Space Governance in the New Space Era

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ABSTRACT

This paper presents a broad, holistic overview of our current space governance system, from the best practices and self-regulation developed by spacecraft operators and relevant industry associations, to the four core treaties of the United Nations, the consensus guidelines of the IADC and UN, the majority approved international standards of ISO and CCSDS, and finally national policy and regulatory governance. Descriptions and examples are provided of the relevant documents issued by each of these categories. The "virtuous cycle" nature of this overall inter-connected governance system is discussed.

A relative comparison is provided for all the primary attributes codified in each of the above space governance documents, as pertaining to spacecraft safety of flight, space traffic coordination and management. The recent AIAA Space Traffic Management (STM) Task 3, capturing of global best practices relevant to safety of flight, is described and summarized. Within this context, the evolving United States regulatory framework is discussed.

1 SAFETY OF FLIGHT: CURRENT STATUS

Recent studies [1, 2, 3, 4, 5] indicate that current approaches to operating in space are not sustainable in the long-term, with post-mission disposal success rates likely needing to be well above the currently suggested 90% level (not to mention the 65% level achieved today in practice [6]). Close approaches regularly occur not only between active spacecraft and other active spacecraft and debris in all orbital regimes [7, 8, 9, 10], but also between debris objects [11, 12]. Safety-of-Flight (SoF) assessments from legacy SSA systems may not always be comprehensive, timely, accurate and transparent to make operational decisions, and current SSA systems only track an estimated 4% of the space object population down to 1 cm in size in both Geosynchronous Earth Orbit (GEO) [13] and Low Earth Orbit (LEO) [14]. Space Situational Awareness (SSA) systems are anticipated to rapidly improve our knowledge and awareness of the space population with the advent and deployment of new sensors, sensor types and commercial SSA services [including 15 and 16]. Yet it is not always clear how much rigor [17] current and future SSA services will use in their operations or in spacecraft operator employment of SSA services. As a result of these many factors, spacecraft operators often cannot tell, with sufficient certainty and veracity, whether their spacecraft are at sufficiently high collision risk to warrant conducting costly collision avoidance maneuvers [18, 19]. Some operators even choose to ignore collision threat warnings in the hope that each impending potential collision event will be a non-event. On top of that, the New Space era is dawning, where we could conservatively face a ten- to twenty-fold increase in the number of orbiting active spacecraft within the next ten years alone. Tremendous advances in launch and spacecraft design, process improvements, management procedures and operations are required to address the demands of New Space.

2 A HOLISTIC APPROACH TO ADDRESSING SPACE DEBRIS

Fortunately for us, "the sky is not falling" just yet. The somewhat bleak safety-of-flight picture portrayed above only serves to remind us that the time to act is now, and we cannot afford to prematurely dismiss or deemphasize any particular space debris mitigation approach. Rather, we must address space debris holistically [20], leaving no stone unturned and avoiding the pursuit of a single favored approach while prematurely downplaying or discrediting all others. As stated in [21], "Lack of effort in any one of these three areas (SSA/STM, Debris Mitigation, and Debris Remediation) makes the other two both more urgent and more difficult. The best approach is to pursue balanced efforts in all three areas simultaneously." In other words, a comprehensive approach to space debris is required that carefully considers and incorporates (1**) Avoiding predictable collisions**, (2) **Orbital debris mitigation,** and (3) **Orbital debris remediation**.

3 SPACE GOVERNACE AND ITS ROLE IN ADDRESSING SPACE DEBRIS

Spanning this trivariate set of holistic space debris approaches is the need for an agile, comprehensive, viable and overarching space governance framework. But what exactly is space governance? We choose to adopt space governance as being "… defined as principles, norms, rules and decision-making procedures around which [space] actor expectations converge in a given issue area" [22]. Governance instruments for space activities include international treaties, principles, guidelines and standards, national regulatory laws and industry-gathered best practices.

