LEGAL CONSIDERATIONS AND FUTURE OPTIONS FOR SPACE SITUATIONAL AWARENESS

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I. INTRODUCTION

On December 20, 2019, President Trump's proposal to create a United States Space Force was signed into law.[1] The Space Force will organize, train, and equip space forces, and provide an elevated focus on the role of space in military activities. As a first step, in August 2019, U.S. Space Command (USSPACECOM) was re-established as the eleventh unified combatant command.[2] Distinct from the new service branch, USSPACECOM employs forces from each of the military services to achieve missions in the space domain. These missions include deterring aggression and conflict, defending U.S. and allied freedom of action, delivering space combat power for the joint forces, and developing space warfighters.[3]

One of the key activities that USSPACECOM is taking on is Space Situational Awareness (SSA).[4] Space Situational Awareness refers to the ability to determine where objects are in space, what they are doing, and where they will be in the future. The U.S. military maintains a catalogue of more than 23,000 objects in Earth's orbit, about 1,800 of which are active satellites.[5] The remainder are defunct satellites, spacecraft components, discarded upper rocket stages, and other debris. Understanding where these objects are and where they are headed is necessary to ensure expensive military satellites are not damaged by inadvertent collisions. This capability is also necessary to detect and attribute purposeful attacks on satellites. The ability to quickly and accurately detect and attribute any such attacks is key to deterring them.

One of the drivers for the creation of the Space Force is the growing consensus among U.S. leaders that space is a "warfighting domain."[6] Officials point to the kinetic anti-satellite tests carried out by China in 2007 and India in 2019 and the maneuvering in recent years of Russian and Chinese satellites that included close approaches to other satellites—in some cases, satellites

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[1] *Fact Sheet*, U.S. SPACE FORCE, https://www.spaceforce.mil/About-Us/Fact-Sheet (last visited Jan. 17, 2020).

[2] Aaron Mehta, *Space Command to Launch Aug. 29*, DEFENSENEWS (Aug. 20, 2019), https://www.defensenews.com/space/2019/08/20/space-command-to-launch-aug-29/.

[3] DEP'T. OF DEF., UNITED STATES SPACE COMMAND FACT SHEET (2019), https://media.defense.gov/2019/Aug/29/2002177208/-1/1/1/USSPACECOM%20FACT%20SHEET.pdf.

[4] Sandra Erwin, *U.S. Space Command's Major Components Will Be Based in California and Colorado*, SPACE NEWS (June 30, 2019), https://spacenews.com/u-s-space-commands-major-components-will-be-based-in-california-and-colorado.

[5] Steve Brady, *18th SPCS Stands Guard over Space*, AIR FORCE SPACE COMMAND (Mar. 6, 2018), https://www.afspc.af.mil/News/Article-Display/Article/1459151/18th-spcs-stands-guard-over-space.

[6] *Attacking Satellites is Increasingly Attractive—and Dangerous*, ECONOMIST (July 18, 2019), https://www.economist.com/briefing/2019/07/18/attacking-satellites-is-increasingly-attractive-and-dangerous.

owned by the United States.[7] In 2018, the Commander of the Air Force's 20th Space Control Squadron made the argument that SSA should be thought of as Space Battle Management—"continuous preparation of the battlespace in order to fight and win a war in space"—and emphasized the need for "effective weaponeering of SSA sensors."[8]

However, the U.S. military is not the only entity in need of high-quality SSA data. In fact, all satellite operators require this information in order to avoid accidental collisions that could damage or destroy their spacecraft. As the number of civil and commercial space actors has increased, the risk of collision—and need for data—has been growing. Emerging plans for "mega constellations" of hundreds or thousands of small satellites is adding to the urgency in this area.[9] Both military and civil satellite operators are aware that collisions in space have impacts reaching far beyond the satellites immediately involved, as these events generate debris that increases the risk of collision for other satellites, with potentially cascading effects.[10]

In this rapidly changing environment, there is a recognition that the status quo is not sufficient for U.S. military objectives nor civil and commercial satellite operator needs. In response, multiple steps are being taken. Outside of the United States, many nations are actively developing or improving their SSA capabilities.[11] Commercial entities have emerged that are collecting, analyzing, and selling their own SSA data and services. The U.S. military is investing in technical improvements and engaging in cooperative agreements with commercial and foreign entities to improve its SSA capabilities. The U.S. Department of Commerce is preparing to take on a new role in sharing SSA data with commercial and foreign entities.[12] Given the many concurrent and often interrelated developments in this sector, there are many possibilities for future international SSA interactions.

