United Nations

A/AC.105/C.1/L.357

General Assembly

Distr.: Limited
1 December 2016

Original: English

Committee on the Peaceful Uses of Outer Space
Scientific and Technical Subcommittee
Fifty-fourth session
Vienna, 30 January-10 February 2017
Item 13 of the provisional agenda*
Long-term sustainability of outer space activities

Outline for the report of the Working Group on the Long-term Sustainability of Outer Space Activities

Working paper by the Chair of the Working Group

At its fifty-ninth session in June 2016, the Committee on the Peaceful Uses of Outer Space extended the mandate of the Working Group on the Long-term Sustainability of Outer Space Activities for a further two years, and agreed on a related programme of work (A/71/20, para. 137).

One of the products that the Working Group is tasked to deliver is a report on its work. A draft report of the Working Group was prepared in December 2014 (A/AC.105/C.1/L.343) and has been before delegations for their consideration. When, at its third intersessional meeting in September 2016, the Working Group discussed updating the draft report, some delegations expressed the view that the content of the report would very much depend on the outcome of the ongoing negotiations towards a compendium of guidelines for the long-term sustainability of outer space activities. In respect of this view, the Chair of the Working Group has prepared an outline for the report of the Working Group, which is contained in the present document. This outline proposes a structure for the report of the Working Group and provides some indicative paragraphs. It is to be understood that some sections of the report will be finalized only once the Working Group is nearer the completion of its work.

I. The long-term sustainability of outer space activities and the Committee on the Peaceful Uses of Outer Space

[*Section I will provide an introduction, addressing why this topic is important, why the international community decided to focus on this area of work at this time, why this topic is an intrinsically multilateral issue, and why the Committee on the Peaceful Uses of Outer Space is the most appropriate forum to undertake this multilateral*

* A/AC.105/C.1/L.355.

work. This section will be drafted once the Working Group is closer to agreeing on a full compendium of guidelines.]

II. Establishment of the Working Group and its terms of reference

[*Section II will provide a summary of the establishment of the Working Group, its terms of reference and its workplan. Indicative paragraphs are provided.*]

1. At its fifty-second session in 2009, the Committee agreed that its Scientific and Technical Subcommittee should include, starting from its forty-seventh session in 2010, a new agenda item entitled "Long-term sustainability of outer space activities" and it proposed a multi-year workplan that was to culminate in a report on the long-term sustainability of outer space activities and a set of best-practice guidelines for presentation to and review by the Committee (A/64/20, paras. 161 and 162). Consequently, in 2010, the Subcommittee established the Working Group on the Long-term Sustainability of Outer Space Activities, and elected Peter Martinez (South Africa) as the Chair of the Working Group (A/AC.105/958, paras. 181 and182).

2. The Working Group's terms of reference, scope and methods of work were agreed at the fifty-fourth session of the Committee in 2011 (A/66/20, annex II). The Working Group was tasked to consider current practices, operating procedures, technical standards and policies associated with the long-term sustainability of outer space activities, throughout all the phases of a mission life cycle. The Working Group was to take as its legal framework the existing United Nations treaties and principles governing the activities of States in the exploration and use of outer space; it was not to consider the development of new legally binding instruments.

3. The Working Group was further tasked to produce a report on the long-term sustainability of outer space activities and a consolidated set of voluntary, non-binding guidelines that could be applied by States, international intergovernmental organizations, national non-governmental organizations and private sector entities to enhance the long-term sustainability of outer space activities for all space actors and for all beneficiaries of space activities. The guidelines should:

(a) Create a framework for possible development and enhancement of national and international practices pertaining to enhancing the long-term sustainability of outer space activities, including, inter alia, the improvement of the safety of space operations and the protection of the space environment, giving consideration to acceptable and reasonable financial and other connotations and taking into account the needs and interests of developing countries;

(b) Be consistent with existing international legal frameworks for outer space activities and should be voluntary and not be legally binding;

(c) Be consistent with the relevant activities and recommendations of the Committee and its Subcommittees, as well as of other working groups thereof, United Nations intergovernmental organizations and bodies and the Inter-Agency Space Debris Coordination Committee and other relevant international organizations, taking into account their status and competence.

