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Long-term sustainability of outer space activities

Bridging the gap: Empowering States in pursuit of space sustainability

Paper submitted by the Islamic Republic of Iran

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Long-Term Sustainability (LTS) of Outer Space Activities

Bridging the Gap: Empowering States in Pursuit of Space Sustainability

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I. Introduction

The increase of space debris, the challenges related to large constellations and the increased risks of collision and interference with the operation of space objects as a result of the growth of the accessibility to outer space as well as the increasing number of stakeholders, definitely affect the long-term sustainability of space activities. The COPUOS guidelines for the Long-Term Sustainability of outer space activities (LTS) aim to assist Member States to mitigate the risks associated with the conduct of outer space activities while preserving the outer space for future generations.

The closely study of the guidelines, particularly the section B indicated that the voluntary implementation of the guidelines posed some challenges for Member States. Not all States possess the means to fulfill these requirements, access necessary data, or harness the requisite technology.

II. Requirements for Voluntary Implementation

1. In order to implementation of the guidelines on voluntary basis, it is essential to address three key categories of requirements: (1) *Data and Information*, (2) *Knowledge and Technology*, and (3) *Infrastructures and Technical Resources*. These categories are critical components of a comprehensive approach to promote safe and sustainable space activities. In the subsequent analysis, each of the three categories outlined in *Section B* of the LTS guidelines are thoroughly evaluated **(Table No. 1)**.

Table No. 1. Requirements for LTS Guidelines (Section B) Implementation

Main Requirement	Subcategory (according to the guidelines)	Required Elements
Data and Information	Information on Space Objects	• Accurate, precise and up-to-date information on orbital data, status, and properties of space objects; • Experiences and information on the operation and end-of-life disposal of space objects; • Information on forecasted uncontrolled re-entry of high-risk space objects
	Information on Conjunction Assessment	Information on appropriate interpretation and usage of conjunction assessment.
	Space Weather Data	• Space weather data, space weather model outputs, and forecasts; • Real-time monitoring, identification of critical data sets, addressing gaps and operational models for space weather
Knowledge and Technology	Space Object Tracking, Trajectory Prediction, and Conjunction Assessment	• Expertise in space objects monitoring, tracking, and conjunction assessment; • Space objects trajectory prediction during uncontrolled re-entries
	Space Weather Monitoring and Forecasting	• Technical expertise in space weather monitoring, data analysis, and forecasting; • Space weather observation, modeling, forecasting; • The impact of space weather on space system design and mission planning
	Laser Beam Illumination	• Technical expertise in using lasers generating beams in near-Earth outer space; • Understanding potential risks associated with laser beam illumination
Infrastructures and Technical Resources	Information Representation and Sharing	Standards and formats for data exchange, Application Programming Interfaces (APIs) for data access and sharing, Cloud-based platforms to share and disseminate multi-resource information
	Space Objects Measurement and Monitoring	• Radar and optical telescopes, ground-based and space-based sensors for measurement, monitoring, and characterization of space objects;

		• Space system design tools, on-board technologies such as transponders, GPS receivers, radio frequency identification as well as computer-aided design software
	Uncontrolled Re-entry Risk Mitigation	Design techniques such as heat shields, explosive bolts for controlled breakup of objects during re-entry, design modifications to minimize risk associated with fragments to survive uncontrolled re-entry
	Space Weather Data Collection and Analysis	Space-based and ground-based assets such as satellites, magnetic fields, and radiation ground-based observatories, computer models to accumulate space weather data, space weather models and forecast tools for observing space weather
	Laser Beam Illumination Analysis	• Computer models to analyze probability of accidental illumination by laser beams, quantitatively evaluating laser radiation power, assessing risk to space objects; • Equipment such as laser rangefinders, laser power meters

III. Conclusion

- The paper, despite the voluntary implementation of the Guidelines, highlights some key "required elements" which are crucial to the implementation of the Guidelines. In this vein, it is crucial to carefully address the challenges associated with the availability of these "required elements" among Member States within the COPUOS.
- International cooperation and capacity building including joint projects, transfer of technology and equipment, knowledge and data sharing, and providing access to infrastructure play a pivotal role in providing the "required elements". In this regard, the Member States have the main responsibility to assist other Member States, irrespective of their degree of economic or scientific development, without discrimination of any kind in developing their space capabilities through cooperative endeavors including capacity-building workshops, knowledge-sharing platforms, technical assistance, and the available tools.
- The implementation of the Guidelines shall be pursued in accordance with Member States' respective needs, conditions, and capabilities, in particular, data and information, knowledge and technology, and infrastructure and technical resource. In this regard, implementation of non-legally binding and voluntary Guidelines is dependent on the international cooperation and technical cooperation delivered to Member States.