

A satellite in orbit over Earth, with a red spiral line and blue orbital paths. The background shows a view of Earth from space, with clouds and landmasses visible.

**CENTER FOR SPACE  
POLICY AND STRATEGY**

**MARCH 2022**

***NO HAVEN FOR MISBEHAVIN':  
A FRAMEWORK FOR VERIFYING  
SPACE NORMS***

**MICHAEL P. GLEASON  
THE AEROSPACE CORPORATION**





#### **DR. MICHAEL P. GLEASON**

Dr. Michael P. Gleason is a national security senior project engineer in The Aerospace Corporation's Center for Space Policy and Strategy and is a well-regarded author on space policy subjects, including international cooperation, space traffic management, national security, and deterrence. He has presented his research on critical space policy issues at conferences in Canada, Europe, Japan, and across the United States. A graduate of the U.S. Air Force Academy, Gleason served 29 years active in the Air Force space career field, including stints in spacecraft operations, on the Air Force Academy faculty, at the Pentagon, and at the Department of State. He holds a Ph.D. in International Relations from George Washington University (GWU) and is an alumnus of the GWU Space Policy Institute. Gleason is the recipient of the Defense Superior Service Medal and the Department of State Superior Honor Award.

#### **ABOUT THE CENTER FOR SPACE POLICY AND STRATEGY**

The Center for Space Policy and Strategy is dedicated to shaping the future by providing nonpartisan research and strategic analysis to decisionmakers. The center is part of The Aerospace Corporation, a nonprofit organization that advises the government on complex space enterprise and systems engineering problems.

The views expressed in this publication are solely those of the author(s), and do not necessarily reflect those of The Aerospace Corporation, its management, or its customers.

Contact us at [www.aerospace.org/policy](http://www.aerospace.org/policy) or [policy@aero.org](mailto:policy@aero.org)

## Summary

International space situational awareness (SSA) data sharing is growing in importance for space safety, space sustainability, and military space activities. But less recognized is that international SSA data sharing enables the emergence and acceptance of voluntary norms of responsible behavior in space. Abiding by norms of behavior constrains freedom of action, which states may be unwilling to do unless they are reasonably assured that other states exercise the same level of restraint in space. International SSA data sharing is the way for most countries to assess other states' adherence with voluntary space norms and, therefore, is vital for broad-based norm acceptance.

This paper describes the importance of international SSA data sharing to space norm emergence and suggests criteria for an international SSA data sharing framework to facilitate global norm adoption. The paper describes how norms emerge and emphasizes the importance of confirming each actors' behavior for establishing mutual restraint. Based upon an assessment of an arms control verification regime typology, the paper analyses three models for an international SSA data sharing framework appropriate for assessing adherence with voluntary norms. Such a framework would benefit space traffic coordination and other space safety, sustainability, and security norms which may otherwise flounder without an internationally accepted means to measure conformance with those norms.

---

## Introduction

To reduce the risk of satellites colliding with other objects in orbit, the United States has shared space object tracking and surveillance data with commercial and foreign space actors since the early 1960s.\* Today, in the form of the United States Space Command (USSPACECOM) Space Situational Awareness (SSA) Sharing Program, the

United States shares space object tracking data with governmental and non-governmental partners around the world to promote a safe, stable, sustainable, and secure space environment.<sup>1,†</sup> Likewise, the growing European Union Space Surveillance and Tracking (EU SST) consortium's stated purpose is to mitigate the risk of collisions

---

\*In accordance with a 1961 DOD-NASA support agreement, the U.S. military provided unclassified space surveillance data to NASA for NASA to share with nonmilitary entities. In the early 2000s, the responsibility for providing space surveillance information to commercial and foreign entities was transferred from NASA to Air Force Space Command (AFSPC). This pilot program ran from 2004 to 2009.

†While many of these services may be moved to the U.S. Department of Commerce (DOC), for now they still reside at USSPACECOM.

between operational spacecraft or debris and safeguard the orbital environment.<sup>2</sup> Commercial SSA service providers also highlight their products for space safety, sustainability, and even military space superiority purposes.<sup>3</sup> But international SSA data sharing has another crucial, but underappreciated, role: it can verify which countries are abiding by voluntary norms of behavior for space and which are not. This paper argues that many countries beyond the United States and its allies need to be able to assess other countries' adherence to norms of behavior for space if the ultimate goal of space norm initiatives is widespread compliance to globally accepted norms and censure for noncompliance.

Several important factors drive this idea. Abiding by norms of behavior imposes material costs and opportunity costs on an actor. Perhaps most importantly, it also costs an actor some freedom of action. States will be unlikely to accept these costs unless they are reasonably assured that other states will exercise the same level of restraint. However, since comprehensively monitoring activities in space around the globe is technologically complex

#### **Space Situational Awareness (SSA)**

SSA includes understanding a space object's orbital location, trajectory, behavior, where it will be at any given time, and other characteristics. SSA depends on data collected by optical and radar space surveillance sensors, the integration of the data collected, and the data's dissemination.<sup>4</sup>

and costly, most countries are unlikely to possess the globe-spanning capabilities needed to monitor the reciprocal restraint of others and therefore will need to find trusted sources of information elsewhere.

If countries outside the circle of the United States and like-minded nations cannot access trusted information on what is happening in space, they are unlikely to rebuke or even recognize bad behavior in space. Consequently, emergent norms may not create enough of a collective expectation internationally for proper behavior in space. That is, the norms may never drive significant reputational or material costs internationally for irresponsible behavior in space, and in turn fail to incentivize bad actors to alter their behavior toward conformity with voluntary norms of behavior. In turn, space safety, sustainability, and security will not benefit as much from voluntary space norms as anticipated among space norm advocates.

This paper synthesizes scholarly literature on norm emergence with scholarly literature on the importance of verification for arms control, showing that a significant number of countries beyond U.S. allies and close partners will need the ability to assess other countries' compliance with space norms. The paper judges that an international SSA data sharing framework for assessing countries' norms compliance is required to build enough support—from enough countries—to influence bad actors' behavior in space. The analysis explores how to construct an international framework for SSA data sharing and suggests three models that could inform the framework's design.<sup>‡</sup>

---

<sup>‡</sup>Technically, “verification of compliance” is a term of art which implicitly refers to legally binding treaties, while “monitoring” frequently refers to non-legally binding international confidence-building measures. Officials use the terms “confirming” and “assessing” to connote non-legally binding, voluntary, norms, best practices, guidelines, standards, and norms of behavior. Nevertheless, these terms are often used interchangeably. (Discussion with U.S. Department of State official, July 15, 2021.)