This Article examines the legal issues related to SSA. What is the international and national legal regime that governs current SSA activities, and how might this regime evolve in the future to address challenges in the rapidly evolving space sector?

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[7] TODD HARRISON, KAITLYN JOHNSON & THOMAS G. ROBERTS, CTR. FOR STRATEGIC AND INT'L STUDIES AEROSPACE SEC. PROJECT, SPACE THREAT ASSESSMENT 2019 (2019).

[8] Erin Salinas, *Space Situational Awareness Is Space Battlefield Management*, AIR FORCE SPACE COMMAND (May 16, 2018), https://www.afspc.af.mil/News/Article-Display/Article/1523196/space-situational-awareness-is-space-battle-management/.

[9] *See generally Satellite Safety: Ensuring the Safety of the International Earth Observing Constellation Satellites*, NAT'L AERONAUTICS & SPACE ADMIN., https://satellitesafety.gsfc.nasa.gov/ (last visited Mar. 17, 2020).

[10] *See* Salinas, *supra* note 8.

[11] *Id.*

[12] Press Release, U.S. Dep't of Commerce, Remarks by Commerce Secretary Wilbur L. Ross at the Space Startup Summit (Oct. 21, 2019) (on file with U.S. Dep't of Commerce Office of Pub. Affairs).

II. SPACE SITUATIONAL AWARENESS AND INTERNATIONAL LAW

SSA is not explicitly mentioned in any of the outer space treaties, nor in any other legally binding international agreement.[13] However, there are multiple clauses within these treaties that may bear on SSA activities and responsibilities.[14]

The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, commonly known as the Outer Space Treaty (OST), provides the broad legal framework for activities in outer space.[15] Gerie Palanca argues that Article I, which states that "exploration and use of outer space . . . shall be carried out for the benefit and in the interests of all countries,"[16] presents an overall culture of space activity that should aim to mitigate collisions and the creation of space debris.[17] Similarly, he notes, Article IX states that "States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance."[18] Joanne Wheeler, LLM, calls attention to the portions of Article IX that call on states to conduct activities with "due regard to the corresponding interests of all other States Parties to the Treaty," and call on states to "avoid harmful contamination."[19] Based on these clauses, one could argue that in the spirit of the Outer Space Treaty, States operating in space should collect, use, and share SSA information in order to avoid debris creation and ensure that space remains usable for all countries now and in the future.

More commonly, however, experts have called attention to Article VI, which notes that States Parties to the Treaty bear international responsibility for national activities in outer space, even if those activities are carried out by non-governmental entities. States Parties are required to provide "authorization and continuing supervision of these activities."[20] Taken together with the

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[13] Stefan A. Kaiser, *Legal and Policy Aspects of Space Situational Awareness*, 31 SPACE POL'Y 5 (2015).

[14] PATRICK M. SCHWOMEYER, THE U.S. OUTER SPACE SITUATIONAL AWARENESS SHARING LAW: SHARING INFORMATION ABOUT SSA AND THE NEED FOR GLOBAL COOPERATION (2013) (Can.); *see generally* Kaiser, *supra* note 13; Gerie W. Palanca, *Space Traffic Management at the National and International Levels*, 16 ASTROPOLITICS 141 (2018); BHAVYA LAL, ASHA BALAKRISHNAN, BECAJA M. CALDWELL, REINA S. BUENCONSEJO & SARA A. CARIOSCIA, GLOBAL TRENDS IN SPACE SITUATIONAL AWARENESS (SSA) AND SPACE TRAFFIC MANAGEMENT (STM) 61–74 (2018); Phillip A. Slann, *Space Debris and the Need for Space Traffic Control*, 30 SPACE POL'Y 40 (2014).