III. Procedural summary of the work of the Working Group

[*Section III will provide a procedural summary of the work undertaken by the Working Group. Indicative paragraphs are provided. Owing to word limits on official documents of the United Nations, attempts have been made to keep the procedural* *summary concise. The Working Group may consider whether it would like a more detailed procedural summary of its work, including all relevant symbol references, recorded in a separate document.*]

4. The Working Group examined the long-term sustainability of outer space activities in the wider context of sustainable development on Earth, taking into account the concerns and interests of all countries, in particular those of developing countries, and consistent with the peaceful uses of outer space.

5. The Working Group took as its legal framework the existing United Nations treaties and principles governing the activities of States in the exploration and use of outer space, in particular article VI of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (the Outer Space Treaty).

6. The Working Group invited contributions from States members of the Committee, relevant international intergovernmental organizations with permanent observer status to the Committee, international non-governmental organizations with permanent observer status to the Committee, United Nations entities, and other relevant international bodies and organizations. The Working Group received contributions from States members of the Committee, as well as from the International Telecommunication Union, the United Nations Educational, Scientific and Cultural Organization, the Office for Disarmament Affairs of the Secretariat, the Economic and Social Commission for Asia and the Pacific, the Asia-Pacific Space Cooperation Organization, the Committee on Space Research, the International Astronautical Federation, the Secure World Foundation, the Space Generation Advisory Council, the Consultative Committee for Space Data Systems, the European Organisation for the Exploitation of Meteorological Satellites and the secretariat of the Group on Earth Observations.

7. Inputs of national non-governmental organizations and private sector entities were also obtained through relevant States members of the Committee and in special workshops organized by the Working Group in 2012 and 2013.

8. The Working Group took into consideration discussions within the Committee and its Subcommittees on the long-term sustainability of outer space activities, as well as progress made by the other working groups of the Subcommittees, such as the activities and recommendations being undertaken in the Working Group on the Use of Nuclear Power Sources in Outer Space and the work of the Scientific and Technical Subcommittee and the Inter-Agency Space Debris Coordination Committee on orbital debris mitigation.

9. The Working Group also established a liaison with the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities established in implementation of General Assembly resolution 65/68. During the fiftieth session of the Scientific and Technical Subcommittee in 2013, the Chair of the Group of Governmental Experts, Viktor Vasiliev, briefed the Working Group on the progress made by the Group of Governmental Experts towards meeting its mandate to develop a report and a set of proposed voluntary transparency and confidence-building measures for States to consider implementing in their conduct of outer space activities. Following the conclusion of the work of the Group of Governmental Experts and the adoption of its report (A/68/189), the Working Group considered the linkages of its work with the recommendations contained in the report of the Group of Governmental Experts. Those linkages are highlighted in section VI of the present report.

10. The Working Group met during the annual sessions of the Scientific and Technical Subcommittee and the Committee. The Working Group also used

opportunities provided by intersessional coordination events, such as meetings, teleconferences, electronic meetings and workshops, as feasible and agreed.

11. As provided for in its terms of reference and methods of work, the Working Group established expert groups to expedite its work:

(a) Expert group A, "Sustainable space utilization supporting sustainable development on Earth", was co-chaired by Enrique Pacheco Cabrera (Mexico) and Filipe Duarte Santos (Portugal), and included approximately 40 experts;

(b) Expert group B, "Space debris, space operations and tools to support collaborative space situational awareness", was co-chaired by Claudio Portelli (Italy) and Richard Buenneke (United States of America), and included approximately 70 experts;

(c) Expert group C, "Space weather", was co-chaired by Ian Mann (Canada) and Takahiro Obara (Japan), and included approximately 40 experts;

(d) Expert group D, "Regulatory regimes and guidance for actors in the space arena", was co-chaired by Anthony Wicht (Australia), who was succeeded by Michael Nelson (Australia), and Sergio Marchisio (Italy), and included approximately 50 experts.

