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Long-term sustainability of outer space activities

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Working paper submitted by the Russian Federation**

1. The examination of issues concerning the long-term sustainability of outer space activities is a new and important factor that is substantially revitalizing the context of multilateral space diplomacy. Relevant activities are based on a strong and practical motivation shared by the vast majority of States, namely that of ensuring, on the basis of objective factors and criteria, a qualitative analysis and the fullest possible assessment, firstly, of the risks associated with space activities, the reasons for the emergence of those risks and the conditions necessary in order to reduce (minimize or eliminate) them and, secondly, the viability and effectiveness of related preventive and corrective measures.

2. The interim results of the work carried out by the Working Group on the Long-term Sustainability of Outer Space Activities of the Scientific and Technical Subcommittee should, in the opinion of the Russian Federation, be viewed as predominantly positive. The activities carried out within the framework of the Working Group effectively assist in the identification of factors determining the long-term sustainability of outer space activities and influencing, inter alia, the nature and magnitude of various risks. In any case, this facilitates a better understanding both of the most pressing problems and of challenges and threats in the long term.

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3. The fact that the extent of the use of outer space is growing while at the same time anthropogenic pollution of space is continuing should not compel the Working Group to rush the adoption of guidelines on the long-term sustainability of outer space activities by means of unjustifiably hasty decisions that have not been fully thought through, particularly with regard to issues concerning the safety of space operations (which relates directly to the long-term sustainability of outer space) and security of outer space activities in general. The working paper submitted by the Russian Federation previously (A/AC.105/L.285) identifies a range of problems requiring greater attention and careful analysis.

4. Factors contributing to, and forecasts of, an increase in objective and subjective challenges and threats relating to spacecraft, networks and infrastructure, and criteria for evolution of challenges into threats, as well as principles and mechanisms for, and forms of, practical cooperation among States in overcoming such challenges and threats, require a comprehensive and well-founded assessment. Only on that basis will it be possible to jointly develop generalized rather than separate criteria for assessing the effectiveness and feasibility of implementation of guidelines on the long-term sustainability of outer space activities.

5. The Russian Federation pursues a policy of responsible and peaceful use of outer space and considers that the prerequisites for renewed and significantly more dynamic consideration of issues relating to the safe and predictable conduct of space activities evolving not only in the Committee on the Peaceful Uses of Outer Space but also in the Group of Governmental Experts on Transparency and Confidence-building Measures in Outer Space Activities and at other forums and consultations will, as a whole, contribute effectively to the establishment of a common system of measures, means and tools for ensuring the safety of space activities. In the context of the preparation of decisions relating to the long-term sustainability of outer space, the future report of the Group of Governmental Experts, the scope of the draft code of conduct for space activities and the possibility of commencement of substantial work on space-related issues at the Conference on Disarmament are obviously also of interest to the Russian Federation. Such a comprehensive approach to what are interlinked issues greatly facilitates the formation of a logically constructed decision-making chain with regard to the long-term sustainability of outer space activities at both the international and the national level.

6. The indisputable independent significance of the efforts undertaken by the Scientific and Technical Subcommittee to establish the concept of and practices for ensuring the long-term sustainability of outer space activities is seen in greater understanding of the fact that States must be capable of conducting space activities in such a way as to reduce and prevent related risks, while consistently improving their regulatory and technological frameworks with a view to achieving this goal. In the Russian Federation, in the context of the fundamental objectives, main areas and key principles of national space policy (set out in the State programme “Space activities of the Russian Federation for the period 2013-2020”, approved by the Government of the Russian Federation in December 2012, and in the “Policy framework of the Russian Federation relating to space activities for the period up to 2030 and beyond”, approved by the President of the Russian Federation in April 2013), additional measures to develop organizational, managerial and technical solutions are to be implemented system-wide facilitating the creation of

conditions conducive to ensuring the long-term sustainability of outer space activities. The Policy framework defines as one of the main tasks of international cooperation pursued by Russia active participation in examining and addressing, at the international level, issues pertaining to the anthropogenic pollution of near-Earth space, including issues relating to prevention of the creation of space debris in, and removal of such debris from, the regions where operational orbits of spacecraft are located. The document sets out the policy objective of ensuring the safety and long-term sustainable development of space activities, compliance with measures to protect near-Earth and deep space and the introduction of technologies and systems limiting the creation of space debris during the launch and operation of space rocket equipment. It also prescribes the establishment of a single State information and analysis system for provision of the safety of space activities and a system for interaction among the relevant federal executive bodies in the event of crisis situations relating to space activities, including cooperation at the international level.