## Norms: Emergence, Cascades, Internalization, and Space

A standard definition of a norm is “a collective expectation for the proper behavior of actors with a given identity.”<sup>5</sup> International consensus on the need for space norms has gained momentum over the last few years.<sup>§</sup> In June 2019, the UN Committee on the Peaceful Uses of Outer Space (COPUOS) achieved consensus among 92 countries (including Russia and China) and adopted 21 voluntary Guidelines for the Long-term Sustainability of Outer Space Activities, often referred to as the LTS Guidelines.<sup>\*\*6</sup> In addition, in response to the December 2020 UN General Assembly Resolution 75-36, “Reducing Space Threats Through Norms, Rules and Principles of Responsible Behaviors,” 30 states (including the United States, Russia, and China) shared their ideas on the further development of norms—despite disagreeing on which norms should be developed.<sup>7</sup> Most recently, in February 2022, a new UN-chartered Open-Ended Working Group (OEWG) began work on making recommendations on possible norms, rules, and principles of responsible behaviors relating to threats by states to space systems.<sup>8</sup>

But agreeing, in general, that norms are needed is just the first step along the path to establishing and implementing specific norms. Creating a collective expectation about proper behavior is a critical next step.

### The Norm Lifecycle

Norms emerge and achieve international acceptance following the three-stage norm lifecycle laid out by Finnemore and Sikkink in their landmark 1998 study, “International Norm Dynamics and Political

Change,” a definitive work in norm scholarship, see Figure 1.<sup>9</sup> The first stage in the norm lifecycle is “norm emergence,” in which norm “entrepreneurs” (or advocates) try to persuade a critical mass of states to embrace the need for new norms. Norm entrepreneurs can be states, international organizations, nongovernmental organizations, and even individuals.

Norm emergence is followed by the “norm cascade” stage, which is reached when a “critical mass” of states have been convinced by norm entrepreneurs to support an emerging norm. States may be convinced to accept the norm for a variety of reasons, such as pressure to conform by other states, the desire to be perceived internationally as a legitimate actor, and even to preserve the self-esteem of individual state leaders. Eventually, growing support for the norm leads to a tipping point. Once the tipping point is crossed, other states begin to quickly follow with their support because the norm now has come to define proper behavior among actors. In the “norm cascade” stage, additional states begin supporting or adhering to a norm without significant effort by norm entrepreneurs because it is simply perceived as the right thing to do.

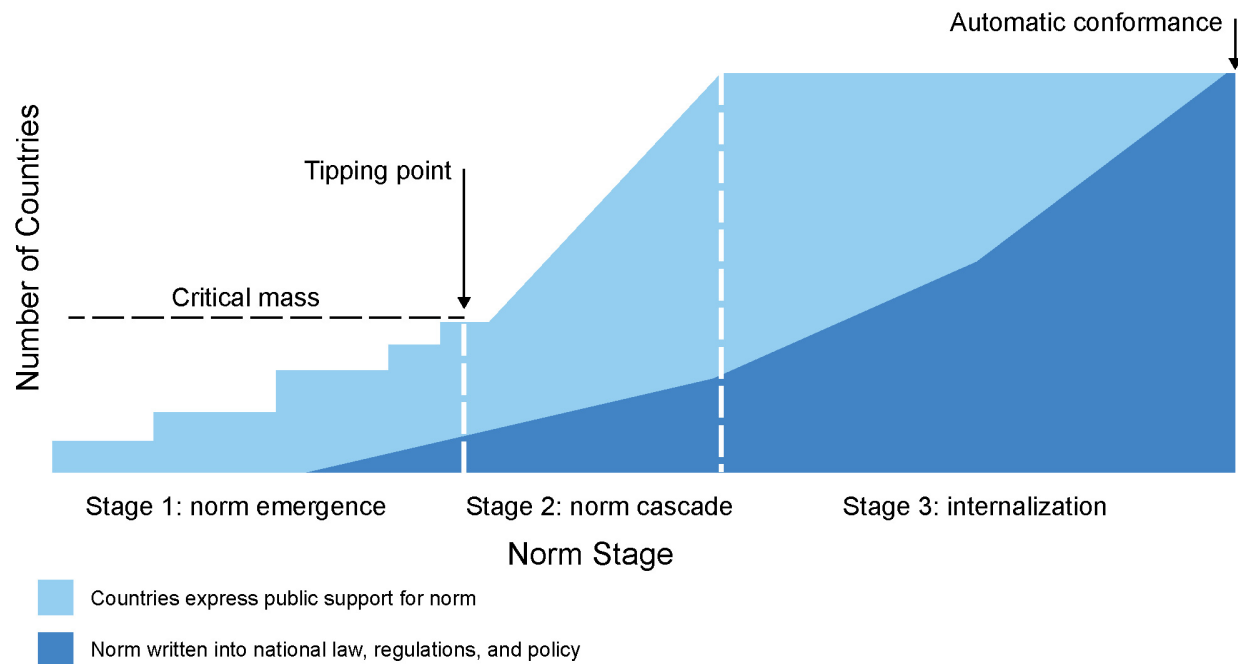
Finally, a norm cascade sets the stage for the third phase of norm development—“internalization”—in which so many actors collectively accept the norm as indicative of proper behavior that the norm takes on a taken-for-granted quality, making conformance effectively subconscious. Bad actors might still violate the norm, but they will stand out for deviating from what is considered acceptable behavior and generate ridicule and censure by other

---

<sup>§</sup> The term “norms” is often used in the space expert community as a catchall phrase for terms such as “code of conduct,” “rules of the road,” “transparency and confidence-building measures,” and standards, guidelines, and best practices. See <https://csp.aerospace.org/papers/establishing-space-traffic-management-standards-guidelines-and-best-practices>.

<sup>\*\*</sup> COPUOS currently has 100 member states.

<https://www.unoosa.org/oosa/en/ourwork/copuos/members/evolution.html>



**Figure 1: Norm life cycle.** (Adapted from Finnemore and Sikkink)

actors, which may cause them to conform in the future. In contrast, responsible actors may be commended by others for conforming to a norm, which reinforces the norm.<sup>10</sup>

### How to Reach Critical Mass

Many emerging norms fail to garner the support of a critical mass of states to reach a tipping point and thereafter fail to become broadly accepted. Norm advocates have two potential paths to follow, however, to help a norm reach critical mass. First, they could focus their persuasive efforts on key states who provide enough “mass” to spark a norm cascade. Alternatively, they can work to create a broad consensus among relevant stakeholders, large and small, whose collective “mass” will be sufficient—even if some critical states do not approve.