12. In line with their specific topics, expert groups A through D compiled information and provided analysis on current practices, procedures and cross-cutting issues associated with the long-term sustainability of outer space activities. The expert groups also identified a number of gaps in existing approaches.

13. The main findings of the expert groups provided the basis from which initial candidate guidelines were developed. Candidate guidelines were also proposed by a number of States members of the Working Group. All candidate guidelines were then taken into consideration for the development of a compendium of guidelines for the long-term sustainability of outer space activities.

14. During its examination of topics within its terms of reference, the Working Group noted linkages between its work and the thematic priorities of the fiftieth anniversary of the United Nations Conference on Exploration and Peaceful Uses of Outer Space (UNISPACE+50), especially in regard to thematic priority number 2, Legal regime of outer space and global space governance: current and future perspectives, and thematic priority number 3, Enhanced information exchange on space objects and events.

15. The Working Group and its expert groups also identified a number of issues requiring further consideration by the Committee and/or its Subcommittees, with a view to possibly developing additional guidelines in future. These issues are listed in section VI of the present report.

IV. Matters addressed by the Working Group and its expert groups

[*Section IV will provide a summary of the substantive considerations of the Working Group and its expert groups. Indicative paragraphs are provided.*]

A. Space and sustainable development

Space activities and sustainable development on Earth

16. Space technologies can play a key role in economic development, social development and environmental protection, the three pillars of sustainable development. They offer valuable tools for supporting sustainable development, the benefits of which are to be leveraged for all humankind. Space-based applications such as Earth observation, global navigation satellite systems, and telecommunications provide objective data and information, which may improve the understanding of trends, assist with the evaluation of needs, and contribute to better-informed decision-making.

17. As the exploration and use of outer space is to be carried out for the benefit and in the interest of all countries, it is crucial that international cooperation should address equitable access to outer space for purposes of human development. International cooperation may take many forms, including the sharing of data, capacity-building activities in technical and legal fields, and support for countries wishing to establish their own national capacities for outer space activities.

18. Space activities themselves should also have minimal negative impact on the Earth or the space environment. The promotion and development of technologies that minimize the environmental impact of launching space assets and maximize the use of renewable resources and the reusability or repurposing of existing space assets can support these efforts.

19. Institutional and public awareness of space activities, space applications, and the benefits they bring to sustainable development should be promoted, with special attention being paid to the needs of young people and future generations. Information-sharing and education offer the best opportunities for raising the profile of sustainable space utilization in support of sustainable development on Earth.

B. Safety of space operations

1. Space debris mitigation

20. The current space debris environment is deteriorating due to an increasing number of orbital objects, despite worldwide efforts to reduce that increase through the implementation of internationally agreed debris mitigation standards and guidelines. Orbital space debris arises from various sources: non-operational satellites, upper stages of launch vehicles, carriers for multiple payloads, debris intentionally released during spacecraft separation from a launch vehicle or during mission operations, solid rocket motor effluents, and paint flakes released by thermal stress or small particle impacts. Debris can also be created by collisions or by the explosion of spacecraft or the upper stages of launchers. Since 2007, major collision events (both accidental and intentional) have significantly increased the proportion of collision-induced debris in the overall debris population.

21. Objects larger than about 10 cm in diameter in low-Earth orbits (LEO) and larger than about 1 metre in the geostationary orbit (GEO) can be detected and tracked with ground-based sensors. The number of objects that are too small to detect from the ground but pose a significant risk to space missions is far larger. Even tiny debris or meteoroids smaller than 1 mm can pose a risk to exposed electric harnesses or other vulnerable components, possibly resulting in the loss of functions or even in a break-up.

22. Operational space objects comprise just five per cent of the overall catalogued population. The remainder of catalogued space objects have the potential to cause catastrophic collisions, yielding large-sized fragments that could lead to further catastrophic collisions. In some orbital regions this may cause an unstable, runaway situation often denoted as the Kessler syndrome, where the increase in the amount of debris from collisions exceeds the reduction due to orbital decay.

23. In 2007, the General Assembly, in its resolution 62/217, endorsed the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space. The Guidelines represent the first international consensus to reduce space debris and are an important step in providing all spacefaring nations with guidance on how to mitigate the problem of space debris. These qualitative guidelines are based on the technical content and the basic definitions of the Space Debris Mitigation Guidelines of the Inter-Agency Space Debris Coordination Committee (IADC).