7. The list of issues under examination by the Working Group's four expert groups gives reason to expect that it will be possible to reach a better understanding of the nature of and factors governing the interplay between the various components of the broad issue of the long-term sustainability of outer space activities, while the substance of the future guidelines will not be limited strictly to the issues of space debris, space operations and space situational awareness.

8. The Russian Federation reaffirms its previously stated position (inter alia, jointly with Ukraine in working paper A/AC.105/C.1/L.322) with regard to the need to develop a guideline for the use and transfer of space technologies within the framework of international cooperation, as provided for in the document "Terms of reference and methods of work of the Working Group on the Long-term Sustainability of Outer Space Activities of the Scientific and Technical Subcommittee". The version of the relevant guideline included in the prepared compilation of the draft guidelines may enable the Scientific and Technical Subcommittee to focus on that issue in greater detail.

9. At the suggestion of the Russian delegation, supported in expert group B, in the guidelines on the long-term sustainability of outer space activities, as currently being drafted, emphasis has been placed on addressing new aspects that have not been discussed previously, without duplication of the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space.

10. The problem of ensuring the long-term sustainability of outer space activities has obvious information- and communication-related dimensions that must be addressed in an active manner. This necessitates the identification of requirements with respect to information whose exchange is to be facilitated by the future guidelines on the long-term sustainability of outer space activities (issues include completeness, reliability, verification, information formats, systems for information exchange). In that regard, the issue of the preparation and adoption of uniform international standards for information exchange in relation to the long-term sustainability of outer space activities is of particular importance. The draft "Conjunction Data Message" standard developed by the Consultative Committee for Space Data Systems (standard CCSDS 508.0-R-1) is an example of progress towards that objective in terms of technical solutions. However, it should be borne in mind that many issues require comprehensive solutions at the policy level.

11. Since the adoption of the Space Debris Mitigation Guidelines, Russia and other countries have built up experience in their application that should be taken into account in the context of the long-term sustainability of outer space activities. Information models of the anthropogenic situation in near-Earth space play a key role in determining the characteristics of long-term sustainability itself. The results of research into the origin, characteristics and evolution of space debris objects represent one of the sources of input data for such models. However, there is as yet no common international practice of exchange of information for the purpose of updating and verifying models within the framework of a single monitoring centre concept. A number of issues in that area that in technical, policy and legislative terms are rather complicated and even delicate, are yet to be addressed. Nevertheless, real opportunities for the establishment and consistent development of such practice exist. A good example is the practice of exchange of information on space debris among the research organizations of several countries, particularly under the International Scientific Optical Observation Network (ISON) project, which is coordinated by the Russian Academy of Sciences and is in partnership relations with the United Nations Basic Space Science Initiative (UNBSSI). The project, which is being implemented in accordance with the objectives set out in relevant United Nations General Assembly resolutions (including resolution A/RES/66/71 of 12 January 2012), serves as an example of open and fruitful cooperation which has greatly enhanced current knowledge of the real extent of pollution of the geostationary orbit.

12. In 2012, design studies on the construction of special ground-based and orbital facilities for monitoring fragments of space debris in various regions of near-Earth space continued to be carried out in the Russian Federation under the guidance of the Federal Space Agency (Roscosmos). As a result, a comprehensive project for further development of existing and the construction of prospective facilities for monitoring near-Earth space objects was created with the aim of providing information support for a unified Space Threats Warning and Countering System.

The project was developed by the JSC “Vympel” Interstate Corporation in cooperation with industrial enterprises and institutions of the Russian Academy of Sciences.

The project covers conceptual issues relating to the development of observation facilities and information and analysis centres for monitoring space debris in near-Earth space and issuing warnings of threats posed by asteroids and comets. The main results of the project are as follows:

(a) Substantiation of the need to improve existing and create prospective Russian means for the detection and monitoring of dangerous space objects, including means for detecting and monitoring anthropogenic space debris in near-Earth space and dangerous asteroids and comets, with the aim of providing data support for activities to prevent and counter threats posed by such objects;

(b) Identification of common requirements for information support with respect to activities to prevent and counter space threats;

(c) Development of a rationale for the establishment of a unified (national) Outer Space Monitoring System as the informational basis for the Space Threats Warning and Countering System;

(d) Development of the structure of the Outer Space Monitoring System and information network to be used by various constituent entities of that system;

(e) Development of a rationale for further advancement of existing and design of new dedicated ground-based and orbital radar and optical means for detecting and monitoring near-Earth space debris and hazardous asteroids and comets, as well as for the development of information and analysis centres for the collection, processing and analysis of measurement data generated by the Outer Space Monitoring System;

(f) Development of a rationale for the construction of new radio systems for monitoring the use of orbital and frequency spectrum resources in near-Earth space;

(g) Substantiation of the need to integrate existing information means and to reinforce inter-agency coordination and interaction with national and foreign users of information on current developments in near-Earth space, dangerous conjunctions between space objects and hazards presented by asteroids and comets.

