Roadmap for Global Agreement on Standards to Advance the Long Term Sustainability of Space

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ABSTRACT

The need for international agreement on standards to preserve the safety and sustainability of the orbital environment is well established. However, the path to agreement is not obvious. This paper identifies elements where international agreement delivers the most benefit to managing the space environment, including mitigation, prevention, and remediation of orbital debris. It uses well established existing international agreement process for aviation to consider as models for the space community and introduces key questions that will help develop a space specific roadmap. The aviation models can be instructive as the majority of the global airspace is international and not subject to any claim of sovereignty. This paper makes the point that while industry agreements are necessary, governments must lead in the in discussion.

Keywords: information sharing, space traffic management, space environment, orbital debris

1. Introduction

The need for international agreement on standards and norms of behavior to promote a safe and sustainable orbital domain is generally accepted by the space community. In addition to efforts inside the US, the European Union has established a Space Surveillance and Tracking Consortium offering to work in cooperation and competition with the United States.[1] While the need to develop a common understanding of best practices for space actors has general agreement, the path to achieve agreement on standards of behavior is less clear.

This paper evaluates existing opportunities and provides a roadmap for the development of international standards for the purpose of meeting the goal of long term sustainability of space.

2. Existing Structures

2.1. COPUOS

The Committee for the Peaceful Uses of Outer Space is the UN body currently

[1] European Space Policy Institute

providing an environment for global agreement. The mandate of COPUOS:

> *"aims at strengthening the international legal regime governing outer space, resulting in improved conditions for expanding international cooperation in the peaceful uses of outer space. The mandate also specifies that the Committee should support efforts at the national, regional and global levels, including those of entities of the United Nations system and international space-related entities, to maximize the benefits of the use of space science and technology and their applications. Overall, the Committee aims to increase coherence and synergy in international cooperation in space activities at all levels."*

COPUOS relies on a consensus based structure and guidelines are voluntary and non-binding. This process was used in the adoption of the 21 Guidelines for the Long-term Sustainability of Outer Space Activities. The process began in 2010 and the guidelines were published 8 years later.

2.2. ICAO

The ICAO structure for the development of Standards and Recommended Practices (SARPs) for aviation utilizes a formal structure of expert groups, bringing input from states, industry, and aviation professions. Proposals from expert groups are reviewed by the technical commission and a formal process of consultation with contracting states and international organizations. It is important to note that the ICAO process does not require consensus and states are able to formally differ from an ICAO standard, however, doing so requires transparency. ICAO uses this transparency as a mitigation for a lack of consensus.

The ICAO process of developing SARPs is often, and accurately, criticized for being slow and somewhat inflexible. This can impede the timely development of necessary processes for accommodating new technologies and new entrants. A closer examination of the ICAO process as it adapted to rapid change provides a view of alternative available processes. ICAO has the ability to develop guidance material using expert groups, but outside the formal consultation processes. The expert group approach relies on input from industry and influential stakeholder states to provide the technical expertise on a designated topic, while the ICAO secretariat provides logistic and administrative support. This provides considerable agility in the development of guidance material on best practices, using the operational expertise of states with the most experience with the subject material. This allows states with less capacity or experience to adopt the guidelines, knowing it has been through an ICAO process and will form the basis for eventual SARPs.

The ICAO process for the development of guidance material may provide a model that could be effectively followed using existing international structures for space diplomacy.

2.3. NextGen-SESAR Coordination

The US Federal Aviation Administration and the EU air navigation service providers each launched major aviation modernization programs in the early 2000's. These are NextGen in the US and SESAR in the EU. These programs included numerous elements that required interoperability and common operating standards. As these two actors represent the majority of global air traffic operations, they elected bilateral coordination to augment the ICAO process. The approach was an unspoken acknowledgement that the dominate players could create standards that met their needs in the near term that would form the basis for global standards to be adopted later. This approach reflected not only the volume of traffic handled, but the willingness of the parties to invest considerable resources in developing both standards and technology.

The models used in the aviation community to address innovation in the industry, including disruptive technology, introduced agility into the formal UN processes. The ICAO process of developing guidance material captures the non-binding, voluntary nature of the COPUOS outputs, but can provide more precision and expedience than a consensus based process. Bi-lateral or multi-lateral efforts to create models for adoption by other states can also expedite the process.

3. Building a Roadmap

In developing a roadmap for agreement, it is recognized that we need to carefully analyze where international agreement is most needed and will yield the greatest benefit for the space community. Discussions on theoretical frameworks for space traffic management have been occurring for many years encountering technical, legal, and political barriers. It is clear that a "solve the whole problem" approach is unrealistic. It is important to note that STM is an enabler, not the objective. The objective is a safe and sustainable space environment. This roadmap serves to approach the issue from a space industry/community, bottom up approach, rather than a top down, regulatory, approach.

Different areas in the space domain require specific expertise. Efficient use of expert groups should focus expertise on the components of the sustainable space question to enable specialized participation.

3.1. Defining Terminology

The first step in developing a roadmap is to ensure there is a common agreement on terms. To that end, the American Institute of Aeronautics and Astronautics (AIAA) launched an effort to identify commonly used terms related to Space Traffic Management, research various uses, definitions, and identify areas of commonality and divergence. This allowed for the separation of key concepts to help scope the activities needed in the roadmap. The output of this activity is contained in a separate report.