24. A number of States are also using the IADC Space Debris Mitigation Guidelines, the European Code of Conduct for Space Debris Mitigation, and standard 24113:2011 (Space systems: space debris mitigation requirements) of the International Organization for Standardization (ISO) as a reference in their regulatory frameworks for national space activities. In this regard, some States have taken measures to incorporate internationally recognized guidelines and standards related to space debris in their national legislation.

25. At a technical level, States that have implemented national mechanisms for space debris mitigation use a range of approaches and concrete actions to mitigate space debris, including the improvement of the design of launch vehicles and spacecraft, end-of-life operations (including passivation and placing satellites into disposal orbits), and the development of specific software and models for space debris mitigation.

2. Space debris monitoring

26. Given the large number of potentially dangerous space debris objects, the complex evolution of both individual objects and their population as a whole, and the vast volume of near-Earth space over which the objects are scattered, regular monitoring of the situation in near-Earth space is extremely challenging and requires significant financial, technical and human resources.

27. No State in the world is currently able to provide a complete and constantly updated picture of the situation in orbit on its own. Thus, there is an objective need to combine capabilities in this area.

28. Space debris monitoring data cannot be correctly interpreted and used without understanding the methodology behind them. This fact must be taken into account during the planning, sharing and collaborative use of data. Therefore, a key aspect of international cooperation in the investigation of the man-made space debris environment in near-Earth space is the development and harmonization of common approaches to evaluating the quality of the data, interpreting them and assessing their potential use for specific tasks.

29. Currently only a few States carry out regular observation of space debris in near-Earth space. The development of common, mutually agreed approaches to verifying the information received from other parties and fusing data from different sources in a qualified way has been and remains a relevant issue. Furthermore there is no international mechanism for exchanging verified information that might be used by different countries which do not carry out observations themselves, but have qualified scientific personnel.

30. Another aspect of the problem is the lack of standard approaches to representing measurement data, which are primary in nature, and derived products on space debris, which include orbital information (centre-of-mass motion parameters), estimations of mass, size, attitude motion parameters relative to the centre of mass, and reflection characteristics.

3. Accuracy of orbital data

31. The accuracy of orbital data depends on a variety of factors, such as the quantity and accuracy of the measurements used, the distribution of measurements over the orbit determination arc, the geographical distribution of tracking sensors, and the suitability of the orbit determination and propagation techniques.

32. For functional objects, orbital data are usually obtained by traditional means, such as processing of ground control station trajectory measurements derived from telemetry. An increasing number of functional space objects use on-board navigation techniques, but the required accuracy of the orbital data is mainly dictated by mission or operational requirements, and these do not necessarily meet the spaceflight safety requirements. For space objects with no functioning on-board equipment, the only direct sources of orbital information are entities processing measurements acquired by radar and active, as well as passive, optical instruments. Radars constitute the primary source of information for large objects in LEO, while passive electro-optical sensors provide the majority of data for objects in high-altitude orbits.

33. The current geographical distribution and capabilities of these sensors are limited and in many cases do not permit the timely derivation of orbits of suitable quality for conjunction analysis and subsequent decisions on collision avoidance manoeuvres. The problem becomes even more pronounced for the increasing number of small-sized intact space objects such as CubeSats.

4. Conjunction assessment

34. More than 1,000 functional spacecraft in orbit today are joined by tens of thousands of pieces of space debris. The orbital collision of the functional Iridium 33 and non-functional Cosmos 2251 in February 2009 proved that a catastrophic satellite collision is a realistic possibility. Today an increasing number of spacecraft operators are attaching greater importance to avoiding collisions. Conjunction assessment can be divided into two categories: prelaunch screening and orbital conjunction assessment.