4 BINDING VERSUS NON-BINDING SPACE GOVERNANCE

There are two basic types of space governance: **Binding** or normative instruments such as treaties, standards and national regulations, and **non-binding** agreements used to convey voluntary, non-normative and/or aspirational content that may be too difficult to achieve international consensus on. These two types are largely complementary to the other, and each contributes materially to the composite space governance framework we have today.

- The four core United Nations (UN) space treaties contain broad tenets. While binding to the States that have ratified them, these treaties are not yet ratified by all spacefaring States.
- Once the four core space treaties were ratified, the international space law community transitioned to multilateral and bilateral agreements and the development of voluntary consensus principles and guidelines for space operations, debris mitigation and space sustainability. While such influential voluntary international guidelines may contain more detailed, challenging, and aspirational goals, they are non-binding.
- Binding national governance and enforcement mechanisms promote space sustainability commensurate with each State's unique interpretation of international common space law, accepted best practices and expected norms of behavior. Unfortunately, disparities in each State's interpretations may at times lead space operators to adopt "flags of convenience," either to avoiding costly analyses, designs, or operational mandates, or to otherwise circumvent tougher regulations.
- Non-binding voluntary industry best practices and self-governance tend to be favored by space operators and commercial industry.

5 SPACE GOVERNANCE AS A 'VIRTUOUS CYCLE'

Some mistakenly think that space debris mitigation requirements originate from a unique source and flow down to the rest of the space governance infrastructure. To see why this is not the case, we will now explore the interactions between satellite operators, international organizations and analysis communities, international standards development organizations, satellite operator associations, and national regulatory bodies as shown in Figure 1 and the roles and contributions each organization makes towards the long-term sustainability of the space environment.

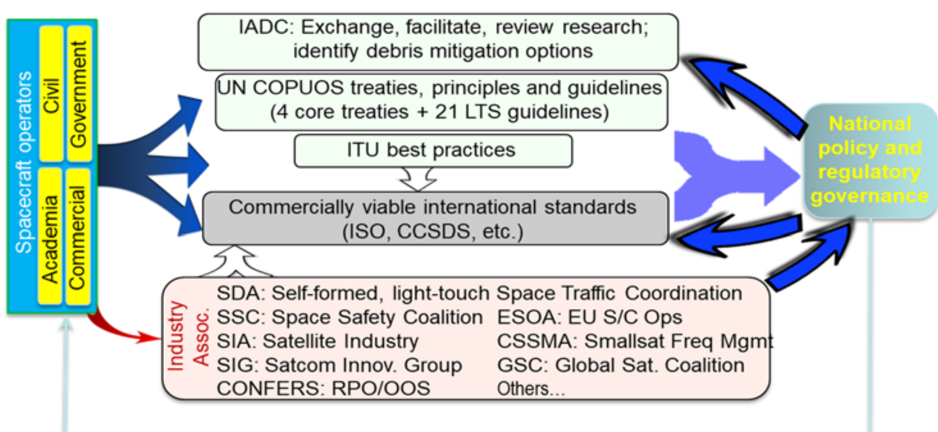

Fig. 1. Organizational interaction of global space debris mitigation activities.

5.1 Space operators and space industry associations

Well-established satellite operators have been operating in space for many decades. They know what works best for their operations, and they have developed long-standing procedures, best practices and norms of behavior. However, there are numerous “new space” operators who have not. This makes it imperative for (1) well-established space operators to share, through forums, publications and industry associations, such best practices and expected norms of behavior; (2) regulatory and standards bodies to educate new space operators on the existing regulations and the standards framework; and (3) standards and regulations to evolve to keep pace with the rapid innovation and quantity of scale associated with large constellations and small satellites.

The space industry is generally self-motivated, both financially and optically, to “do the right thing” and willing to go above and beyond existing binding regulations. On one hand, the space industry is generally not keen to be regulated because regulations can impose inconveniences, constraints, delays and costs. On the other, space operators may seek regulation if it helps maintain the business case of their operating regime or governs competing or interfering operators.