Critical states are defined as those states whose acceptance is required or else the norm is compromised and will not take hold. It is reasonable to argue that the United States, Russia, and China

are the most critical states for space norms and if these major space powers do manage to reach agreement on space norms, a norm cascade will quickly follow with space norms becoming widely accepted among all spacefaring nations. But that seems unlikely in the foreseeable future given many ongoing space policy disputes and other disputes between the three states. More likely, the United States and like-minded nations with significant space capabilities—including France, Japan, the European Union, and others—may accept the same proposed space norms (representing some critical states) but their weight alone will not be sufficient to create a new, collective global expectation of proper behavior in space. China, Russia, and other countries outside the U.S. circle will not be influenced enough to support the space norms and constrain their freedom of action in space, and the norm will fail to achieve critical mass, resulting in a hollow shell. Even worse, it could lead to Russia, China, and others promoting alternative, competing norms of behavior in space, which defeats the

purpose of U.S. space norm advocates and defies the definition of a norm in the first place.

If the goal of space norm advocates from the United States and like-minded nations is to fashion globally accepted standards of responsible behavior in space, an alternative strategy is to generate widespread support for proposed space norms among as many countries as possible. Broad consensus among some critical states and a range of other relevant states will define the collective sense of how states ought to behave in space. This would mean reaching beyond existing partners, allies, and like-minded nations to a more diverse group of space stakeholders. Only then will those states who adhere to the norm be applauded and those who deviate from the norm be censured by enough states to matter. And only then will a norm exist and reflect the collective sense of proper behavior.

### ***Building Broad Consensus***

In the absence of consensus among critical states, Finnemore and Sikkink found that critical mass can be achieved when *at least* one-third of the total states in the world, (i.e., about 60 states) accept the norm.<sup>††</sup> This means space norm advocates will need to identify which countries beyond the United States and its allies, China, and Russia are important when it comes to generating enough international support for norms of responsible behavior for outer space.

With that in mind, the United States and other space norm advocates could focus their persuasive efforts just on states that have the independent ability to launch satellites in space, but that comprises only 14 countries today and is not enough.<sup>‡‡</sup> The 28 states with which the United States has SSA Sharing Agreements matter but also are not enough to generate a norm cascade. This indicates the need to look beyond existing partners and agreements.

The number of states with established interests in space is growing significantly. Sixty-five states plus the European Space Agency and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) have put satellites in space, indicating those countries have made significant investments and have national interests in space.<sup>11</sup> A state's membership in the UN Committee on the Peaceful Uses of Outer Space (COPUOS) also indicates which countries have national interests in outer space. Significantly, COPUOS membership is not automatic; it is based on acceptance by the existing member states, indicating that upon such acceptance, existing member states recognize the applicant's legitimate national interests in space activities and their diplomatic importance to the peaceful uses of outer space. In fact, between 2001 and 2022, COPUOS membership has grown from 64 states to 100 states.<sup>12</sup> Finally, all of the approximately

---

<sup>††</sup> Although this analysis focuses on voluntary norms of behavior, the concept of critical mass can be found in legally binding normative efforts as well. In the case of the 1997 Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction, advocates against landmines began to make a strong public case against the use of landmines more than five years before the ban was reached. Draft agreements were floated but the number of states supporting the effort only grew slowly. However, in May 1997, the number of states supporting the ban reached approximately one-third of the total states in the world and, thereafter, a norm cascade occurred. Further, Finnemore and Sikkink argue, "Where treaties exist, the entry into force of the treaty may be a useful proxy for the critical mass necessary to say a norm exists." In fact, the 1982 United Nations Convention on the Law of the Sea (UNCLOS), Article 308 requires 60 countries to ratify before it comes into force. The 1992 Chemical Weapons Convention, Article XXI requires 65 countries to ratify before it comes into force.

<sup>‡‡</sup> States and intergovernmental organizations with proven independent space launch capabilities today include China, European Space Agency, European Union, France, India, Iran, Israel, Japan, New Zealand, North Korea, Republic of Korea, Russia, United Kingdom, and the United States.



193 countries in the world benefit from space activities that improve their citizens' quality of life and help protect their safety and security.<sup>13</sup> Recall from above that over 160 countries voted in favor of recent UN resolutions on further developing norms of behavior for outer space, indicating some level of interest in space activities and their desire to moderate irresponsible behavior. Norms entrepreneurs should not dismiss out of hand the need to persuade non-spacefaring countries about the need for space norms.

#### **Important Country Groupings for Space Norms**

- ♦ Major space powers: 3
- ♦ States with independent space launch capability: 12
- ♦ States with which the United States has SSA data sharing agreements: 28
- ♦ States with at least one satellite: 65
- ♦ COPUOS member states: 100
- ♦ All countries: ~193

The purpose of this tally is to show that there are dozens of states with space interests that are not closely aligned with the United States or Russia or China, but are relevant nevertheless. For example, support from Brazil, India, Indonesia, Nigeria, Pakistan, South Africa, or Vietnam could help tip the scale in favor of preferred norms of responsible behavior in space. To have a reasonable expectation that critical mass can be achieved without agreement among the United States, China, and Russia, space norm entrepreneurs should cast their net wide enough to persuade at least one third of the world's countries that conforming with space norms is the proper way to behave, while non-adherence will generate rebuke from the international community.

### **The Importance of Confirming Other Countries' Adherence to Norms**

Even though space norms will not prevent all bad behavior in space, their ability to set the boundaries of good behavior and bad behavior in space will be more effective when a sufficient number of states are able to confirm other states' compliance with the norm. This will require an international framework for SSA data sharing.

When a state conforms to a norm of behavior, that state is implicitly—and often explicitly—accepting constraints on its freedom of action. For a norm that constrains freedom of action to take root globally, states must have assurance that other states are exercising the same level of restraint, especially in a core national security realm such as space.<sup>14</sup> In fact, a norm's wide acceptance rests upon states' abilities to confirm other states' reciprocal restraint. Canada's response to UN General Assembly Resolution 75/36 reflects this idea, stating that Canada “recognize[s] the importance of verification to international peace and security, including to ensure confidence that parties are complying. Tangible and realistic verification mechanisms enhance credibility, promote transparency and accountability, and build confidence among participating States.” In addition, senior U.S. official Audrey Schaffer wrote, “To the extent that the international community can observe what is happening in space, norms will shape world opinion about these behaviors, branding them as simply irresponsible or something more egregious such as potentially unlawful. This will require, at a minimum, compelling evidence based on space situational awareness information from a trusted source.”<sup>15</sup>

And there's the rub; if a sufficient number of states do not have the independent ability to confirm mutual restraint by other states, do not necessarily trust the external entities they must rely on to provide them with compliance information, or do



not have the ability to confirm the accuracy of information from outside sources, those states may not have the confidence to support a space norm. At the least, they may hesitate when asked to put their prestige and other national interests on the line to censure behavior that deviates from the norm. The norm will fail to achieve critical mass, fail to cascade, and fail to reflect a collective expectation of proper behavior.

It follows that for space norms to reach critical mass, a significant number of countries not aligned closely with the United States, China, or Russia will need access to trusted, timely SSA information to confirm for themselves other actors' behavior in space. The logical consequence of this finding is that to minimize the chances that space norms fall flat, an international framework for SSA data sharing for monitoring adherence with space norms should be carefully considered.