35. Launch vehicle operators are encouraged to avoid collisions during the system's launch phase and are expected to plan launch windows to avoid potential conjunctions with orbital objects. Some launch vehicle operators adjust launch times by screening for collisions with the International Space Station; a few of them also screen for collisions with functioning spacecraft. Some conjunction assessment organizations offer prelaunch collision avoidance screening services to assist launch vehicle operators in performing screenings and adjusting launch times. However, there are gaps in this process.

36. For example, there are no common standards to represent planned orbital insertion phase trajectories (i.e., before injection of all payloads into final orbits) and associated uncertainties for use in conjunction assessment analysis as described above. There is also no common practice for performing conjunction assessment analysis during the actual orbital insertion phase (until initial orbital insertion of all payloads). Even with the capability to perform conjunction assessment, the ability to adjust launch trajectories is limited by launch vehicle design and technology, and cannot be addressed by a guideline. Precise orbital insertion is often limited by fundamental

technical constraints. Further technical research and development would be required to address this gap.

37. There are various ways to address conjunction assessment in the orbital phases. Some operators are able to perform conjunction assessments themselves. Other operators work with appropriate organizations capable of performing conjunction assessments to screen the orbital parameters of functioning spacecraft against other space objects to identify potential conjunctions. Some operators interact directly with other operators to perform conjunction assessments and collision avoidance manoeuvres for spacecraft for which they are responsible.

5. Contact information for entities responsible for controlling spacecraft or performing conjunction assessment

38. When an orbital close approach is predicted after conjunction assessment or a trajectory adjustment is performed for orbital collision avoidance, timely notifications are important. It is also important to have timely coordination between relevant entities responsible for spacecraft operations and conjunction assessment.

39. Contact information facilitates coordination between relevant entities to make appropriate trajectory adjustment decisions. This contact information can also allow States with space monitoring capabilities to provide close approach notifications to potentially affected spacecraft operations entities, allowing them to make timely decisions on trajectory adjustments for collision avoidance. Moreover, entities with information on debris-producing events can also use contact information to share this information with other entities responsible for launch operations, spacecraft operations or conjunction assessment.

40. Although the national regulations of some States require private-sector satellite operators to provide contact information to entities that control spacecraft, there is no commonly agreed practice for States to compile and share this contact information with other States for the purpose of timely coordination for collision avoidance.

6. Prior notice of launches and controlled re-entries

41. During launches of space objects or controlled de-orbiting of space objects it is possible to provide prior notice for areas where surviving fragments of launch vehicle stages or spacecraft might fall. The projected ground impact area and time of fall can be estimated during the planning of the launch or while planning the controlled re-entry of a space object.

42. The value of furnishing such information in the context of the long-term sustainability of outer space activities is twofold:

(a) Prior notice of controlled re-entries of large spacecraft is a safety issue. Timely notices enable the reduction of risks of possible injuries or damage to assets on the Earth’s surface and in its airspace;

(b) Such notices are one of the measures to enhance transparency and trust between States, demonstrate responsible behaviour and enable appropriate awareness of such events.

43. The practice of providing special notices in aviation and maritime navigation is well developed and in current use. These notices contain, inter alia, information on danger zones in air and maritime areas that for a certain period of time can constitute a danger for aircraft and ships.

44. Only a few States currently have the technical capability to monitor the uncontrolled re-entry of objects into the Earth’s atmosphere, and no State has the

technical capability to predict the location and time of an uncontrolled re-entry with sufficient accuracy to issue actionable warnings.

7. Standards for sharing orbital information

45. Receiving, accumulating, sharing and distributing orbital information is necessary for ensuring the safety of orbital operations and for the determination and analysis of physical characteristics of space debris objects.

46. Strictly speaking, orbital information not accompanied by an assessment of its precision or calculated with simplified motion models should not be used when a decision about a potential collision avoidance manoeuvre is being made. Simplified motion models introduce a significant margin of error into the assessment of the predicted centre of mass position of the approaching object.

47. The existing, internationally recognized orbital information standards offer a considerable degree of flexibility for the description of both the data and the models for obtaining them. However, the formal use of information provided in line with those standards does not necessarily result in a correct conclusion, because the models used to process the basic measurement data, including models for accuracy estimation, may differ from one another.