Rather than regulation, some space operators would prefer to focus on the intent of consensus sustainability guidelines and standards rather than precisely how to do it. This is the goal of the Safety Case framework adopted by the United Kingdom [23], which is intriguing in its ability to let the spacecraft designers and operators devise ways to achieve long-term space operations sustainability without prescribing potentially more costly or perhaps less efficient requirements that stifle innovation and incur costs. Still other operators feel that regulations are actually good for business.

Space industry associations play a valuable role in developing space industry consensus, information sharing and promoting space industry objectives and aspirations. Their insight and influence can be invaluable in fostering responsible space operations and educating the broader space community on orbital debris mitigation best practices and expected norms of behavior. Popular examples of such entities include the Consortium for Execution of Rendezvous and Servicing Operations (CONFERS) best practices [24], the Satellite Industry Association [25] and the Space Safety Coalition [26].

5.2 Inter-Agency Debris Coordination Committee (IADC)

The IADC serves a valuable function in suggesting and coordinating national research on space debris, mitigation and related topics. A key product of the IADC is its IADC Guidelines [27], which are non-binding guidelines for approaches to avoid creating space debris in both current and future space activities. One might view this set of guidelines as the “start of the food chain,” upon which international, satellite operator and national regulatory mechanisms are often based. But it’s not that simple: The IADC guidelines were initially based upon operator guidelines and rules, beginning with the NASA Process for Limiting Orbital Debris [28]. An IADC member recently noted that (1) if the world-wide satellite operations community were to uniformly adopt stricter practices than the current IADC guidelines, the IADC would likely adopt the stricter guidelines so as to better protect the space environment; and (2) if space-faring nations were to adopt stricter regulations than the IADC guidelines, then the IADC would likely also strengthen their guidelines to follow suit. This is an indicator of the iterative and dependent nature of orbital debris mitigation activities depicted in Figure 1.

5.3 United Nations

The United Nations Committee for the Peaceful Use of Outer Space (UN COPUOS) is the international body where 92 COPUOS member states share their views on space activities and best practices. While substantive provisions of the four core UN space treaties may be coextensive with customary international law (binding on States irrespective of whether they are a treaty party), there are increasing numbers of space actors that have not yet ratified these international space treaties. And even for those who have, the provisions in these treaties do not sufficiently address space sustainability.

The UN COPUOS ratified its current set of Space Debris Mitigation Guidelines [29] in 2007. More recently, the UN COPUOS ratified twenty one consensus Long-Term Sustainability of Space Activities (LTS) guidelines [30] in June of 2019. While both documents represent a truly momentous achievement, the voluntary nature of state actor compliance with these guidelines means that they are not sufficient by themselves. A critical follow-on activity will be to promote the implementation of these LTS Guidelines, a process which might include harmonization of national regulations governing spacecraft design, space operations and disposal activities with the guidelines.

These binding UN treaties and non-binding LTS Guidelines and resolutions are joined by other key space governance instruments, to include:

- Proactive, self-initiated satellite operator and satellite industry initiatives to protect the long-term sustainability of space, to include the comprehensive legal and computational Space Traffic Management (STM) framework operated by the Space Data Association (SDA) since 2010, as well as current efforts to identify consensus best practices across the space operations community in organizations such as the Satellite Industry Association (SIA), the Space Safety Coalition (SSC) and Secure World Foundation (SWF).
- Comprehensive commercial Space Situational Awareness (SSA) and STM systems that employ new sensors, algorithms, and data pooling constructs.
- Existing government SSA systems (particularly the 18SPCS Conjunction Assessment process and their efforts to promote ephemeris data sharing).

For all of their merits and inherent goodness, non-binding guidelines by themselves have proven to be insufficient, since current space operator compliance with post-mission disposal guidelines for both large and small satellites in LEO is only about sixty percent.

5.4 Space standards development organizations

The two leading developers of international space standards today are the International Standards Organization (ISO) and the Consultative Committee for Space Data Standards (CCSDS). Standards developed and maintained by ISO provide commercially- and contractually-implementable mechanisms that are aligned with IADC, UN COPUOS, and ITU guidelines. ISO is the premiere international standards organization, with space standards [31, 32] comprising only a small fraction of the overall set of active ISO standards. ISO orbital debris mitigation and operations standards are focused on capturing commercial, market-relevant best practices and expected norms of behavior.