[15] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Dec. 5, 1979, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

[16] *Id.* at art. I.

[17] Palanca, *supra* note 14.

[18] *Id.* (quoting Outer Space Treaty, *supra* note 15, at art. IX).

[19] Outer Space Treaty, *supra* note 15, at art. IX.

[20] *Id.*

responsibility to avoid harmful contamination, this could be interpreted to mean that states are required to ensure that satellite operators in their state, both governmental and commercial, use SSA data to avoid collisions that would damage other spacecraft and generate debris that contaminate the space environment.

In addition to the OST, scholars have also noted that the 1972 Convention on International Liability for Damage Caused by Space Objects (the Liability Convention) and the 1976 Convention on Registration of Objects Launched into Outer Space (the Registration Convention) are relevant to this issue.[21] Article III of the Liability Convention makes clear that States are internationally liable if a space object for which their state is responsible damages the space object of another state.[22] This strengthens the incentives that States have to ensure that satellite operators for which they are responsible use SSA data to avoid any potential collisions. If a collision does occur that damages another satellite, the state may be liable for that damage.[23]

Further, Article I defines the term "space object" "to include component parts of a space object, as well as its launch vehicle and parts thereof."[24] This suggests that states are liable not only for the damage done during the initial collision, but also for any subsequent damage that occurs due to the debris created from the collision. This provides further incentive for the collection and use of SSA data to avoid collisions, as the total amount of damage caused over time could be significant. It also creates an incentive to have access to SSA data of adequate quality to identify the country at fault if a nation's own satellites are damaged by an in-space collision.

Article VI of the Liability Convention adds additional complexity, noting that liability would not hold in cases where "the damage has resulted either wholly or partially from gross negligence . . . on the part of a claimant State."[25] So, one might argue that, if a state failed to obtain and act on high-quality SSA data, that state would be ineligible to seek compensation for damage caused by the collision.[26] This argument would be stronger if low-cost or

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[21] *See*, *e.g.*, PATRICK SCHWOMEYER, THE U.S. OUTER SPACE SITUATION AWARENESS SHARING LAW: SHARING INFORMATION ABOUT SSA AND THE NEED FOR GLOBAL COOPERATION (2013); Slann, *supra* note 14, at 40–42.

[22] Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention].

[23] It is important to note that these incentives are complicated by the fact that there is no clear guidance in determining fault in a collision between two spacecraft. In the case that an accidental collision occurs, it is not clear which of the two states involved would be found to be at fault, and perhaps neither would be held responsible. This may be part of the reason that no claims related to in-space collisions have ever been submitted under the Liability Convention.

[24] Liability Convention, *supra* note 22, at 2392.

[25] *Id.*

[26] One could also argue that nations without access to SSA data might be better able to seek compensation than those with high-quality SSA systems. States without good data

free SSA data were widely available, creating an incentive for nations to share their SSA data. Yu Takeuchi notes that the criteria for fault liability can gradually change based on advancements in technology and changes in standard operating procedures.[27] For example, if freely available SSA data was used by most satellite operators, a satellite operator that chose not to use the data may not be eligible to seek damages in the event of a collision.

Typically, the desire to not lose one's own satellite will be sufficient incentive for any spacecraft operator to do their best to avoid collisions. As the number of relatively small, inexpensive satellites increases, however, the liability-related incentives may become increasingly important. Some spacecraft operators have begun designing constellations with a "Silicon Valley" mindset that allows for failure and rapid replacement of small, relatively inexpensive satellites. For these operators, the loss of one or more of their own satellites may be a minor issue,[28] but liability for damage to a multi-million-dollar satellite could be sufficient to bankrupt their business. While an interesting approach from a business perspective, from a space debris perspective, this new model is a problem.