8. Space weather effects on space systems

48. Space weather is the collection of changes in the Earth's natural environment and space-based and terrestrial infrastructure caused by solar events that alter the solar system space environment. These solar events include flares, the sudden eruptions of energetic photons and charged particles from the Sun's surface; coronal mass ejections, in which the Sun typically sheds billions of tons of mass of its atmosphere as magnetized plasma; and the solar wind, the continuous outflow of charged particles that race through the solar system at around 400 to 800 km/s or more. On Earth, these charged particles and high-energy photons have an impact on the dynamics of the near-Earth space environment, specifically the magnetosphere, ionosphere, and even the neutral atmosphere, and affect the operation of terrestrial and space infrastructure.

49. These space weather phenomena lead to increased radiation hazards for astronauts, charging of spacecraft surfaces and internal charging of spacecraft components, degradation of spacecraft solar arrays and materials, anomalous behaviour of electronic components, failure of computer memory units, blinding of optical systems, degradation or loss of spacecraft tracking information, anomalous drag and loss of altitude.

50. Space weather also causes changes in the ionosphere that disrupt high-frequency communications and alter the signals of global navigation satellite systems (GNSS). Commercial flights over the poles must reroute, at considerable expense, to protect crews from radiation exposure and to assure communications capability. Solar coronal mass ejections can disrupt the Earth's magnetic field, leading to electrical blackouts, potentially on a continental scale. Since global banking and finance rely on timing signals from GNSS, loss of this service due to a solar storm would lead to disruptions of this economic sector with unforeseeable secondary impacts. Space weather can also adversely affect some terrestrial infrastructure, including high-voltage electrical transmission systems and pipelines.

51. Additionally, swelling of the atmosphere as a result of space weather can change satellite orbits, thereby degrading space situational awareness information. This occurs in two ways. Firstly, the space debris population and its evolution are tied to the altitude-dependent density of the atmosphere, which is dependent upon solar effects.

Secondly, the ability to predict conjunctions and hence enable collision avoidance also depends on accurate knowledge of atmospheric density.

9. Models and tools for space weather prediction

52. Significant improvements in the mitigation of space weather effects can be obtained from a synergistic approach to the monitoring of space weather in the heliosphere that includes the modelling of space weather dynamics, the generation of space weather forecasts, studies of the impacts of space weather on technological systems, and the development and implementation of technical standards for the design and manufacture of vulnerable terrestrial and space-based infrastructure, including satellites.

53. A variety of Earth-based and space-based sensors are used to gather information about the conditions on the Sun, the interplanetary space environment, the Earth's magnetosphere, radiation belts and the ionosphere. These observations must be integrated to provide comprehensive situational awareness of space weather. These data are also used for space weather modelling and forecasting.

54. A variety of models have been developed to address different phenomena that contribute to space weather. These include models for sunspots, solar flares, solar coronal mass ejections, the solar corona, and the solar wind. There are also models for the interaction of these solar phenomena with the interplanetary space environment and with the Earth's magnetosphere, the Van Allen radiation belts and the Earth's ionosphere and atmosphere.

55. The risks posed by space weather phenomena to space systems may be mitigated from an engineering and operations perspective through implementing certain design approaches, technical standards and operational practices that reduce or avoid the adverse effects of space weather on operational space systems.

56. The long-term improvement of space weather services requires coordinated, committed partners from around the world. International cooperation is necessary to create a shared satellite-based system for critical observations, to maintain reliable access to regional data, to advance service capabilities, and to ensure the global consistency of the end products that are delivered to users of space weather information and data services. There is an urgent need to adopt a coordinated approach to the collection, collation, and access to key data, metadata, design guidelines, space weather models and forecasts, and the reporting of the occurrences of space weather effects and related information, such as records of operational satellite anomalies.

C. Regulatory frameworks for space activities

1. Regulatory practices

57. The development of national regulatory frameworks provides an opportunity to promote behaviours that enhance the long-term sustainability of outer space activities. In this regard, it is important to encourage advisory input from participants in space activities likely to be affected by any regulatory developments.