The results of the work carried out in this field have been well received at the interagency level. The requisite conditions and procedure for practical implementation of the proposals that have been developed are currently being elaborated in details.

13. The exchange of information on fragments of space debris, obtained using all types of ground-based and orbital measurement, will facilitate a deeper understanding of the long-term forecasts of the extent of pollution of near-Earth space used by experts from various countries. It may be presumed that such exchange will also assist in the formulation of clearer criteria for assessing the threat posed by large fragments of space debris from the point of view of expediency of their removal from orbit. Without such information exchange, the practical and effective implementation of measures to ensure the long-term sustainability of outer space activities will be problematic.

14. It appears useful to give due consideration within the framework of expert group B to the draft guideline, currently being elaborated, that envisages a recommendation to States to distribute notifications on areas of airspace and the oceans that may be affected during space launch operations and the controlled removal of space objects from orbit. The Russian Federation proceeds from the understanding that if, within the framework of such procedures for the issuing of notifications, the principle of openness is observed and practical considerations are taken into account, such notifications should be “tied” to specific space operations.

15. Practice has shown that the implementation of Guideline 3 of the Space Debris Mitigation Guidelines, containing a recommendation to avoid accidental collisions in orbit, is extremely difficult in practice for the following reasons:

(a) Firstly, the guideline refers to “known objects”. However, to date there is no universally recognized international database of all objects in orbit (functional and non-functional space objects, including fragments of space debris) that contains regularly updated orbital data and estimations of the accuracy of that information. It is precisely such an international database that should serve as a tool in the implementation of the guideline under consideration. Otherwise, a specific participant in space activities may interpret “known objects” as referring to the population of objects known precisely to that participant. In such a case, a situation

might arise in which a space object manoeuvres to avoid a possible collision with a "known object" only to enter the trajectory of likely collision with another object not known to the said participant in space activities but quite possibly known to another participant in space activities;

(b) Secondly, the term "available orbital data" used in the guideline is, as practice has shown, understood by some participants in space activities as essentially any orbital data from any source. However, by no means all such data can or should be used to assess the risk of conjunction of objects. Orbital data that are not accompanied by any estimation of its accuracy should not, in principle, be used in making the relevant calculations, and especially not in taking decisions as to whether it is necessary to carry out avoidance manoeuvres. Likewise, orbital data calculated using simplified motion models that introduce a significant margin of error into the assessment of the predicted centre-of-mass position of the approaching object should not be used in analysis. If a spacecraft that is adjusting orbit poses a threat to another spacecraft (in that it is expected to be in conjunction with that spacecraft), then data on its movement trajectory that take into account all future (planned) orbit change operations during the time interval the analysis is carried out should be used as orbital data for the purposes of analysis of the conjunction risk. Thus, the requirement of effective and practical implementation of the guideline under consideration inevitably necessitates creation of a unified, internationally recognized source of reliable and regularly updated orbital data on objects in near-Earth space;

(c) Thirdly, there is currently no uniform, universally accepted standard for calculating the probability (risk) of collisions on the basis of which it would be possible to decide whether or not a spacecraft should carry out an avoidance manoeuvre. Consequently, every operator of spacecraft, when calculating such probability, is forced to rely solely on its own methodology;

(d) Fourthly, the problem of preventing likely collisions during launches is even more complex. This is because in many cases (particularly during launches of spacecraft into high orbits) the launch phase is long and complex and involves several inter-orbital transfers. At the same time, the flight control systems used are constantly being improved supporting increasingly complicated launch sequences. Accordingly, in a number of cases it is extremely difficult to select a specific trajectory during launch specifically for the purpose of analysing collision risks (the actual trajectory may, within certain limits, differ from the trajectory calculated prior to the launch, and the space area encompassing all possible trajectories might cover a significant expanse of near-Earth space). This circumstance presents further challenges to assessment of probable collisions during planned launches and necessitates both the development of considerably complex algorithms and programs and the establishment of close cooperation in information exchange between launching entities and organizations that monitor objects in near-Earth space.

