenda item entitled “General exchange of views” and in the sessions of the Scientific and Technical Subcommittee under the agenda item entitled “General exchange of views and introduction of reports submitted on national activities”. The topic has also been considered by the Committee under specific agenda items.

70. In preparation of UNISPACE+50, a series of high-level forums were organized by the Office for Outer Space Affairs to address the cross-sectoral impact of integrating economic, environmental, social, regulatory and policy aspects of outer space in pursuance of global sustainable development. The forums identified four key pillars in addressing the broader perspective of space activities: space economy, space

diplomacy, space society and space accessibility. The “space accessibility” pillar refers to user communities and decision makers being able, on an equal basis, to benefit from and use space technologies and space-based data. During the first forum, the United Nations/United Arab Emirates High-level Forum: Space as a Driver for Socioeconomic Sustainable Development, held in Dubai, United Arab Emirates, in November 2016, the need for broadening access to space was recognized.

71. These efforts are building towards an inclusive global “Space2030” agenda, which will call for strengthened cooperation in outer space activities.

72. Non-governmental organizations such as the International Astronautical Federation, the International Academy of Astronautics, the International Institute of Space Law and the International Law Association, as well as international forums such as the Committee on Space Research, the International Mars Exploration Working Group, the International Lunar Exploration Working Group, the International Space Exploration Coordination Group and the International Space Exploration Forum, also support collaboration, exchange and coordination.

73. The International Space Exploration Coordination Group is the space agencies’ forum for advancing a common vision on the next steps in implementing a global effort for space exploration and in laying the foundation for future partnerships. The third version of the Global Exploration Roadmap was published in January 2018.

74. The first International Space Exploration Forum, held in Washington, D.C. on 9 January 2014, marked a continuation of the dialogue initiated by the European Commission and ESA and aimed at the further exploration and utilization of outer space and enhanced understanding of the benefits of space exploration.

75. The second International Space Exploration Forum was held in Tokyo on 3 March 2018 with the participation of 45 countries and international organizations. The participants discussed the significance of advancing international collaboration and coordination efforts in space exploration and welcomed the continuation of the International Space Exploration Forum as a ministerial-level forum. The participants adopted three outcome documents, namely the Joint Statement of the Second International Space Exploration Forum, the Tokyo Principles for International Space Exploration, which they welcomed as a basis for Governments to engage in dialogue to promote international cooperation and long-term space exploration endeavours that deliver benefits to humanity, and the International Space Exploration Forum terms of reference. These three documents will be included in a conference room paper to be submitted to the Committee on the Peaceful Uses of Outer Space at its sixty-first session.

76. All States active and interested in space exploration are invited to participate in the above-mentioned forums and to use the benefits provided by the forums to support the achievement of national objectives in the exploration of outer space.

C. Facilitating sustainable global collaboration

77. International cooperation in the exploration of outer space may be carried out using various models, including joint development and manufacturing of space assets; the conduct of space operations; the sharing of information and/or data; and exchanges and/or training involving scientific research and personnel. There is a need to be informed of, and create synergy with, existing entities when proposing and developing new collaboration models.

78. States members of the Committee on the Peaceful Uses of Outer Space, while pursuing their individual and collective objectives in the exploration of outer space, are producing guidelines for the long-term sustainability of outer space activities. The guidelines are especially important for States with emerging capabilities in space exploration. The experiences in the exploration of outer space are shared by technical experts from all of the regional and international mechanisms involved.

79. The landscape of modern space exploration is characterized by significant contributors on every continent, in both the public and the private sectors, and among spacefaring countries, as well as among those countries just beginning to explore outer space. New innovative partnerships among these actors are being encouraged.

80. A strong foundation for future partnerships and global engagement is ensured by the shared principles of international law concerning friendly relations and cooperation among States, including principles and legal provisions embodied in the Outer Space Treaty, which have paved the way for present and future collaboration models. In the past, successful international cooperation projects in space exploration have been jointly developed and have focused on shared benefits for all humankind.

81. In order to involve more countries in such international cooperation, there is a need to identify, during the sessions of the Committee on the Peaceful Uses of Outer Space, areas of common interest and to assign priorities for action to explore opportunities among the developers and users of space technologies.

VI. Allowing space exploration activities to become open and inclusive on a global scale

A. New opportunities

82. The international community should consider the expansion of human and robotic activities in the solar system, making use of ongoing developments in space technology and its applications. With the development of new space technology and lower-cost launch vehicles, there are new opportunities for all countries to enhance capabilities in space exploration and benefit from space technologies.

83. Space exploration is an engine for the economy. Advancements resulting from space exploration activities are being put to good use in other fields. Applying the knowledge and the technologies resulting from efforts to explore space benefits all countries.