The 1976 Registration Convention sets up a mandatory system for registering objects launched into space.[29] Objects are registered with the United Nations Secretary General with basic information regarding the object's orbit and general function. The registry includes the date and location of launch, and States are required to notify the Secretary General when the object is no longer in earth orbit.[30]

Part of the goal of the registry is to assist in the identification of these objects and "contribute to the application . . . of international law governing the exploration and use of outer space."[31] Most relevant to the issue of SSA, Article VI of the Registration Convention states that in cases in which the registry is inadequate for identifying a space object that has caused damage, "other States Parties, including in particular States possessing monitoring and tracking facilities, shall respond to the greatest extent feasible to a request by

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could argue that they were unable to detect or maneuver, and thus were not negligent. Nations that had access to adequate SSA data but failed to act on it would be more likely to be considered negligent. However, to the extent that commercial SSA data is available, or in cases where nations with high-quality SSA data make that data, or the resulting conjunction assessments, freely available, they can help to negate such an argument. Thus, in a roundabout way, this creates an incentive for SSA data sharing.

[27] Yu Takeuchi, *Law and Policy for Space Situational Awareness Towards Space Traffic Management—A Japanese Perspective*, 6 J. SPACE SAFETY ENGINEERING 130, 135 (2019).

[28] To the extent that collisions may create debris that significantly increase collision risks in the orbit in which their constellation operates, these operators are also naturally incentivized to avoid collisions.

[29] Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention].

[30] *Id.* at 17.

[31] *Id.* at 16.

that State Party . . . for assistance under equitable and reasonable conditions in the identification of the object."[32] The Registration Convention does not require that nations share SSA data, but it does strongly encourage it, at least in instances where damage has occurred.[33]

However, Kaiser notes that although the drafters of the Registration Convention intended it to be useful in the identification of space objects in issues of responsibility and liability, the information required is not sufficient to do so in today's space environment. Furthermore, by identifying the exact information a state is required to disclose, the Registration Convention implies that further information is not legally required. This provides a legal basis to argue that under current international law, SSA data exchanges are purely voluntary, not a legal obligation.[34]

As demonstrated above, collecting, using, and sharing space situational data seems well within the spirit of the Outer Space Treaty. The treaties also create multiple incentives for nations to collect and use data, with respect to their own space activities as well as those of entities for which they are responsible. Because nations are liable for damage caused by their spacecraft, they have an incentive to use SSA data to predict and avoid collisions that may cause such damage—through the initial collisions as well as subsequent collisions caused by the resulting debris. In addition, nations have an incentive to maintain good SSA to identify the responsible nation in the case that their own spacecraft is damaged by an in-space collision. Sharing SSA data can help to increase the likelihood that other nations act responsibly in space and are liable for any damage caused if they do not. However, despite the encouragements and incentives created by the treaties, none establish a legal requirement for collecting, using, or sharing SSA data.

III. SPACE SITUATIONAL AWARENESS AND U.S. LAW

Given the lack of international requirements, and because of the importance of SSA data for military activities, SSA developments—both legal and technical—have traditionally occurred on the national level. The United States maintains the most advanced SSA capability in the world. The military operates the vast Space Surveillance Network, made up of ground- and space-based telescopes as well as radars.[35] The 18th Space Control Squadron (18 SPCS) processes this data along with other information about the identity of spacecraft in orbit and generates a catalogue of space objects.[36] Based on this

[32] *Id.* at 18.

[33] *Id.*

[34] Stefan A. Kaiser, *Legal and Policy Aspects of Space Situational Awareness*, 31 SPACE POL'Y 5, 5–12 (2015).

[35] LAL ET AL., *supra* note 14, at app. A.