Practical solutions to the problems indicated above should, in the context of the long-term sustainability of outer space activities, be developed considering, inter alia, the decisions expected to be taken within the framework of the Group of Governmental Experts.

16. One of the topics selected for examination by expert group B is functional spacecraft manoeuvre notifications. However, to date, no common definition of "manoeuvre operation" (that would, in particular, take care of gradations of velocities or of adjustment of orbital parameters etc.) has been established. Depending on the mission of a given spacecraft, "manoeuvre" might be understood as a target change in velocity of several millimetres per second, several centimetres per second, several metres per second or even — in the process of inter-orbital transfers during launch into the target orbit — more than a kilometre per second. With this in mind, a considerable amount of information on the spacecraft itself (mass, attitude, etc.), on its propulsion systems (characteristics, operating modes, etc.) and on the planned sequence of operations (orientation of the spacecraft, ignition sequence of propulsion systems, etc.) is in any case needed in order to calculate the trajectory of the spacecraft, taking into account the acceleration produced by its engines. It is unlikely that such data could be provided with respect to all functional spacecraft (if the furnishing of such data by various countries is possible at all, given the delicate nature of the issues concerned). Furthermore, in terms of ensuring the safety of flights, there is no particular need for such information.

In some situations (for example, if a spacecraft is keeping its station in geostationary orbit using low-thrust propulsion, when trajectory adjustment engines are engaged for many hours), it may be inappropriate, in principle, to refer, in the context of addressing the problem of preventing possible collisions, to a "manoeuvre operation" and to use information on the predicted position of the centre of mass of the spacecraft. Instead, it may be appropriate to refer to a description of the region of space in which the spacecraft in question is located. The practice of simplified description of such regions is broadly applied, for example, by the International Telecommunication Union for space stations in the geostationary orbit. Modalities should therefore be elaborated for the application of a similar approach with regard to the task of ensuring the long-term sustainability of outer space activities.

Thus, the only type of information necessary for analysis of possible dangerous conjunctions is data on the predicted position of the spacecraft's centre of mass and on the estimation of the accuracy of that predicted position. That information is produced by the relevant organizations responsible for the control of the spacecraft, and takes into account any planned changes to the trajectory of the centre of mass of the spacecraft.

In the context of the practices of non-governmental organizations as examined by the Working Group, experts noted that within the framework of the activities, for example, of the non-profit Space Data Association, the type of information exchanged is indeed orbital information that takes into account planned trajectory changes, rather than information on manoeuvres.

Whenever in the context of the long-term sustainability of outer space activities consideration is given to issues relating to planned or completed changes to the trajectory of a functional spacecraft owing to the acceleration produced by the spacecraft itself ("manoeuvre operation"), the possibility and appropriateness of using the terms "ephemerides information", "trajectory description" or "spacecraft centre of mass position description" instead of "manoeuvre" or "manoeuvre operation" should be considered.

At the present stage, no universally accepted practice has yet taken shape with regard to the exchange of reliable orbital data that take into account operations to change the orbit of spacecraft. When discussing that issue, it might be useful to consider, inter alia, the recommended standard "Orbital data messages" (standard CCSDS 502.0-B-2) developed by the Consultative Committee for Space Data Systems.

17. The Russian Federation views the development of guidelines for ensuring the long-term sustainability of outer space activities as a major and system-wide project as a result of implementation of which — so it is planned — a series of new international and national mechanisms for interaction between participants in space activities will be put in force. In that context, and on such premises, the Russian Federation is formulating its position with regard to analysis of the idea taken up by the Working Group concerning the establishment, by making use of a "supranational procedure", of direct contacts and links between spacecraft operators themselves and between those operators and centres for monitoring and analysis of the situation in near-Earth space. It is notable that, also in the work which has been carried out within the framework of the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space on draft recommendations on national legislation relevant to the peaceful exploration and use of outer space, clear attempts have been made to lend legitimacy to such a "supranational procedure".

As a preliminary comment, it appears that the rather widely anticipated positive effect of the implementation of such procedures is definitely being overestimated, while potential negative consequences of possible serious errors during the preparation and adoption of decisions on specific actions to be taken in certain situations are clearly being underestimated.