CCSDS develops standards that allow space actors to exchange, understand and work with space navigation and communications data. CCSDS currently maintains 150 active standards, and 1,094 missions are or will soon be relying on CCSDS standards in their mission operations. Of these 150 active standards, the Orbit Data Message (ODM) [33] is one of the most successful and well-used CCSDS standard today [34]. Appropriately so, since it is the standard way to share orbital information, ephemerides, maneuvers, covariance, vehicle metadata, and much more space object information. The Conjunction Data Message (CDM) [35] and others are also heavily used in space operations to convey collision risk events.

5.5 National regulators

National regulatory agencies (such as the United States' Federal Communications Commission or FCC) play a pivotal pre-flight role to ensure sustainable satellite designs and space operations within the international orbital debris mitigation framework. Prescriptive regulations may likely be needed in cases where commercial/financial incentives may not adequately protect the space environment. Commercial and government space operators likely may have a fundamentally different focus than protection of the space environment; consider that a commercial operator's collision avoidance thresholds are probably set as a four-way balance between financial outlay, operational costs, mission duration (maneuvering fuel), and risk of commercial services degradation or outage. Perhaps, in the interest of space sustainability, acceptable collision risk levels should be set by international guidelines or national regulations based on ensuring the safety and stability of our orbital environment as is done in Air Force Instruction 91-217 [36], which specifies collision risk levels for both launch and on-orbit object collision avoidance to be 1.e-6.

6 ADAPTIVE SPACE GOVERNANCE

The space domain today is characterized by a broadening and increasingly diverse set of activities and actors. Developing effective legal and policy regimes for these activities requires the coordination of multiple different stakeholder groups and the identification of enhanced mechanisms for improving understanding between the private sector and the multilateral space governance fora. However at the same time there is considerable uncertainty in the technical and business factors driving this expansion. New activities require new approaches to governance, yet those governance approaches must be appropriate and fitting to the activities being governed and must not stifle innovation.

A concept applied often in the governance of climate change and sustainable environmental management might be instructive to efforts to develop effective governance structures for new space activities. Emerging from the institutional management study of common pool resources and environmental asset management “Adaptive governance is defined as ‘the evolution of rules and norms that better promotes the satisfaction of underlying human needs and preferences given changes in understanding, objectives, and the social, economic and environmental context’” [37]. Reviews of adaptive governance approaches in the climate and environmental sustainability fields indicate that it “enabled actors to collaborate across diverse interests, sectors, and institutional arrangements and detect opportunities and problems as they developed while nurturing adaptive capacity to deal with them.” [38] Adaptive governance promotes flexibility and responsiveness to change in social, economic, and environmental conditions through multilevel (local, national, and international) information exchange.

Applied to space activities, adaptive governance is the idea that “you can't effectively regulate what you don't know” (e.g., technological approaches, business models); yet for new applications, regulations are needed to provide legal certainty and common rules and to satisfy international obligations. Achieving this balance requires a system of regular updates to regulatory provisions and frameworks, rather than attempts to address new applications in totality. It also requires exchanges of information between technical, economic, business, policy and regulatory communities. It is a philosophy of governance, rather that specific structure or approach. For example an international working group developing a set of legal building blocks to enable commercial utilization of space resources has found that it is “neither necessary nor feasible to attempt to comprehensively address space resource activities in the building blocks: space resource activities should be incrementally addressed at the appropriate time on the basis of contemporary technology and practices.” [39]

7 AIAA CHARACTERIZATION OF GLOBAL SPACE GOVERNANCE

Following publication of its 2017 STM white paper [40], the American Institute for Aeronautics and Astronautics (AIAA) decided to delve into the topic of Space Traffic Management. The AIAA STM Working Group #3 (WG3), chaired by one of the authors, was composed of fourteen individuals spanning many elements of the space sector, including academia, government/civil, legal, insurance, FFRDCs, space operator and commercial industry representatives.