### ***Expanding the SSA Circle of Trust for Confirming Compliance***

If the United States is only concerned with convincing its allies and partners that a space norm is being complied with, it would be relatively easy to establish a framework for confirming compliance with the norm since those countries most likely have a sufficient level of trust in U.S. leadership and the information and assessments the United States provides. Indeed, after picking up the responsibility from U.S. Strategic Command in 2019, the U.S. Space Command has 28 SSA data sharing agreements with other governments and is regularly adding more. Of the current SSA agreements, signatories include 15 NATO countries and the U.S. defense alliance partners Australia, New Zealand, Japan, Republic of Korea, and Thailand.<sup>§§</sup> Close

defense cooperation also exists between the United States and Israel as well as the United States and United Arab Emirates, both of whom have signed SSA data sharing agreements. These agreements demonstrate that these countries have a degree of trust in U.S.-provided SSA information. The United States should not have a difficult time assuring these countries about the compliance of other countries with U.S.-favored norms of behavior in space. Ideally, these countries will affirm such norms publicly by censuring irresponsible behavior when it occurs, as several—but not nearly all—of these countries have done in response to Russia's November 2021 destructive anti-satellite test in low Earth orbit.

The United States should not concern itself with sharing SSA data with Russia and China. Russia and China have independent capabilities to confirm responsible behavior in space. Indeed, an international SSA data sharing framework for verifying space norm compliance does not need to be designed to assure them of reciprocal restraint by the United States and its partners, although it would be nice if it did so. Russia's and China's allies and partners (such as Belarus, Iran, North Korea, and Syria) also are unlikely to trust externally provided SSA information on norm compliance, so the SSA sharing framework does not need to include them either.

To maximize the chances of generating a critical mass of support for a space norm and stimulating a norm cascade, an international SSA data sharing framework should focus instead on delivering credible SSA data to the remaining roughly 30-plus spacefaring nations, the 60-plus remaining COPUOS members, and as many of the

---

<sup>§§</sup>The U.S. has SSA data sharing agreements with Australia, Belgium, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Peru, Poland, Portugal, Republic of Korea, Romania, Spain, Thailand, United Arab Emirates, and the United Kingdom, including the European Space Agency (ESA), and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). Sandra Erwin, "U.S. Space Command signs space data sharing agreement with Peru," September 20, 2020, <https://spacenews.com/u-s-space-command-signs-space-data-sharing-agreement-with-peru/>.

120 countries of the Non-Aligned Movement as possible.<sup>\*\*\*</sup> Doing so would constitute over a third of the world's countries that have enough confidence in the norm monitoring information to support space norms, to reprimand irresponsible behavior when it occurs, and thereby affirm a norm's existence even if China, Russia, and other countries have not agreed to it. But most of these remaining countries currently lack trusted sources of SSA information, denying them the ability to confirm other countries' adherence to space norms.

Here is an opportunity for U.S. leadership. But if the United States fails to lead in the establishment of an appropriate international SSA data sharing framework for norm verification, U.S.-favored norms may flop. This could open the door to alternative means of verification that favor the interests of Russia or China, which may be contrary to U.S. interests. In any case, if the United States leaves a verification gap in its strategy for promoting voluntary norms of responsible behavior for outer space, others may fill it.

### Assessing Norm Verification Framework Models

The design of an international SSA data sharing framework for monitoring compliance with voluntary norms of behavior in space also matters. There are several key design elements that would affect whether an SSA-based verification regime would be acceptable to various stakeholders: suitability, scalability, level playing field, level of control, degree of transparency, ease of communication and information sharing, and cost sharing.<sup>16</sup> These design elements are summarized in

Table 1. Most fundamentally, the design of the international SSA data sharing framework for assessing adherence with norms must be suitable for the task of assessing specific behaviors. For example, most arms control agreements have been primarily focused on capping, reducing, or eliminating numbers of weapon systems, warheads, stockpiles, and so forth. Success in arms control has usually been defined by numbers—the lower the numbers the better.<sup>17</sup> In turn, verification of compliance focused on counting things. But monitoring behavior is not as straightforward as counting things. The design of the international SSA data sharing framework should account for this difference in purpose compared to the traditional focus of arms control verification. Likewise, the focus on developing widely accepted *voluntary* norms of behavior for space means the framework would need to be suitable—from a cost perspective—for confirming adherence with something in which it is voluntary for stakeholders to go along with anyway. Similarly, a framework must be sufficiently scalable to include enough countries for norm acceptance to reach critical mass.

Also, stakeholder buy-in increases when the stakeholders have a seat at the table during the development of any regime. In this case, it is important that countries not aligned closely with either the United States or with Russia or China be able to participate in the international SSA data sharing framework establishment. Bringing them into the process early increases their understanding of how confirming compliance happens and avoids the perception that a framework is not transparent or trustworthy because they were not allowed a voice

---

<sup>\*\*\*</sup>The Non-Aligned Movement is an international organization with 120 member states dedicated to representing developing countries' interests. Member states cannot be formally aligned with or against any major power. It is the largest grouping of states in the world, after the United Nations. Britannica, "Non-Aligned Movement," <https://www.britannica.com/topic/Non-Aligned-Movement>, and "About the Non-Aligned Movement," <http://www.namstct.org/about.html>.

Table 1: Critical Design Factors	
Suitable	Stakeholders view design as reasonable for verifying compliance with <i>voluntary</i> norms of behavior.
Scalable	The design can accommodate and satisfy enough countries and other stakeholders.
Participation	Stakeholders' buy-in increases when they have a seat at the table in regime design.
Degree of Control	Stakeholders' buy-in increases when they have a voice in a regime's management, decision-making, and dispute resolution processes.
Degree of Transparency	Stakeholders' buy-in increases when they have visibility into regime management, operations, costs, other key information.
Information Access	Stakeholders' buy-in increases when they have trusted means of dialogue, information exchange, and other means of communication.
Cost Sharing	Stakeholders' buy-in increases when there is burden-sharing among stakeholders.

at the start. Moreover, involvement will increase countries' support for the norms being monitored and reduces apathy or pushback when it comes to calling out irresponsible behavior in space.<sup>18</sup> Robin Dickey's "Building Normentum: A Framework for Space Norms Development" makes a similar point when pointing out that starting with the "easiest" partners or a small like-minded group can create a perception of exclusivity among the broader community. Such a negative perception can cause progress on proposed norms to "stall."<sup>19</sup>

States' buy-in also is influenced by the degree of control stakeholders have in a regime's management, decision-making, and dispute resolution processes. If countries not closely aligned to the United States have no say, it will be more difficult to convince them of the credibility of an international SSA data sharing framework for assessing adherence with norms or of the credibility of norms of behavior for outer space in the first place. And these countries may never join in condemning bad behavior, leaving the norm

unaffirmed as a collective expectation of proper behavior, and withered on the vine.

