

Long-Term Sustainability of Outer Space Activities and Space Traffic Management

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This research addresses the critical importance of long-term sustainability and coordinated management of space traffic in the era of rapidly increasing space activities. It focuses on the necessity for globally coordinated action and robust legal frameworks to ensure operational, feasible, and enforceable space sustainability and traffic management strategies. The discussion highlights the environmental, ethical, and economic challenges posed by space debris and the proliferation of space activities. It also examines key initiatives and guidelines for space sustainability and traffic management, including the roles of space situational awareness (SSA) and the integration of SSA capabilities with effective space traffic management (STM). The presentation emphasizes the urgency of promoting environmentally responsible behaviors and sustainable practices in space activities, advocating for a future-focused approach that balances current needs with the preservation of outer space for future generations.

Keywords: Space Sustainability, Space Traffic Management, Space Environment, Space Debris, Space Law, Space Policy.

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Introduction

Long-Term Space Sustainability and Space Traffic Management are two highly complex and critical topics for the state of space environment issues that, for now, remain as mere concepts rather than real tools powered by global commitment and engagement fostering order, transparency, certainty and predictability of operations in space.

Who truly cares about these concepts? Who strives to shape an adequate legal enterprise where these concepts are operational, feasible, self-sufficient mechanisms, and fully enforceable for the purposes of accountability? It is unfortunate to say that this most definitely is not the case for all space actors.

We cannot scale up future space activities and continue to take advantage of space technologies without properly coordinating space sustainability and space traffic.

Many would ask why space sustainability carries an importance. I will explain different aspects of this question and its relevance to our current time.

Ethical and environmental concerns

Today we see a steady growth in the number of space actors, with many launching a myriad of space objects. What has been a privilege of few and a luxury to many in the previous decades has now become an affordable opportunity to almost everyone in the sector.

Miniaturization of satellites, increasing number of cost-efficient launch options, escalating frequency of launches, better logistic solutions and accessibility of launch sites from different parts of the world, growing competitiveness and diversification of launch services market all require change through coordinated action and global commitment.

Even though space is infinite, economically attractive orbital slots are limited per se.

Many space actors are launching space objects without caring about the repercussions. The discrepancy problem of an exponentially growing number of deployed space objects without the foreplanning of what measures will be taken once the objects turn non-functional, makes the space environment unsustainable, thus undermining its value for upcoming space missions and currently offered critical space-based services (Goldberg, 2020).

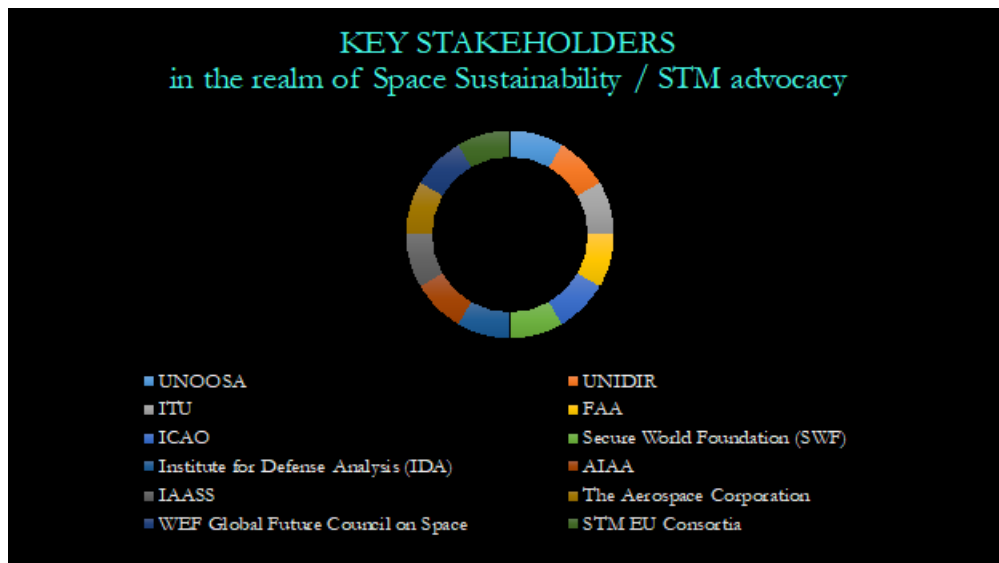
Space environment could be compared to a basket where numerous objects are thrown by different players in an uncoordinated way. Every space actor is governed by its own interests. At a certain point the basket will be full and therefore unable to further accommodate the objects. Same as a limited in size basket, the most economically attractive space resources / orbital slots are also rare and limited. Another comparison could be made to space highways that to be efficiently driven, require clear rules and coordinated efforts / responsible behaviors of all stakeholders.