WG3 was chartered to “provide a body of knowledge highlighting best practices and information related to conjunction analysis and risk assessment in order to provide assistance to new entrants into the STM area.” To this end, WG3 sought to compare and contrast various government, commercial, and international space governance instruments. WG3 opted not to characterize ALL aspects of space governance (e.g., omitting ground equipment, finance, change of ownership and some licensing procedural requirements), WG3 did choose to incorporate as many attributes as it could that were reasonably relevant to STM, SSA, SoF, space operations and sustainability.

7.1 AIAA STM Space Governance characterization process

The WG3 team proceeded to gather, parse and characterize 76 space governance documents representing the regulatory frameworks of eleven countries and 27 international and industry entities. The resulting 209 unique binding requirements and non-binding attributes were then binned into 21 broad requirement categories and further delineated by the responsible party, the space object(s) involved, and the affected space operations life cycle(s).

The parsed textual content was then “scored. While it was recognized that many ways exist to score the captured textual content, for this initial examination it was decided to assess how **detailed** and **demanding** the content was, with “detailed” defined as “specific, concrete, contractually suitable” and “demanding” defined as stringent, robust and more difficult to achieve.” All attributes within each broad category were then assigned a normalized weight based upon the evaluator’s assessment of overall importance within that broad category. Then, for every space governance document owned by a given country, entity or entity category, the maximum score was selected for each particular attribute, multiplied by the normalized weight and summed with all other attributes within each broad category.

The scoring process is shown in Equations (1) and (2)

$$\sum_{j=0}^{\#Attributes\ in\ Broad\ Categ} wt_j = 1.0 \tag{1}$$

$$Score_{Broad\ Category_j} = \sum_{j=1}^{\#Attributes\ in\ Category} wt_j \ max\left(Detailed_{ij} \times Demanding_{ij}\right),\ i = 1..\#documents\ per\ entity) \tag{2}$$

It is acknowledged that this scoring approach has weaknesses, chiefly that the evaluation is still subjective and inexact. Yet the hope was to obtain a well-informed evaluation based upon the specific textual content of each governance document.

Importantly, it is noted that “low scores” do not necessarily signify a lack of importance. Consider the complementary nature of treaties, guidelines, regulations, where “… the treaty abstains from regulating specific activities, supplying instead the basic legal building blocks for addressing new activities and capabilities. The treaty’s open-textured principles do not prescribe a single solution in most cases, but shape and constrain the universe of solutions.” [41]. As well, “A trend [where] multilateral treaty-making gives way to bilateral and non-binding alternatives does not itself signal a decline in … international law.” [42] General, non-specific, non-demanding treaty clauses are in fact critical in steering guidelines, regulations and industry best practices.