84. Opportunities exist for commercial endeavours and businesses to contribute to the space economy. Opportunities also exist for countries with emerging or limited capabilities in space exploration to engage in space activities in a sustainable space economy.

B. Capacity-building

85. Given the notable benefits of space exploration and innovation activities, it is desirable to fully include in such space activities countries with emerging or limited capabilities in space exploration. Initially, this may involve the dissemination of information as well as targeted capacity-building. Small ground-based facilities, such as those for space environment monitoring and astronomical observation or data archives, may act as a gateway to the development of national capabilities in space science.

86. Exploring opportunities of integrated human and robotic missions for the exploration of deep space in the near future may, in the long term, result in an incremental build-up of capabilities for more complex missions for both spacefaring and non-spacefaring countries.

87. Systematic and continuous investments in capacity-building are necessary not only to ensure a sufficient supply of, inter alia, graduates in the fields of science, engineering, political science and law, but also to encourage creativity, innovation and even entrepreneurship. This is true for spacefaring countries, for countries with emerging capabilities in space exploration and for countries with limited capabilities that intend to adopt a stepwise approach to the exploration of outer space.

88. Nearly all space agencies and space-related research establishments have educational and capacity-building programmes (often implemented in close collaboration with institutional and academic partners) that support the short-term objectives, as well as the long-term educational needs, of their respective space programmes.

89. By exploiting the interdisciplinary study of outer space, and by using outer space for teaching, learning and training, capacity-building programmes are effectively exposing young people to STEM. At the university level, such programmes may provide significant practical experience by using outer space as a professional working environment.

90. Some of these capacity-building programmes are open to young scientists, engineers, diplomats and lawyers from other countries. In search of the best minds, such programmes offer unique opportunities for young professionals from countries with emerging or limited capabilities in space exploration. Students from other countries may benefit from the unique transfer of practical knowledge on space-related matters, access to state-of-the-art space facilities and direct interaction with space professionals and thus be able to transfer that knowledge further when they return to their home countries.

91. Given the notable benefits of space exploration and innovation activities, it is desirable to fully include in such activities countries with emerging or limited capabilities in space exploration. Together with space agencies, private entities and research establishments, the Office for Outer Space Affairs supports and coordinates programmes for countries with emerging capabilities in space exploration, providing opportunities for such countries to build their own space capabilities, to utilize space infrastructure and to carry out experiments under microgravity conditions.

92. There are other examples of such cooperation involving countries with emerging capabilities in space exploration. Such countries, in particular young persons from such countries, may benefit from the development of knowledge and the transfer of technology through training in existing regional and international institutions, such as the regional centres for space science and technology education, affiliated to the United Nations.

C. Openness and resilience of architecture

93. Focusing on the design and standardization of interfaces could strengthen collaboration at the technical level. Moreover, it assists countries with emerging capabilities in space exploration, as it enables them to have access to, work with, contribute to and build upon existing space infrastructure, without having to replicate at the national level all the in-depth, costly and time-consuming background work.

94. Spacefaring countries and countries with emerging capabilities in space exploration should promote cooperation in the planning, design and construction of space infrastructure to ensure the openness and resilience of architecture. In particular, spacefaring countries should share, in accordance with the provisions of the relevant outer space treaties, their experience and advanced technologies with other countries not only to enhance the construction of space infrastructure but also to ensure openness and resilience of the architecture.

D. Open access to space data and simulations

95. Open access to space data and simulations also support capacity-building and inclusivity.

96. Some sources of data and computer simulations are funded by public money. It is therefore reasonable to expect that the data thus generated become available to the interested public through appropriate policies and procedures.

97. Using astronomy as an example, it is noted that data from major observing facilities (e.g. the Hubble Space Telescope, or the Very Large Telescope of the European Southern Observatory) are exclusively available to the original proposer of the observing programme (known as the principal investigator) for a limited time, but they are released to the general public after a certain period, typically one year.

98. The data archives are easily accessible through web interfaces, using state-of-the-art tools for man-machine interaction. Users are not expected to know the technical details of the detectors or of the storage technology. In fact, efforts have been made to combine many data archives, and the software acts as a virtual observatory.

99. Along with the data, there are data analysis software packages, designed to operate on the most common computer platforms, which can be downloaded with standard format at no cost. This provides an excellent opportunity for scientists from all countries to obtain high-quality data and to analyse them using cutting edge software.

100. Such tools and mechanisms could help promote and make more widely available existing open planetary data and data systems. These could be used for exploration and for training and research purposes. The network connections and the hardware required to access and to exploit the data have become much more affordable.

101. There are benefits in applying remote-sensing techniques to merge and visualize data and in opening up access to terrestrial field analogue simulations and experimentation. One recent example is the Open Universe initiative (A/71/20, para. 299), aimed at promoting open data accessibility and transparency in astronomy and space science. The initiative is being promoted by the Italian Space Agency (ASI) with a view to facilitating access to space science data for scientists in all countries.