[36] *Id.*

catalogue, they are able to conduct conjunction analyses to determine if two objects are likely to be in close proximity in the near future, potentially warranting a maneuver to decrease the risk of a collision.[37] For many years, a subset of the catalogue was made available to NASA, which then made the data available to other space operators.[38]

The National Defense Authorization Act for Fiscal Year 2004 established a pilot program within the Department of Defense for provision of satellite tracking support to entities outside United States Government, including foreign and commercial entities. Data was only to be provided when it was determined to be in the national security interests of the United States, and entities wishing to receive data were required to sign an agreement not to transfer any data or technical information to other entities.[39] As a result, the U.S. Air Force set up the space-track website, through which a portion of the data in the space catalogue was made available to registered users. The quality of data available through the website was lower than that in the internal 18 SPCS system and was generally considered insufficient for conducting independent conjunction analyses.

The National Defense Authorization Act for Fiscal Year 2010 established the SSA Data Sharing Program. The act authorized the Secretary of Defense to both provide SSA information, as well as obtain such information, from non-U.S. government entities. The act also stated that the United States is immune from any suit in any court related to the provision of SSA data.[40] This stipulation is reflected in the space-track website user agreement. The user agreement also notes that data in the public catalogue should not be used for conjunction assessment.[41]

While users are not able to conduct independent analyses, the 18 SPCS screens all active satellites against the satellite catalog multiple times a day, and if a close approach is detected and meets certain emergency criteria, 18 SPCS will attempt to notify the satellite owner or operator. To receive more complete information, as well as other advanced services, entities must sign an SSA Sharing Agreement with USSPACECOM.[42] In April 2019, the United States signed its 100th Space Situational Awareness Agreement. Agreements

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[37] *Id.*

[38] Rick W. Sturdevant, *From Satellite Tracking to Space Situational Awareness: The USAF and Space Surveillance*, 55 AIR POWER HIST. 4, 19 (2008).

[39] National Defense Authorization Act (NDAA) for Fiscal Year 2004, Pub. L. No. 108-136, § 913, 117 Stat. 1392.

[40] National Defense Authorization Act (NDAA) for Fiscal Year 2010, Pub. L. No. 111-84, § 912, 125 Stat. 2190.

[41] *User Agreement*, SPACE-TRACK.ORG, https://www.space-track.org/documentation#/user_agree (last updated Aug. 1, 2019).

[42] *SSA Sharing & Orbital Data Requests (ODR)*, SPACE-TRACK.ORG, http://www.space-track.org/documentation#odr (last visited Oct. 13, 2019).

have been signed with twenty nations, two regional organizations, and seventy-eight commercial satellite owner-operator-launchers.[43]

In 2015, Congress passed the U.S. Commercial Space Launch Competitiveness Act. The act directed the Secretary of Transportation to examine the feasibility of taking on the task of processing and releasing safety related SSA data and information.[44] The resulting report confirmed that it would be feasible for a civil agency, specifically the Department of Transportation, to take on this role.[45]

In June 2018, the Trump Administration released Space Policy Directive 3 (SPD-3), which deals with SSA and Space Traffic Management. SPD-3 calls for advancements in SSA science and technology, facilitation of U.S. commercial leadership in SSA, and provision of U.S. Government-supported basic SSA data free from direct user fees.[46] The directive stated that the Department of Commerce should take on the role of distributing SSA data and information.[47] Congress then wrote this planned transition into law, although it did not specify which civil agency would take the lead. The John McCain National Defense Authorization Act for Fiscal Year 2019 required the President to provide a plan for a department or agency, other than the Department of Defense (DoD), to provide SSA services and information to non-U.S. Government entities.[48] It required that beginning in 2024, the DoD only share information when necessary to meet national security interests.[49]

At the same time the U.S. government was beginning to improve its data sharing capabilities, commercial entities also emerged to address the demand for better SSA data. These companies focus on data collection, catalog development and conjunction analyses, and other special services.[50] Companies collecting information on space assets using ground-based systems are not subject to regulation.