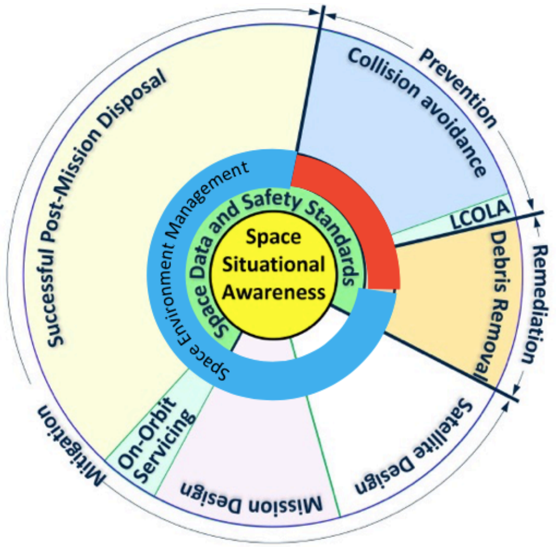
3.2. Space Situational Awareness

A fundamental goal of space situational awareness (SSA) is actionable knowledge about the orbital and near space environment. This calls for attaining current and predictive information. With respect to Earth, SSA can be described as the understanding derived from studying the near-Earth environment, which includes a number of subjects.

Although descriptions of SSA may vary, this goal together with a number of tasks are shared. Tasks (and techniques) for achieving actionable awareness of the current and future situation in orbit include observation, monitoring, detection, data collection and analysis, characterization, data and information dissemination and predictions.

3.3. Space Environment Management

Managing the space environment is distinct from managing space traffic. Traffic implies operational, maneuverable satellites. The space environment includes those objects as well as non-maneuverable satellites and debris. To manage the space environment, it is necessary to consider debris mitigation, remediation, and prevention. It is a more comprehensive concept than that of space traffic management, which tends to focus more narrowly on collision avoidance.



3.3.1. Mitigation

Mitigation is the activity of limiting the addition of new debris in the space environment via a forward looking mitigation strategy. That strategy may include standards recommending propulsive collision avoidance capability for mission duration and deorbit and to fix requirements for the deorbit of all hardware at end of mission.

3.3.2. Remediation

Remediation is required due to objects abandoned before debris mitigation guidelines were put in place and poor mitigation compliance. Remediation is a reflective approach to clean up the current orbital environment recognizing that there is the ability to identify globally selected objects that have statistically greatest debris-generating potential to curtail the risk of collision between two nonfunctional objects leading to significant debris generation.

3.3.3. Prevention

While mitigation is forward looking and remediation is backward looking, the prevention of debris generation from active satellites is the tactical element of managing the space environment. This is an active role often associated with space traffic management, requiring the avoidance of collisions in space between active satellites or between an active satellite and debris.

3.3.3.1. Collision Avoidance

Collision avoidance standards should provide predictability to other operators in shared orbits. Operator provided information on intent and planned maneuvers is needed to augment space situational awareness systems. As space becomes more congested, it is necessary to establish common understanding and agreement on right of way or coordinated avoidance maneuvers. Information sharing regimes can augment the sensor and catalogue based space situational awareness frameworks.

3.3.3.2. On-orbit Servicing

On-orbit servicing provides an opportunity to extend the maneuverable life of an artificial satellite. This creates an opportunity to prevent abandonment of objects placed in orbit before this technology was available. However, it also requires intentional physical contact between satellites which needs to be understood in the context of a system designed to prevent collisions in space.

4. **Key Questions**

In developing a roadmap for international agreement, it is important to consider whether the existing administrative structures can effectively meet the need, leading to some key questions:

- Can existing structures in COPUOS be used to develop guidance material/best practices without requiring consensus?

- If not, are there other international structures available with the capacity and credibility to lead the effort?
- What activities are already underway in the international spaceflight community including those of standards-making bodies like CCSDS, ISO and ASTM?
- Are state actors in active discussions outside the UN COPUOS process?
- What mechanisms can be put in place to capture industry-based activities in this area to put conclusions into a framework of global agreement?
- What current laws, treaties, and agreements may pose a barrier to implementing new standards or norms of behavior needed for a safe and sustainable orbital environment? Looking at these structures form the basis for ongoing work.

5. Consequences of Inaction

The consequences of inaction are significant. The safety risks in orbit are not hypothetical, two satellites collided in 2009, the International Space Station has been damaged by debris, two defunct satellites came within meters of a catastrophic collision in 2020, and as the domain becomes more congested, the competition for access to desirable orbits increases. There are both safety and economic incentives to make progress on this matter. The orbital domain has the potential to deliver a trillion dollar space economy. However, this cannot be realized without ensuring a safe and sustainable environment. Predictions of increasing pace of launch and exponential rates of growth in constellations has been realized, we are no longer in a theoretical position. A considerable amount of work is ongoing but lacks a central focus to deposit the results of the work into a formal process for international agreement.

6. Conclusion

The interest of the space community is well served by progressing efforts to achieve international agreement on norms and standards of behavior in space that will lead to a safe and sustainable orbital environment. Using a stepwise approach that identifies the areas where the most benefit can be derived is an essential first step. It is important to note, there are ongoing activities within the space community to develop industry best practices and efforts by standards making bodies to reinforce them. While industry expertise is essential in developing technical requirements, governments cannot delegate their responsibility in the diplomatic process. International agreement requires the participation of governments.