Scholars and practitioners have studied the importance of transparency in international affairs for decades.<sup>20</sup> Transparency is crucial for building trust between nations, reducing misunderstanding and miscalculation, and reinforcing the credibility of shared information. Transparency in a regime's management and operations also influences the credibility of its output. A non-transparent "take our word for it" approach to norms monitoring will most likely be insufficient in persuading an adequate number of countries to support space norms and will prevent voluntary space norms from being effective in altering behavior.

Stakeholders also must be able to exchange views regularly and share quality SSA data in a timely manner. An international SSA data sharing framework for norms monitoring should facilitate a consultative process for discussing issues, containing disagreements, and negotiating. It should

also facilitate appropriate communication networks, protocols, and other tools for getting credible, transparent compliance information out to the world.<sup>21</sup> This involves multidirectional communication, not just broadcasts from one actor. Unilateral statements calling out irresponsible behavior—based on unilateral capabilities—may be necessary, but they are unlikely to be sufficient.

Of course, costs are a significant factor as well. In this regard, costs include material costs and other transactional costs in time and effort in fashioning, managing, operating, and maintaining a verification regime. Burden sharing may be done in many imaginative ways. For example, in-kind contributions may include sensor data, collision avoidance information, communication network usage, databases, facilities, and personnel exchanges while financial contributions may include voluntary contributions, trust funds, and direct exchanges of funds. Alternatively, a contribution scale may be designed with proportional funding criteria based on Gross National Product, the number of satellites a country has in orbit, or other metrics.

### **Assessment of Verification Regime Types**

To get emerging norms on the path to achieving a critical mass of support, a norm cascade, and eventual acceptance and internalization in countries around the world, stakeholders need an internationally accepted SSA data sharing framework for confirming norm compliance. In the “Space and Verification” study, Ambassador Roger G. Harrison offers a typology of arms control verification regimes: unilateral verification, cooperative verification, multilateral verification, and open verification.<sup>22</sup> Harrison’s typology can inform the design of a monitoring regime appropriate to an international SSA data sharing framework. This study finds that an international SSA data sharing framework for monitoring space

norms can be structured imaginatively incorporating the best of the unilateral, multilateral, and open verification regime types described below.

### **Cooperative Verification**

Cooperative verification entails states agreeing to steps that dramatically increase transparency. These steps include mandated exchanges of sensitive information, prohibitions on concealment of some sensitive activities, prohibitions on interference with technical means of verification, and most importantly—politically sensitive on-site monitoring and on-site inspectors.

The cooperative verification regime type has worked in the past for treaties involving nuclear and conventional forces, but it is not a good model for confirming compliance with space norms because it fails the suitability and scalability criteria outlined in Table 1. Although parties to such agreements do have a voice and share information, a cooperative verification regime is very intrusive since it includes on-site inspections. There is certainly information that could be collected in this manner, through activities like on-site inspection of SSA sensors, sharing of algorithms and sensor calibration methods, and pre-launch inspections of payloads and spacecraft. But this approach poses significant questions for whether the value of such information is worth the cost of such complex and intrusive activities, especially when only attempting to verify conformance with voluntary norms of behavior. Moreover, what would countries have the capacity to inspect, and what information would countries be willing to reveal?

This approach may have significant value for counting warheads and weapons systems on the ground, but it is particularly difficult to translate from traditional arms control verification to monitoring space norm compliance. The other three verification regime types provide more opportunities and elements that could inform an international SSA data sharing framework.



### **Unilateral Verification**

Unilateral verification is when states rely completely on their own means to verify others' compliance with an agreement.<sup>23</sup> The 1967 Outer Space Treaty exemplifies this approach. In such cases, states use their own intelligence, surveillance, and reconnaissance capabilities, including national technical means (NTM), to verify other states' compliance. Based on the multiple bilateral USSPACECOM SSA Data Sharing agreements with U.S. allies and partners, we can presume U.S. allies and partners are willing to rely on U.S. monitoring of behavior in space to a significant degree. Let us call this circle of trust *extended unilateral verification*. This is the most straightforward verification means from a U.S. perspective and can be a significant part of an international SSA data sharing framework.

The United States should continue developing bilateral SSA Sharing Agreements and other instruments with its allies and partners in order to provide them the confidence that Russia, China, and other actors comply with space norms, and to enable protection and defense of U.S. allied and partner on-orbit assets. The emerging extended unilateral verification regime evinced by the U.S. DOD-led SSA Sharing Agreements can reveal noncompliance or "cheating," providing the United States and its allies and partners confidence that malign or threatening activities in space can be detected in a timely manner, before noncompliance has a chance to alter the relative strategic or operational position of the United States.<sup>24</sup> It also enables the United States and its allies to speak with a unified voice when censuring irresponsible behavior, potentially bringing significant pressure onto a noncompliant country. But this does not necessarily mean a norm will reach a critical mass of support among nations, spark a norm cascade, and become broadly accepted.

The U.S. Space Command's Internet portal, Space-Track.org, is another important U.S. tool and has

been a widely used source of data on space objects for more than a decade. Space-Track.org has earned significant credibility among many stakeholders.<sup>25</sup> Even so, the United States is planning to move some responsibility for public dissemination of some space situational awareness safety data out of the DOD to the Department of Commerce (DOC). That move alone is a conscious effort by the United States to further transparency and trust in U.S. SSA data sharing activities. In addition, the inclusion of nongovernmental and nontraditional sources of SSA data in DOC's Open Architecture Data Repository (OADR) will improve the quality and ideally further legitimize the SSA data provided by DOC to the world.<sup>26</sup>

While necessary and important, these U.S.-centric efforts will likely not have requisite buy-in from enough countries if the goal is to help norms emerge and reach critical mass. Extended unilateral verification simply will not include enough countries to enable a critical mass of norm support and may cause resentment among those with no seat at the table. Most countries likely perceive that they do not have sufficient transparency into or voice within the U.S.-centric processes. They do not have sufficient insight into the provenance of the information collected and disseminated. They also do not share the cost burden, raising the issue of free riding. It may be difficult to convince them to reprimand irresponsible behavior in space based on U.S.-provided SSA data alone and in which they have no way to assess its trustworthiness. Indeed, nonparticipating countries may be left vulnerable to counternarratives and misinformation regarding who is acting irresponsibly in space. This vulnerability provides an open door for others to offer alternative verification means and perhaps alternative norms.