E. Citizen science

102. Traditionally, science has been conducted by institutions such as universities or by institutes funded by Governments or industry. The main reason was that the infrastructure required to conduct meaningful scientific research was available only in such organizations.

103. With the advent of personal computers and tremendously enhanced data exchange opportunities, this scenario has changed. In fact, most laptops today are more powerful than many of the computers available to universities only a short time ago.

104. In addition, the data produced using scientific instruments such as telescopes and spacecraft are available in digital archives, many of them permanently online and accessible through the Internet. It has thus become possible for the public to peruse the data, whether for the purpose of satisfying personal interests or for the purpose of conducting scientific investigations. Citizen science has the potential to involve large numbers of private citizens and in this way to propagate scientific thinking throughout societies.

VII. Identifying governance and cooperation mechanisms to support global partnership in space exploration and innovation

A. Global governance of outer space activities

105. The United Nations treaties and principles on outer space are the cornerstone of global governance of outer space activities.

106. The Outer Space Treaty is the basis of international space law, and it provides fundamental principles such as the following:

(a) "The exploration and use of outer space … shall be carried out for the benefit and in the interests of all countries … and shall be the province of all mankind" (article I);

(b) "Outer space … shall be free for exploration and use by all States" (article I);

(c) "Outer space … is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means" (article II);

(d) "The Moon and other celestial bodies shall be used … exclusively for peaceful purposes" (article IV).

107. For over 50 years, those fundamental principles have provided a sound basis for the sustainability, safety and security of global outer space activities.

108. It is extremely important and necessary to enhance cooperation among spacefaring countries and countries with emerging or limited capabilities in space exploration and innovation. Various bilateral and multilateral mechanisms have been established for such cooperation at the regional and global levels. Those mechanisms have proved useful for, and exerted strong influence on, the development of cooperation among spacefaring countries and countries with emerging or limited capabilities in space exploration. Coordination among the existing United Nations mechanisms would be helpful in the development of a global partnership in space exploration and innovation.

B. Cooperation mechanisms for space exploration and innovation

109. It is important to consider a coordinated approach to accelerating activities related to space exploration and innovation for the benefit of all humankind. As a growing number of countries, institutions and private entities are today actively engaged in such activities, such coordination and collaboration models are expected to be — in principle — open and inclusive, bringing the expertise and competence of different types of participants at the institutional, national and international levels, and should be pursued with multiple, diversified contributions.

110. In pursuing the goals of global space exploration, it is indispensable to share visions and scenarios for space exploration. With such common scenarios, both the public and private sectors can use their collective resources effectively and efficiently at different levels, by various ways and means, to benefit humanity as a whole, and realize large-scale missions in the coming decades.

111. In order to maximize the efforts of various initiatives being conducted by different participants, there is an expectation to synergize their activities through the existing means of exchanging views, such as the agendas of the Committee on the Peaceful Uses of Outer Space and its subcommittees and other international forums. These cooperative platforms could facilitate the discussion and coordination of the initiatives and programmes being planned and conducted around the world.

112. The Committee on the Peaceful Uses of Outer Space is an important forum in which spacefaring and non-spacefaring States alike can continue to discuss important issues regarding humanity's horizons in space and the furthering of exploration and innovation objectives.

113. The Office for Outer Space Affairs, which services and provides substantive support to the Committee on the Peaceful Uses of Outer Space, has considerable experience in implementing frameworks for cooperation.

VIII. Recommendations

114. The Action Team on Exploration and Innovation, in accordance with its terms of reference (A/AC.105/2017/CRP.21), has agreed on the following recommendations:

(a) The Committee on the Peaceful Uses of Outer Space should consider including on its agenda an item entitled “Space exploration and innovation”;

(b) Member States and observers of the Committee should be encouraged to provide their views on space exploration and innovation and on how to organize work under such an agenda item, including on the possibility of establishing a working group on that agenda item;

(c) The Committee should review ways and means of working with non-governmental entities, including industry and private sector entities, in order to better consider all aspects of space exploration and innovation;

(d) Bilateral and multilateral cooperation involving States and international intergovernmental organizations in space exploration and innovation should be encouraged where pertinent. New mechanisms and/or forums for cooperating in space exploration activities could be identified, including by considering the participation of industry and States with emerging capabilities in space exploration;

(e) All States should conduct their space exploration activities taking into account the long-term sustainable and peaceful use of outer space;

(f) The Office for Outer Space Affairs should be requested to include capacity-building activities (including workshops and/or exchange or international fellowship programmes) on space exploration and innovation, with particular emphasis on STEM;

(g) The Office for Outer Space Affairs should develop, within existing resources, a section on its website to assist in the dissemination of information on space exploration and innovation, particularly taking into account the needs of developing countries.