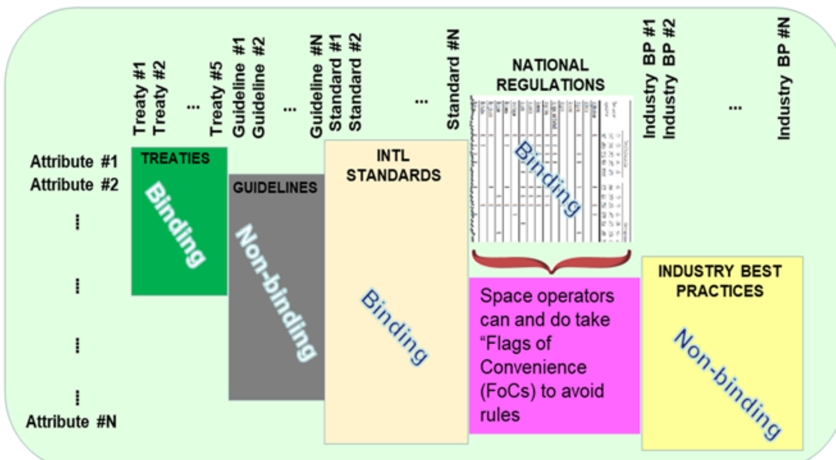

Fig. 2: AIAA STM WG3 space governance characterization diagram

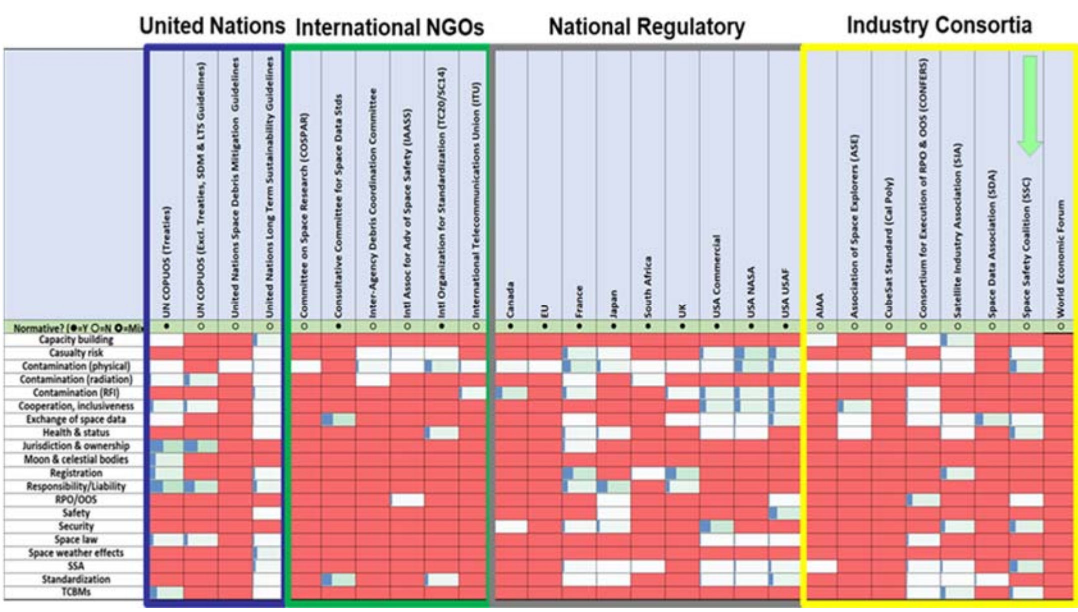

Fig. 3: Space governance characterization scoring results

7.2 Characterization of global space governance: Results

The initial release of this characterization [43] is shown in Figure 3. Red shading in a cell denotes that the particular document in question was not found to contain content relevant to that broad category. White background shading denotes that some content was indeed found, and the blue bar specifies the summation of the normalized scores for each of the attributes within that broad category from zero to one hundred. One can readily see that top-level requirements tend to be contained in international treaties and guidelines, whereas national regulations and industry consortia were complementary by providing more detailed and demanding binding and non-binding content, respectively. The lack of red in the UN LTS column clearly shows the comprehensive gains achieved through international consensus adoption of these guidelines.

7.3 The power of adoption or incorporation by reference

A number of space governance instruments adopted were aligned with or otherwise incorporated by reference to other space governance instruments. The benefit of this was clearly observed, as one could construct a meaningful set of space guidelines, regulations or best practices even in a half-page document by simply incorporating other documents. Prime examples of this are the European Space Agency requirement that its Contractors must adopt standards developed by the European Cooperation for Space Standardisation (ECSS), which in turn incorporates by reference ISO Standard 24113, "Space Systems: Space debris mitigation requirements" [44]; also, the Space Safety Coalition's best practices document incorporates by reference "existing standards and guidelines as published by the IADC, UN COPUOS, and ISO."

7.4 Space governance gap analysis

Based upon the above space governance characterization and evaluation, a "gap analysis" was conducted. In general, there appeared to be insufficient focus on SSA, algorithms, data pooling, development and mandated use of space standards, quality assurance, monitoring, completeness, timeliness, accuracy. More specific gaps identified in the study are listed in Table 1.