Those planning space-based SSA systems must seek a license from the National Oceanic and Atmospheric Administration (NOAA) to conduct "non-Earth imaging." These regulations include a number of restrictions on data

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[43] Karen Singer, *100th Space Sharing Agreement Signed, Romania Space Agency Joins*, U.S. STRATEGIC COMMAND (Apr. 26, 2019), https://www.stratcom.mil/Media/News/NewsArticleView/Article/1825882/100th-space-sharing-agreement-signed-romania-spaceagency-joins/.

[44] U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 704 (codified as amended at 51 U.S.C. § 10101 (2015)).

[45] DANIEL MORGAN, CONG. RESEARCH SERV., R45416, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION 16 (2018).

[46] Space Policy Directive-3, 83 Fed. Reg. 28,969 (June 18, 2018).

[47] *Id.*

[48] John S. McCain National Defense Authorization Act for Fiscal Year 2019, Pub. L. No. 115-232, 132 Stat. 1636 (2018).

[49] *Id.* at 2106.

[50] LAL ET AL., *supra* note 14, at 53.

quality and data sharing. Imagery resolution is limited to 0.5 meters or coarser, and the imagery may only be disseminated if metadata such as time, position, and attitude of the sensor is removed.[51] Tracking data must be correlated with the U.S. Government-approved space track catalog found at space-track.org, and all uncorrelated observations must be submitted to NOAA for correlation and determination of release-ability. Observations determined to be non-releasable must be purged from servers and storage devices.[52] Some industry groups have complained that these regulations are overly restrictive and will limit U.S. commercial developments, while having no impact on the actions of potential adversaries.[53]

In April 2019, the Department of Commerce released a request for information on commercial capabilities in SSA data, suggesting they are open to coordinating with commercial entities in the creation of a civil government SSA capability.[54] However, Congress has not yet fully supported the administration's plans. In the Fiscal Year 2020 spending bill, the House Appropriations Committee rejected the proposal to elevate the Office of Space Commerce within the Department of Commerce and did not provide funding to enable other plans laid out in SPD-3.[55]

Over the past fifteen years, U.S. law and policy has been promoting increased SSA data sharing with non-U.S. government entities, moving from a DoD-run pilot program to an operational program with 100 partners and now potentially transitioning to a civil agency-run data sharing program. The United States has been supportive of commercial SSA developments in the United States, actively working with both commercial and foreign entities. Still, the future of SSA systems globally is uncertain. The next section looks at three potential future arrangements for global provision of SSA information.

IV. THE FUTURE OF SPACE SITUATIONAL AWARENESS

SSA information is critical to defense organizations that require such information to monitor and protect military space assets, as well as to detect and

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[51] JOSEF KOLLER, DEP'T OF DEF., UPDATES TO NATIONAL SECURITY RELATED LICENSE CONDITIONS 5 (2017).

[52] *Id.*; Licensing of Private Remote Sensing Space Systems, 84 Fed. Reg. 93 (proposed May 14, 2019).

[53] BRIAN WEEDEN, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., RIN 0648-BA15, COMMENTS OF THE CONSORTIUM FOR THE EXECUTION OF RENDEZVOUS AND SERVICING OPERATIONS IN THE MATTER OF LICENSING OF PRIVATE REMOTE SENSING SPACE SYSTEMS-ADVANCE NOTICE OF PROPOSED RULEMAKING (2019).

[54] Request for Information on Commercial Capabilities in Space Situational Awareness Data and Space Traffic Management Services, 84 Fed. Reg. 14645, 14645 (Apr. 11, 2019).

[55] Theresa Hitchens, *HAC Stiffs New Commerce Bureau for Satellite Regulation*, BREAKING DEF. (May 21, 2019), https://breakingdefense.com/2019/05/hac-stiffs-new-commerce-bureau-for-satellite-regulation/.

attribute any attacks on space assets. Non-military satellite operators also need the information to avoid unintentional collisions that could damage or destroy their spacecraft. It could also potentially be used to help determine liability in case of such damage. If SSA information is broadly available and use of this information becomes standard operating procedure, failure to use it could potentially be considered gross negligence and could negate the ability to seek damages in case of a collision. Each of these applications requires timely, accurate, and trusted SSA information. This section examines three potential regimes under which such information may be provided in the future, including: (1) a U.S.-centric system, (2) a cooperative international system, and (3) a multipolar system.