Nonetheless, it is appropriate for the United States and its allies and friends to put their trust in U.S.-centric SSA data sharing mechanisms—just as it is fine for Russia, China and their partners to put their

trust in the SSA systems they control, and for the EU to have more trust in the EU Space Surveillance and Tracking Consortium (EU SST) than in U.S.-controlled SSA data sharing approaches. These unilateral verification methods can be a key part of the international SSA data sharing framework, but they do not ameliorate the need for the rest of the world to have verification methods they can trust.

### **Multilateral Verification**

Multilateral verification refers to a regime in which a treaty-based intergovernmental organization is responsible for verification. For example, compliance with the nuclear Non-Proliferation Treaty is overseen by the International Atomic Energy Agency. “International inspectors” conducting “international inspections” are key indicators of this regime type.

Perhaps the most important advantage of this regime type is that international organization-based international inspectors are usually perceived as less biased and more transparent in their evaluations than a single state can be, so their assessments are viewed as credible and carry significant weight internationally, creating pressure on noncompliant countries.<sup>27</sup> Treaty-based international organizations facilitate buy-in among member states since all members have a seat at the table and have input into the organization’s priorities, have visibility into the organization’s management, and member states share information and consult each other routinely, which enhances transparency.

However, establishment of a treaty-based international organization to monitor compliance with voluntary norms fails the suitability and scalability criteria established in Table 1. Reaching broad international agreement on the parameters of such a treaty-based international organization simply for the sake of monitoring compliance with voluntary norms of behavior seems questionable. International organizations are costly to negotiate up front and difficult to establish when several

prospective member states need to be included and given voice. Given the core national security aspects of many space activities, established space powers and their allies and partners (along with a sufficient number of unaligned countries) may find it impossible to agree on a treaty that establishes such an international organization.

Still, the multilateral verification regime type has many favorable aspects that should factor into an international SSA-sharing framework for verifying compliance with voluntary norms of responsible behavior for outer space. The institutional mechanisms modelled by formal, treaty-based international organizations can be replicated to some, ideally less formal, degree in a future international SSA data-sharing framework.

### **Open Verification**

The “open verification” regime type offers several advantages as a model for norm monitoring, but also comes up short. The “open verification” regime type derives from the spontaneous organization of citizen-led “Helsinki Watch Groups” in the 1970s to monitor the Soviet Union’s compliance with the human rights provisions of the Helsinki Agreement on European Cooperation and Security (CSCE) also referred to as the Helsinki Accords.<sup>28</sup> Helsinki Watch Group reports were more detailed and more credible than the information the 35 member states provided. Also, like current efforts to develop voluntary norms of responsible behavior for space, the Helsinki Accords were not a legally binding treaty, but rather political commitments from member states to abide by a set of provisions. Similar concepts have many labels—such as societal verification, open data, citizen crowdsourcing for monitoring, collaborative networks, and transnational advocacy networks.<sup>29</sup>

Open verification relies on civil society to confirm a state’s compliance with its international obligations. “Civil society” as usually defined includes non-governmental organizations (NGOs), such as

universities, professional associations, advocacy networks, think tanks, clubs, social media communities, labor organizations, social entrepreneurs, and grassroots associations. Importantly, this analysis includes the commercial SSA industry as players in the open verification regime concept.<sup>30</sup>

An open verification-based regime could potentially meet all the criteria spelled out in Table 1, depending on how strictly or loosely those criteria are applied. For example, states will likely have relatively equal control (or little or no control) and influence (or little or no influence) in the regime's design and operation. Similarly, civil society actors might provide transparency into their management, operations, costs, and other key information. Furthermore, because it would be based on non-governmental, voluntary associations, an open verification-based regime's cost to governments could be comparatively low.

But open verification has its weaknesses too. Its potential may be diminished by its fragmented nature and other impediments, including diverse observation standards and calibrations, differences in orbit determination schemes, non-standardized data formats, ad hoc communication networks, and non-standardized technical capabilities.<sup>31</sup> Of course, commercial space surveillance entities have a vested interest in providing quality information, but competitive pressures can cause them to overpromise, overhyping their capabilities and products while proprietary information protections prevent independent assessment of their claims.<sup>32</sup> And naturally they want to be paid. Universities, NGOs, and other civil society entities should be motivated to contribute solid information as well, but their efforts might be inadequate given funding needs. The quality of the information offered by civil society might be the biggest concern for countries with established SSA capabilities and methods. The United States and its partners might

judge it is not worth the trouble to get involved in these complexities—since they have their own capabilities and trusted sources of information—and thereby take a hands-off approach.

Despite these challenges, the open verification regime type has several features that could inform an international SSA data sharing framework for confirming conformance with voluntary norms of responsible behavior for outer space.

Table 2 summarizes Harrison's four verification regimes across the seven critical design elements described in Table 1.

## **Synthesis and Models for an International SSA Sharing Framework**

An international SSA data sharing framework for verification of norms of behavior for space activities can be structured imaginatively, incorporating the positive aspects of the extended unilateral, multilateral, and open verification regime types, including contributions from civil society and commercial SSA entities.

A hybrid verification framework should be designed to allow SSA data contributions from U.S. extended verification tools such as the nascent Open Architecture Data Repository (OADR) and Space-Track.org; contributions from the EU SST consortium; and contributions from civil society, commercial SSA, and other entities. Such a conceptual framework should promote buy-in for space norms among a wide swath of countries and enable space norms to become accepted by the majority of countries around the world.

Encouragingly, there already are many disparate civil society efforts underway in the United States and other countries to develop tools that maximize transparency and trust in SSA data sharing and, with some vision, collective effort, and U.S. leadership,

Table 2: Roll Up of Verification Assessment					
	Cooperative	Extended Unilateral		Multilateral	Open
	Among Parties to the Agreement	Inside Circle of Trust	Outside Circle of Trust	Among Parties to the Agreement	Among Parties Reliant on Open Verification
Suitable for Verifying Compliant with Voluntary Norms	Very unlikely	Likely	Unlikely	Unlikely	Possibly
Scalable to Enough Countries	Very unlikely	Unlikely		Unlikely	Possibly
Participation	High	Adequate	Insufficient	High	Adequate
Degree of Control	High	Adequate	Insufficient	High	Adequate
Degree of Transparency	High	Adequate	Insufficient	High	Adequate
Information Access	High	Adequate	Insufficient	High	Adequate
Cost Sharing	High	Adequate	Insufficient	High	Adequate

may be important pieces of a comprehensive international SSA data sharing framework for monitoring norm adherence. Civil society efforts include the Satellite Dashboard project by the Center for Strategic and International Studies, the Secure World Foundation, and University of Texas-Austin; the International Virtual Observatory Alliance (IVO)<sup>33</sup> and citizen-based, amateur observer, public crowd source initiatives such as TruSat; and several commercial space situational awareness service companies.