Table 1: Identified space governance gaps

Quality Control	**Independent verif/validation**
Operator phonebooks, personnel roles	**Active Debris Removal (ADR)**
Comprehensive, timely, accurate	**Just-in-Time Debris Removal (JDR)**
Deployment strategies: trackability, association, discrimination	**Decision-quality risk assessment procedures and safety metrics**
"Rules of the road"	**Covariance realism tests**
Data normalization: Reference frames, units, timing, elements	**Standards and regulations that incentivize good behaviors**
Rendezvous/Proximity Operations (recently approved NWIP)	**Data pooling protecting Intellectual Property, prioprietary data**
On-Orbit Servicing (recently approved NWIP)	**SSC suggested inclusions**
Earth Orientation Parameters	**Standards for Uncorrelated Track association**
Space Weather	**Ephemeris sharing to support optical transit deconfliction**
Atmosphere models	
Tasking	**Algorithms, performance assessment and assurance**
Anomaly data sharing (and how to share it)	**- Orbit determination**
Satellites-as-a-sensor	**- Orbit propagation (numerical)**
Comparative SSA	**- Space weather prediction**
Standards governing spacecraft visual magnitude, paints, etc.	**- Force modeling**

8 DIVERSIFIED SPACE GOVERNANCE IN THE UNITED STATES

As depicted in the aforementioned AIAA Characterization of Global Space Governance, the regulatory and policy functions related to commercial space in the U.S. are currently distributed across several agencies. This means that there is no single central organization responsible for licensing of space activities; companies must approach multiple agencies for license applications depending upon the nature of their activities.

8.1 U.S. Interagency Approach

It also means that an interagency process is required within the U.S. government for review of license applications and for policy coordination. Key agencies and organizations include:

- *Federal Communications Commission (FCC)*: All non-governmental satellite operators domiciled in the U.S.; seeking to launch from the U.S.; or seeking to serve the U.S. market ("market access") must apply to the FCC

International Bureau Satellite Division for an authorization (“license”) to utilize U.S. spectrum. The “International Bureau administers international telecommunications and satellite programs and policies, including licensing and regulatory functions. The bureau also promotes pro-competitive policies abroad, coordinates global spectrum activities, and advocates U.S. interests in international communications and competition.” The FCC is an independent agency of the U.S. government, meaning it sets its own policies and procedures, is not subject to Executive Branch policy guidance, and is subject to oversight by Congress. The FCC maintains separate licensing policies for Geostationary Systems and for Non-Geostationary Systems. There are separate “parts” (or rules) for licensing for experimental, amateur, and commercial systems (a separate category for commercial small satellite constellations has recently been created). The FCC is also responsible for authorizing Earth stations (ground segment) spectrum in the U.S. In addition the FCC is currently the U.S. agency responsible for requiring space debris mitigation plans from satellite operators as part of the spectrum-use licensing process.

- *Federal Aviation Administration (FAA)*: Since 1984 the Office of Commercial Space Transportation (AST) within the Department of Transportation has been responsible for both regulating the U.S. commercial space transportation industry and for encouraging, facilitating and promoting the growth of that industry. Currently AST is an office within the Federal Aviation Administration (FAA). FAA-AST focuses on “facilitation of a safe, efficient, and successful U.S. commercial space transportation industry.” It issues launch and reentry licenses for U.S. domiciled launch operators or commercial launches from U.S. territory. It administers a spaceport licensing process. It also administers a payload review process for U.S. domiciled nongovernment payload operators or non-U.S. operators launching on a U.S. flagged vehicle. The payload review process seeks to ensure that a license applicant or payload owner or operator has obtained all required licenses, authorizations, and permits. FAA-AST is also responsible for integration of space activities with the management of the National Airspace System (air traffic).
- *Department of Commerce*: The U.S. Department of Commerce currently has several regulatory and policy functions distributed through several agencies and organizations subordinate to the Department. These include:
  - The Commercial Remote Sensing Regulatory Affairs (CRSRA) office within the National Oceanic and Atmospheric Administration (NOAA) Satellite and Information Services (NESDIS). CRSRA is responsible for issuing remote sensing licenses. Any non-governmental U.S. person or entity seeking to operate a system capable of imaging the Earth from space must apply for a license to do so from NOAA.
  - The Department of Commerce shares responsibility with the Department of State for administration of the U.S. export controls and export licenses, which include items related to space and satellite activities.
  - The Bureau of Industry and Security also maintains periodic tracking and analysis of the state and health of the U.S. Space Industrial Base.