The draft guideline relating to this issue in its current version lacks a reasonably sufficient depth of detail with regard to institutional aspects and loses sight entirely of the regulatory functions and areas of responsibility of States according to the fundamental principles of international space law. In particular, the norm contained in article VI of the 1967 Outer Space Treaty, which establishes the responsibility of States for national activities in outer space, whether such activities are carried on by governmental agencies or by non-governmental entities, are actually disregarded. The guideline should therefore, inter alia, provide for a mechanism for cooperation between participants in space activities through contact focal points officially designated by each State or international intergovernmental organization engaged in space activities. At the same time, it may allow for certain more flexible and expeditious forms of direct interaction between and with operators, subject to the procedure, that should be provided for in the same principle, for obtaining the concurrence of the national authority responsible for conducting space activities or of any other competent body carrying out relevant licensing and monitoring functions.

The considerations set out above do not imply that the Russian Federation would prefer to curtail an increase in the level of involvement of national space operators in the adoption of decisions relating to ensuring the safety of flight of spacecraft in conditions of anthropogenic pollution of near-Earth space. On the contrary, in the Russian Federation work has been completed on the first phase of the establishment of an automated detection and warning system for hazardous situations in near-Earth space (ASPOS OKP) that implements organizational and

technical procedures for interaction with operators of spacecraft, and the procedure for providing operators of spacecraft with timely, reliable and complete information is being strengthened. The system provides operators of spacecraft with the necessary opportunities for obtaining information from a centralized source (under the auspices of Roscosmos) for use in planning safe operations in space. In the meantime, operators have the possibility of direct interaction with one another using standard technical solutions and procedures for information exchange.

18. With regard to the preparation of the draft guidelines on the long-term sustainability of outer space activities, considerable attention should be given to the modalities for practical implementation of the recommendations of the United Nations General Assembly on enhancing the practice of States and international intergovernmental organizations in registering space objects (resolution A/RES/62/101).

The Administrative Regulation of the Federal Space Agency on the implementation of the State function of maintaining the registry of space objects launched into outer space by the Russian Federation entered into force in Russia in 2010. The said Administrative Regulation, which supersedes previous regulations, sets out in detail the sequence and type of all relevant administrative actions. The registration procedure involves the receipt, verification, gathering and use of information on space objects that have been launched and the incorporation of amendments and clarifications in records upon the results of interaction with federal executive bodies concerned, as well as persons operating space objects, international organizations and foreign States in accordance with the requirements of the legislation of, and the international obligations undertaken by, the Russian Federation.

Roscosmos, when deciding to carry out a launch, takes into account whether or not there are legal or other grounds for the registration of such space objects. In communications concerning the launch of a foreign space object, a reference should be made to the specific State in whose registry that space object is to be recorded. In that regard, in accordance with inter-agency coordination procedures, a draft directive on the launching of such a space object is submitted to the Government of the Russian Federation.

In the Administrative Regulation, specific provision is made for cases in which there are two or more launching States, including the Russian Federation, in respect of a space object, and when the registration request is not planned to be made in the Russian Federation. In such cases, Roscosmos or another federal executive body, in order to ensure that the Government of the Russian Federation adopts a directive on the launching of such a space object, initiates the procedures required in order to obtain from the organization that has signed a contract for the launch of that space object the assurances of the State under whose legislation property rights over the space object are registered, or of another interested State with regard to the inclusion of the space object in the national registry of that State.

In view of the format and content of the United Nations General Assembly recommendations referred to above, which are distinguished by many merits, their practical application (whether in full or in part) objectively necessitates the in-depth review (enhancement) of current national statutory procedures for the regulation of a number of aspects of space activities that to a large extent relate to issues of

national safety. Consequently, the voluntary implementation of such long-term recommendations, particularly those requiring greater openness on the part of all States, requires a significantly higher degree of confidence in their relations with one another. This underscores the fact that the dimensions of the problem of the long-term sustainability of outer space activities, both those that are currently perceived and those to be identified in the future, in many ways depend on political and legal categories and concepts relating to the domain of strengthening confidence in outer space activities. There are reasons to expect that the implementation of a significant number of complex procedures and functions arising from the recommendations of the General Assembly will inevitably necessitate the development of mechanisms based on a sufficiently broad international basis.

19. The Russian Federation, within the framework of strengthening and expanding legislative, administrative and technical resources for addressing current tasks associated with the long-term sustainability of outer space activities, intends to ensure the comprehensive development of ways and means of adapting best practices and the enforcement of improved procedures in that area. Such activities, for objective reasons, presuppose extensive research on a range of space activity scenarios and the preparation of reliable assessments of the relationship between the costs of implementing certain solutions and the results obtained. This should be duly taken into account in the activities of the Working Group.