But so far most of these civil society efforts are disjointed without any unified framework on how to stitch them together to facilitate norm emergence

and achieve a critical mass of support for norms among countries not closely aligned with the United States, China, or Russia. That may be acceptable, especially if permissioned digital ledger technology models (often referred to as “blockchain”) for decentralized space information sharing come to fruition and enable sufficient trust in information from multiple sources.<sup>34</sup> But in the meantime, and perhaps while incorporating innovative concepts for decentralized space information sharing, the United States could guide an international effort to assess and pool together the fragmented civil society efforts and combine them with U.S., EU SST, and other unilateral verification regimes, as well as



Table 3: Notional Hybrid Verification Assessment	
	For All Countries
Reasonable for Verifying Compliance with Voluntary Norms	Likely
Scalable to Enough Countries	Likely
Participation	Adequate
Degree of Control	Adequate
Degree of Transparency	Adequate
Information Access	Adequate
Cost Sharing	Adequate

commercial SSA service providers, while leaving them open to contributions from formal international organizations.

A hybrid verification regime could provide an appropriate international SSA data sharing framework for verification of norms of behavior for space activities. Several models for similarly conceived international data sharing frameworks already exist. For example, the World Meteorological Organization (WMO) shows how an innovative public-private partnership could facilitate international SSA data sharing among civil society, governments, and commercial enterprises—and be chartered to verify countries’ voluntary conformance with norms of responsible behavior in space.<sup>35</sup> The WMO is a formal treaty-based intergovernmental organization and UN agency but has recently begun engaging and forming partnerships with non-governmental organizations, academia, foundations, associations, and the private sector operating in the global

weather enterprise.<sup>36</sup> The WMO’s multi-stakeholder approach is an exemplar of global data sharing, public-private engagement, and addressing the critical factors that make its data and operations acceptable to all stakeholders. However, it faces the same limitations as the multilateral regime type because countries may not see a similar organization for SSA data sharing as worth the cost and effort of establishing a new international treaty organization.

Organizations that are less formal could also serve as exemplars for a hybrid norm monitoring regime. For example, the International Charter: Space and Major Disasters features several intriguing facets. Space agencies, space system operators, and nongovernmental entities provide satellite imagery for disaster monitoring through the International Charter whereby they provide universal access to timely observations, free of charge.<sup>37</sup> Charter activities are funded by members through substantive in-kind resource contributions and commitment to share common costs. Preapproved disaster management organizations from member states can access relevant information by calling a confidential phone number 24 hours a day, 365 days a year.<sup>38</sup>

Similarly, Space Climate Observatory International is an informal group of space agencies and international organizations created in June 2019 to increase international coordination to enable accurate assessment and monitoring of climate change’s consequences.<sup>39</sup> SCO International currently has 36 members or “Partners,” primarily from a wide variety of national space agencies but has no legal personality in its own right and “depends on the good will and capabilities of SCO Partners.”<sup>40</sup> SCO International’s combination of loose structure, emphasis on open data sharing and transparency, and partnering among multiple national space agencies and international organizations is promising, but so far SCO lacks civil society participation.

A quick survey finds several more loosely structured international information sharing entities exist across many areas of interest. For our purposes, these three examples provide ample evidence that mutual interest in international information sharing and data exchange for safety and sustainability through creative institutional structures is possible when justification is clear and the political will exists.

## **Conclusion**

Scholarly research shows at least a third of countries in the world need to accept a norm for it to reach critical mass and become globally accepted, especially if key actors disagree. To reach the necessary level of international acceptance, it is likely that many countries beyond the United States and like-minded nations will need access to trusted SSA information so they can confidently assess other countries' behavior in space. Otherwise, even space norms very carefully developed from a technological and diplomatic standpoint may never stimulate a collective expectation for the proper behavior of actors in space and never drive significant reputational or material costs internationally for irresponsible behavior.

The United States can lead in proposing an international SSA data sharing framework that will accelerate the further development of space norms, ultimately advancing U.S. goals with regard to space traffic coordination and space safety, sustainability, and security. A wide variety of international information sharing institutions exist and can inform the design of such a framework. Outer space should provide no haven for misbehavior'.

## **Acknowledgments**

The author would like to thank the many experts, officials, and colleagues who informed the research and foundation of this paper. Thanks to Robin Dickey, who helped crystalize ideas and diligently edited the paper, and those who reviewed the paper and provided feedback during its development. Thanks also to Joseph Hidalgo for the cover design and Mary Mills for pulling it all together.