58. Regulation of space activities may involve multiple regulatory bodies dealing with different issues pertaining to, inter alia, launch safety, on-orbit operations, radio frequency usage, remote sensing activities, end-of-life disposal and controlled items. For this reason it is important to ensure that appropriate communication and consultation mechanisms are in place within and among the competent bodies that oversee or conduct space activities. Communication within and among relevant

regulatory bodies can promote regulations that are consistent, predictable and transparent so as to ensure that regulatory outcomes are as intended.

59. Regulations should address risks to people and property and should provide clear guidance to participants in space activities under the jurisdiction and/or control of a particular State.

60. Existing international standards and recommended practices can complement regulation. These include standards published by ISO, the Consultative Committee for Space Data Systems, and national standardization bodies and recommended practices published by IADC and the Committee on Space Research (COSPAR).

61. Dissemination of information and appropriately targeted outreach and education can assist all participants in space activities in gaining a better appreciation and understanding of the nature of their obligations, which can lead to improved compliance with the existing regulatory framework and the practices currently being employed to enhance the long-term sustainability of outer space activities. This is particularly valuable where the regulatory framework has been changed or updated, resulting in new obligations for participants in space activities.

2. Spectrum protection

62. Radio frequency communications play a key role in space activities. Radio waves not only convey commands to satellites, but also allow satellites to transmit data back to Earth and to provide services that are critical to the normal functioning of the modern information society. Radio frequency interference can interrupt or impede the performance of satellites and result in the loss of data or disruption of services. In addition, a number of space-based systems for Earth observation rely on certain regions of the electromagnetic spectrum and are susceptible to interference from artificial sources of electromagnetic radiation.

63. As the radio frequency spectrum is a finite resource which crosses national boundaries, international coordination and cooperation is needed to ensure that this resource is used in a rational and equitable manner, in accordance with the Radio Regulations and Recommendations of the International Telecommunication Union.

64. Even with existing international mechanisms for cooperation, further work is needed to ensure that countries or groups of countries have equitable access to radio frequencies, to ensure that space activities are conducted in such a way as to prevent harmful interference with the space activities of other States and intergovernmental organizations, and to improve measures for prompt resolution when cases of harmful radio frequency interference do occur.

3. Registration information

65. The Convention on Registration of Objects Launched into Outer Space, adopted by the General Assembly in its resolution 3235 (XXIX) of 12 November 1974 and entered into force on 15 September 1976, is one of the five international treaties governing outer space developed under the auspices of the United Nations. As of December 2014, there were 62 States parties to the Registration Convention and four signatory States. There were also three international intergovernmental organizations that have declared their acceptance of the rights and obligations under the Convention. States not parties to the Convention can use General Assembly resolution 1721 B (XVI) of 1961 as the basis for voluntary registration submissions.

66. Under the Registration Convention, every space object launched into Earth orbit or beyond shall be entered in a registry maintained by its launching State. The Convention defines “launching State” to mean (a) a State that launches or procures the

launching of a space object; or (b) a State from whose territory or facility a space object is launched.

67. General Assembly resolution 62/101 recommends enhancing the practice of States and international intergovernmental organizations in registering space objects and also recommends, with regard to the harmonization of practices, that consideration should be given to the furnishing of additional appropriate information to the Secretary-General of the United Nations on the geostationary orbit location, any change of status of a space object in orbit, such as change of status in operations (inter alia, when a space object is no longer functional), the approximate date of decay or re-entry, the date and physical conditions of moving a space object to a disposal orbit, the date of change in supervision, the identification of the new owner or operator, any change of orbital position and any change of function of the space object.

68. The lack of comprehensive information on objects launched into orbit results in a patchy and incomplete picture of what is in orbit and where. This affects space situational awareness, and ultimately safety too, if a potentially hazardous situation arises and inadequate information is available to identify a space object and/or its operators, or it is unclear under whose control or jurisdiction the object falls. The importance of the link between supervision and registration is therefore underlined. Providing appropriate and accurate information about space objects, as recommended by Assembly resolution 62/101, requires a close link between the operator of the space object and the supervising State. It is desirable that the State of registry should also be the State initially responsible for the supervision of space operations of a given space object.