The problem of an unsustainable space environment can be perceived from three different angles: environmental, ethical and economic. From an environmental perspective, space debris risks generating more debris and constitutes a hazard for operational satellites and activities in space. Unsustainable space environment questions the accessibility of space for future generations, raising a vital ethical concern. Risk posed to the safety of an operational environment for space activities, resiliency of space infrastructure or assets, probability of rendering a satellite non-functional requiring its replacement, and the continued provision of services have a direct impact on expected economic benefits and return on investment.

Image, reputation, competitive advantages, and acknowledgement of specific behavioral lines for economic interests represent key incentives for voluntary implementation of space sustainability and space debris mitigation guidelines.

We see an increasing number of stakeholders advocating in the realm of space sustainability (SS) and Space Traffic Management (STM); their numbers are growing and the gap in their consolidation efforts is widening.

Legal grounds have significantly evolved over the last years and we are thrilled to see the long-term sustainability guidelines being adopted. Even though the development mainly took place on the non-binding level, it still portrays a much-needed effort.



The LTS Guidelines and Space Sustainability Challenge

The LTS guidelines approach the space sustainability issue from four different angles: 1) policy and regulatory, 2) safety of space operations, 3) international cooperation, capacity-building and awareness, 4) scientific and technical research and developments (UNOOSA Guidelines, 2018).

Space can help achieve many Sustainable Development Goals; however, space is a worthy goal in itself and deserves to be added as the 18th Goal. In parallel to this, the space community should start thinking about Space Sustainability Goals.

The ESA Annual Space Environmental Report became one of the reference editions in a short period of time. It provides a transparent overview of global space activities, estimates the impact of these activities on the space environment, and quantifies the effect of internationally endorsed mitigation measures (ESA Report, 2023).

More specifically, it outlines space environmental history in numbers, environmental status, intentional object release, fragmentation history, end-of-life operations history, and environmental metrics.

Another authoritative initiative that relates to the status of space environment is the Space Security Index (SSI), which is purported to improve trust and transparency related to space activities and to provide a common, comprehensive, objective knowledge base to enhance capacity for dialogue and policies that contribute to the governance of outer space as a shared global common (Space Security Index, 2020). Previously, the SSI was merely publishing annual reports. However, as of last year, they launched a collection of fact-based guides and assessments of interrelated trends and developments in space.

The World Economic Forum, and more specifically its Global Future Council, came up with the concept of Space Sustainability Rating, which is currently being developed by a consortium of stakeholders. The purpose of this is to support long-term sustainability of the space environment by increasing transparency among actors' debris mitigation efforts. It

is expected that SSR will constitute a comprehensive rating for the sustainability of space missions, bringing more transparency to the sector while also rewarding responsible actors.

SS, in addition to responsible behaviors, heavily relies on SSA and STM for responding to the questions ‘WHAT’ and ‘HOW.’

SSA is a tool to know what to coordinate, manage and control. What is critical to know is: Who has the SSA data and where do they get them from? Which data and information are shared? With whom are those SSA data shared? Based on which legal grounds? Under which terms? How to efficiently bridge SSA capabilities with STM mandate?

Knowledge (SSA) without action (STM) has little value, however action (STM) without generally accepted, transparent, certain and thus predictable rules fail to be an efficient solution for a sustainable space environment (Nightingale et al., 2016).

Currently, there are rules for all other types of traffic but not for Space Traffic (...) Why is that? This remains an open question.

Conclusions

Proper implementation of STM is based on three pillars: mandate, capabilities, and funding. What activities do we exactly intend to manage? How do we intend to execute this function? Is it about managing, coordinating, regulating, and controlling? Who defines the authority and grants the global mandate for it to be recognized by all space actors? Who has such capabilities? Where is the limit of this mandate? STM might need to coordinate with other related types of traffic, e.g. maritime and air. Who will fund STM?

Space sustainability requires determination, focus and action. This can’t be further delayed.

We should more actively promote environmentally conscious and responsible behaviors in space, showcase best practices, assist stakeholders wishing to align their activities with space sustainability guidelines, focus on implementation and enforcement mechanisms, incentivize responsible and environmentally sustainable behaviors, promote the platforms for inclusive and interdisciplinary dialogue on space sustainability and STM, make the dialogue uninterrupted by fostering a continuous engagement and participation of all key actors at all stages of the dialogue, and coordinate the parallel ongoing initiatives on the same subject.

When investing in sustainable space, we invest long-term. Caring about the impact of space activities on the space environment, we must invest in sustainable and eco-friendly solutions and technologies, change or adjust laws and policies, reconsider licensing processes, find the best feasible solutions to incentivizing sustainable space behaviors, and finally, recognize and showcase best practices.

Quoting “Our common future” report through the prism of space: ‘space requires sustainable development that meets the needs of the present without compromising the ability of future generations to meet their own needs.’ By incentivizing and showcasing ‘environmentally sustainable’ and responsible behaviors, we can change the current paradigm.

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