## References

- <sup>1</sup> SPACE-TRACK.ORG, <https://www.space-track.org/documentation#/odr>
- <sup>2</sup> Pascal Faucher, Regina Peldszus, Amélie Gravier, “Operational space surveillance and tracking in Europe,” *Journal of Space Safety Engineering*, 7, (2020): 420-425.
- <sup>3</sup> LeoLabs, <https://www.leolabs.space/>, and ExoAnalytic Solutions <https://exoanalytic.com/space-domain-awareness/>
- <sup>4</sup> “Space Briefing Book,” Space Foundation, [https://www.spacefoundation.org/space\\_brief/space-situational-awareness/](https://www.spacefoundation.org/space_brief/space-situational-awareness/).
- <sup>5</sup> Peter J. Katzenstein, editor, “The Culture of National Security: Norms and Identity in World Politics,” p. 3, <http://www.ciaonet.org/book/katzenstein/katz01.html>
- <sup>6</sup> “Long-term Sustainability of Outer Space Activities,” United Nations Office for Outer Space Affairs, Accessed May 12, 2021, 22 <https://www.unoosa.org/oosa/en/ourwork/topics/longterm-sustainability-of-outer-space-activities.html>
- <sup>7</sup> United Nations, General Assembly, Plenary Meetings Coverage, Dec 7, 2020. <https://www.un.org/press/en/2020/ga12296.doc.htm>
- <sup>8</sup> UN First Committee, “Reducing space threats through norms, rules and principles of responsible behaviours, A/C.1/76/L.52, October 14, 2021.
- <sup>9</sup> Martha Finnemore and Kathryn Sikkink, “International Norm Dynamics and Political Change,” *International Organization* 52, no. 4 (1998): 901.
- <sup>10</sup> Kenneth N. Waltz, “Neorealism and Its Critics,” Robert O. Keohane, Editor Chapter 3, “Reductionist and Systemic Theories”, Columbia University Press, New York, (1986): 64.
- <sup>11</sup> United Nations Office for Outer Space Affairs, United Nations Register of Objects Launched into Outer Space, <https://www.unoosa.org/oosa/en/spaceobjectregister/submissions/states-organisations.html>
- <sup>12</sup> United Nations Office for Outer Space Affairs, Committee on the Peaceful Uses of Outer Space, Membership Evolution, <https://www.unoosa.org/oosa/en/ourwork/copuos/members/evolution.html>
- <sup>13</sup> Robert Wilson, Michael Gleason et al, *The Value of Space*, the Aerospace Corporation Center for Space Policy and Strategy (May 2020).
- <sup>14</sup> Roger G. Harrison, Space and Verification, Volume 1: Policy Considerations, Eisenhower Center for Space and Defense Studies (November 9, 2010): under “Key Points,” <https://swfound.org/media/37101/space%20and%20verification%20vol%201%20-%20policy%20implications.pdf>
- <sup>15</sup> Audrey M. Shaffer, “The Role of Space Norms in Protection and Defense,” *Joint Forces Quarterly*, 4<sup>th</sup> Quarter, 2017, [https://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-87/jfq-87\\_88-92\\_Schaffer.pdf?ver=2017-09-28-092555-747](https://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-87/jfq-87_88-92_Schaffer.pdf?ver=2017-09-28-092555-747)
- <sup>16</sup> Rebecca Reesman, Michael P. Gleason, Layla Bryant, and Colleen Stover, “Slash the Trash: Incentivizing Deorbit,” The Aerospace Corporation Center for Space Policy and Strategy (April 2020): 4. [https://aerospace.org/sites/default/files/2020-04/Reesman\\_SlashTheTrash\\_20200422.pdf/p](https://aerospace.org/sites/default/files/2020-04/Reesman_SlashTheTrash_20200422.pdf/p)
- <sup>17</sup> Michael Krepon, “Winning and Losing the Nuclear Peace: The Rise, Demise, and Revival of Arms Control”, Stanford University Press (2021): 495.
- <sup>18</sup> Rebecca Reesman, Michael P. Gleason, Layla Bryant, and Colleen Stover, “Slash the Trash: Incentivizing Deorbit,” The Aerospace Corporation Center for Space Policy and Strategy (April 2020).
- <sup>19</sup> Robin Dickey, “Building Normentum: A Framework for Space Norm Development”, The Aerospace Corporation Center for Space Policy and Strategy (July 2021): 8.
- <sup>20</sup> See for example see Alexandru Grigorescu, “Transparency of Intergovernmental Organizations: The Roles of Member States, International Bureaucracies and Nongovernmental Organizations,” *International Studies Quarterly*, Vol. 51, No. 3 (September 2007): 625-648, <http://www.jstor.org/stable/4621731>; Sean P. Larkin, “The Age of Transparency International Relations Without Secrets,” *International Affairs*, (May/June 2016); and Daniel R. McCarthy and Matthew Fluck, “The Concept of Transparency in International Relations: Towards a Critical Approach,” *European Journal of International Relations* (June 16) 2016.
- <sup>21</sup> Joseph S. Nye, Jr, “The End of Cyber-Anarchy?” *Foreign Affairs*, Vol 1010, No 1, January/February 2022, p. 41.
- <sup>22</sup> Roger G. Harrison, “Space and Verification, Volume 1: Policy Considerations” Eisenhower Center for Space and Defense Studies, (November 9, 2010): 10.
- <sup>23</sup> Ibid.
- <sup>24</sup> Roger G. Harrison, “Space and Verification, Volume 1: Policy Considerations” Eisenhower Center for Space and Defense Studies, (November 9, 2010): 13.
- <sup>25</sup> Tiffany Chow, “Space Situational Awareness Sharing Program: An SWF Issue Brief,” *Secure World*

- Foundation, (September 22, 2011):  
[https://swfound.org/media/3584/ssa\\_sharing\\_program\\_issue\\_brief\\_nov2011.pdf](https://swfound.org/media/3584/ssa_sharing_program_issue_brief_nov2011.pdf)
- <sup>26</sup> Scott Pace, “Op-ed: NOAA is stalling U.S. space traffic management,” *Space News*, June 19, 2021. <https://spacenews.com/op-ed-noaa-is-stalling-u-s-space-traffic-management/>.
- <sup>27</sup> Martha Finnemore and Kathryn Sikkink, “International Norm Dynamics and Political Change,” *International Organization* 52, no. 4 (1998): 902.
- <sup>28</sup> Roger G. Harrison, “Space and Verification, Volume 1: Policy Considerations” Eisenhower Center for Space and Defense Studies, (November 9, 2010): 10.
- <sup>29</sup> For example, see Rose Gottemoeller, “Rethinking Nuclear Arms Control,” *The Washington Quarterly*, 43:3, 139-159, <https://doi.org/10.1080/0163660X.2020.1813382>. And David Ronfeldt, “A Long Look Ahead: NGOs, Networks, and Future Social Evolution,” RAND (2005), <https://www.rand.org/pubs/reprints/RP1169.html> and Margret E. Keck and Kathryn Sikkink, “Activists Beyond Borders,” Cornell University Press, 1998.
- <sup>30</sup> Civil society: An essential ingredient of development,” George Ingram, April 6, 2020. <https://www.brookings.edu/blog/up-front/2020/04/06/civil-society-an-essential-ingredient-of-development/>; Also see “The Future Role of Civil Society,” World Economic Forum, January 2013, [http://www3.weforum.org/docs/WEF\\_FutureRoleCivilSociety\\_Report\\_2013.pdf](http://www3.weforum.org/docs/WEF_FutureRoleCivilSociety_Report_2013.pdf); and Charles Kojo VanDyck, “Concept and Definition of Civil Society Sustainability,” CSIS, June 30, 2017. <https://www.csis.org/analysis/concept-and-definition-civil-society-sustainability>.
- <sup>31</sup> David Finkelman, “Is International Collaboration for Space Situational Awareness Possible?” *SpaceNews*, October 2021, 25.
- <sup>32</sup> Ibid.
- <sup>33</sup> International Virtual Observatory Alliance, <https://ivoa.net/>
- <sup>34</sup> Harvey Reed, et al, Decentralized space information sharing as a key enabler of trust and the preservation of space, *Advanced Maui Optical and Space Surveillance Technologies Conference (AMOS)*, September 2021, [www.amostech.com](http://www.amostech.com)
- <sup>35</sup> Suggested by David Finkelman in, “Is International Collaboration for Space Situational Awareness Possible?” *SpaceNews*, October 2021, 25.
- <sup>36</sup> Public Private Engagement, <https://public.wmo.int/en/our-mandate/how-we-do-it/public-private-engagement-ppe>.
- <sup>37</sup> The International Charter Space and Major Disasters, <https://disasterscharter.org/web/guest/home>
- <sup>38</sup> Text of the Charter On Cooperation To Achieve The Coordinated Use Of Space Facilities In The Event Of Natural Or Technological Disasters Rev.3 (25/4/2000).2, <https://disasterscharter.org/web/guest/text-of-the-charter>
- <sup>39</sup> Space Climate Observatory, About SCO, <https://www.spaceclimateobservatory.org/about-sco>.
- <sup>40</sup> Terms of Reference SCO International, January 30, 2020, <https://www.spaceclimateobservatory.org/about-sco>.