V. Guidance for States and international intergovernmental organizations

[*Section V will provide information on the topics on which the Working Group has reached consensus and on why the international community felt the time was right to agree on related guidance. This section will be drafted once decisions are made on what content will be included in the full compendium of guidelines.*]

VI. Working Group considerations

[*Section VI will reflect ideas that the Working Group considered but upon which no consensus was reached. A summary of the substantive debates on various ideas will be included. This content will be drafted once decisions are made on what guidelines will be included in the full compendium.*]

VII. Topics for future consideration

[*Following from the consideration of section VI, this section will suggest topics for future consideration. Indicative paragraphs are provided. For the time being, the indicative paragraphs focus on recommendations made by the expert groups, as it will only be possible to finalize this list of topics for future consideration once decisions are made on what guidelines will be included in the full compendium.*]

69. The expert groups identified a number of issues relevant to the long-term sustainability of outer space affairs that are still open or for which the current state of knowledge is inadequate to propose candidate guidelines. The expert groups have therefore recommended these issues as topics for future consideration by the

Committee and its Subcommittees. These topics are presented in the following subparagraphs:

(a) The Committee should consider the issue of the exploitation of natural resources in outer space in the context of sustainable development;

(b) The Committee should consider the compilation of a compendium of measures, practices, standards and other elements conducive to the safe conduct of space activities, including the sustainable exploitation of natural resources in outer space. Such a compendium could be made freely available and promoted by all participants in space activities, including States and international intergovernmental organizations;

(c) The Committee should work towards the development of initiatives for space benefits and for equitable, efficient and rational access to space to support sustainable development on Earth;

(d) The Committee should consider the development of new standards for the avoidance of harmful contamination of outer space to promote the long-term sustainability of outer space, including celestial bodies;

(e) The Committee should consider the scientific, technical and legal questions arising from active removal of space debris. For instance, regulatory issues still to be addressed include the identification of the launching State and the responsible State in relation to a space object, the question of whether it is necessary to get the consent of the State or States involved, and the question of who bears the costs and risks of such an activity. The Committee should consider whether active space debris removal could be undertaken or authorized by a single State, or if an international framework for active space debris removal under international consensus would be more suitable;

(f) The Committee should consider ways and means to develop a basis for the coordination of ground- and space-based research and operational infrastructure to ensure the long-term continuity of critical space weather observations;

(g) The Committee should consider ways and means to improve the coordination of space weather information, including observations, analyses and forecasts, to support decision-making and risk mitigation related to the operation of satellites, spacecraft, and suborbital vehicles, including rockets and vehicles used in human spaceflight;

(h) The Committee should work towards developing definitions of terms related to a number of key issues affecting the long-term sustainability of outer space activities. Regulation is generally most effective when there is a clear understanding of the scope of the regulation. In addition, the increasing connection between ground infrastructure and space infrastructure indicates that the definition of space activities may become important to States in the future, within their national regulatory frameworks;

(i) The Committee should work towards developing regulations relating to the ownership of space objects. While under existing international law, all objects in space are under the jurisdiction of a State, regardless of their funding source, functionality or integrity, space objects increasingly have multiple owners. Hosted payloads are increasingly common, increasing the number of ownership interests in a single satellite. A single launch can now deliver the payloads of many different entities into orbit (for example, launching a number of CubeSats), which could potentially blur the lines of responsibility and ownership;

(j) The Committee should work towards enhancing the practice of States and international intergovernmental organizations in registering space objects, as recommended by the General Assembly in its resolution 62/101 of 17 December 2007. A variety of practices currently exist with regard to the quality and timeliness of information being provided, and this undermines the utility of global information-sharing;

(k) The Committee should work towards improving consistency in the practice of States concerning licensing, registration fees and insurance requirements. Inconsistencies in current practices concerning licensing, registration fees and insurance requirements may encourage "regulation shopping", which may not encourage efficient practices and procedures in relation to the long-term sustainability of outer space activities;

(l) The Committee should work to implement a process to evaluate the impact, and review the progress of, the implementation of the guidelines on the long-term sustainability of outer space activities, and to update the guidelines, if deemed necessary.