  The Trump Administration is currently working to consolidate many of these functions under the Office of Space Commerce. The mission of the Office of Space Commerce is “to foster the conditions for the economic growth and technological advancement of the U.S. commercial space industry.”
- *National Aeronautics and Space Administration (NASA)*: NASA does not have a regulatory function or authority beyond providing technical consultation as needed during the interagency coordination process. However it plays an important role in coordinating the development of the U.S Government Orbital Debris Mitigation Standard Practices (ODMSP), which are applied to U.S. government satellite missions, integrated into U.S. government spacecraft contracts, and applied in elements of U.S. commercial space regulation. Other agencies involved in the ODMSP update include: the Departments of Defense, State, Commerce, and Transportation, the Office of the Director of National Intelligence, and the FCC in a consultative role.
- *Department of Defense*: Like NASA, the Department of Defense (DoD) does not have a regulatory function or authority, beyond serving as part of the interagency license review process. The U.S military also currently makes basic Space Situational Awareness data available to all space operators as a safety of spaceflight public service.

8.2 U.S. space governance framework update

The Executive Branch of the United States government is in the process of updating and reviewing the framework by which it provides authorization and oversight of private sector space activities. The process began during the

Obama Administration and has been accelerated under the Trump Administration with the release of Space Policy Directive 2 (SPD-2) in May 2018, which directed the Secretary of Commerce and Secretary of Transportation to review and update existing licensing processes for commercial space launch and remote sensing; and Space Policy Directive 3 (SPD-3) [45] in June 2018, which directed the development of a National Space Traffic Management Policy. [46]

8.3 U.S. National Space Council regulatory recommendations

The Trump Administration has reestablished the National Space Council as an office for space policy development and coordination across the Executive Branch. Chaired by the Vice President, the National Space Council covers a portfolio of civil, commercial, and national security space policy issues. Its membership is composed of: the Secretary of State, the Secretary of Defense, the Secretary of Commerce, the Secretary of Transportation, the Secretary of Homeland Security, the Director of National Intelligence, the Director of the Office of Management and Budget, the National Security Advisor, the Administrator of the National Aeronautics and Space Administration, the Homeland Security Advisor, and the Chairman of the Joint Chiefs of Staff. The National Space Council has promulgated a series of recommendations to modernize the regulatory framework in the United States to be more responsive and effective in response to ongoing private sector innovation. Recommendations include:

- Re-invigorating space-related functions within the Department of Commerce and consolidating most commercial space-related approval processes within a single administration in the Office of the Secretary of Commerce; with the exception of existing spectrum oversight and launch and re-entry licensing responsibilities at the Federal Communications Commission (FCC) and the Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST), respectively.
- Establishing a "mission authorization" process, with default presumed approval, for nontraditional commercial space applications and services (i.e. apart from launch, remote sensing, or communications satellites)
- Establishing the Department of Commerce as the civil agency tasked with leading Space Traffic Management (STM) and Space Situational Awareness (SSA).
- Initiating a government-wide review and update of the Orbital Debris Mitigation Standard Practices (ODMSP).

9 SUMMARY

It is clear that a holistic approach to managing space debris is necessary, given our current safety-of-flight situation and the possibility of an impending twenty- to fifty-fold increase in SSA and STM demands and associated safety risk stemming from the dawning New Space era. Because space governance plays an important role in all aspects of this holistic approach, this paper provides an overview and characterization of our virtuous cycle of international, national and industry space governance. The AIAA STM Working Group 3 characterization of global space governance shows the relative contributions of each component of space governance, including an initial scoring of the space governance instruments from which a gap analysis is then conducted. This gap analysis identified key areas requiring future space governance development, including an improved focus on SSA, algorithms, data pooling, development and mandated use of space standards, quality assurance, monitoring, and enhanced SSA and risk assessment completeness, timeliness, accuracy.

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