A. U.S.-Centric Space Situational Awareness System

The first scenario is an extension of the current status quo. The U.S. military collects SSA data, conducts conjunction analyses for all active space objects, and provides conjunction warnings to all satellite operators, as well as open access to basic catalog information, all free of charge.[56] While some other entities operate SSA systems, none do so on the scale of the United States, and none provide free access to data for all users.[57]

The United States has demonstrated a commitment to continue providing this service through both executive directives and policy as well as law. SSA programs are complex and expensive, and under this regime, satellite operators around the world, including foreign governments and private entities, could avoid significant costs by relying on the highly capable U.S. system.

However, a number of operators have already expressed discomfort about relying solely on the U.S. military for SSA information, particularly given the opacity of the information.[58] The United States does not share its sensor data or its high-fidelity catalog, nor does it provide any insight into its algorithms and methods of analysis.[59] The United States is increasing the amount of information it makes available and intends to continue to improve the quality its SSA information overall, but given the military sensitivities, access to information will likely always be limited to a significant extent.[60]

As more space objects are launched, potential conjunctions and the need for maneuvers will become more common. As this occurs, it will be more important for operators to be able to conduct independent analysis to

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[56] LAL ET AL., *supra* note 14.

[57] *Id.* at F-2, iii.

[58] *Id.* at V.

[59] *Id.* at 38.

[60] Theresa Hitchens, *Intel Community's Secrecy Culture Frustrates DoD Sat Safety Effort*, BREAKING DEF. (Aug. 26, 2019), https://breakingdefense.com/2019/08/intel-community's-secrecy-culture-frustrates-dod-sat-safety-effort/.

determine whether they will conduct a maneuver—something that is not possible when underlying sensor data is not shared. If a global space traffic management regime is developed that requires operators to conduct maneuvers under certain circumstances, it will likely be problematic that operators around the world will need to trust the United States to determine when such circumstances occur. Similarly, space actors may not be comfortable trusting the United States for information regarding attribution and liability. These seemingly intractable challenges suggest that there will be a demand for alternative sources of information.

B. International Space Situational Awareness Program

Another option proposed numerous times is an international SSA program. David Koplow argued that spacefaring nations should create a new international organization for SSA as a step towards avoiding conflict in outer space.[61] As part of this effort, nations would "unite to pool their resources in monitoring outer space and sharing information about the location, trajectory, and attributes of space objects."[62] He states that such a system, made up of resources from many states, would be more capable than any one country could achieve on its own.[63] Koplow argues that although this system could be created based on non-legally-binding activities, it would be more firmly grounded in a new treaty.[64] He notes that there is president for cooperative verification regimes in other treaties, and that cooperative ventures in space activities have been "spectacularly successful" in the past.[65]

Focusing on non-military uses, P.J. Blount argues that an international SSA system, built on open data sharing, is necessary to enable space traffic management activities.[66] If satellite operators are expected to move their space assets to avoid collisions, they must trust the data underlying such a requirement.[67] Blount argues that "the ability to verify data is implicit to trust in that system," and thus the data must be made openly available to facilitate such verification.[68] Blount acknowledges that implementation of this system may be a challenge, given the national security aspects of SSA systems, as well as the fact that three of the most advanced SSA systems are operated by

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[61] David A. Koplow, *The Fault is Not in Our Stars: Avoiding an Arms Race in Outer Space*, 59 HARV. INT'L L.J. 331, 377 (2018).

[62] *Id.* at 372.

[63] *Id.* at 377.

[64] *Id.* at 378.

[65] *Id.* at 379.

[66] P.J. Blount, *Space Traffic Management: Standardizing On-Orbit Behavior,* 113 AJIL UNBOUND 120, 122 (2019).

[67] *Id.*

[68] *Id.*

nations—the United States, Russia, and China—with adversarial relationships with each other.[69]

This is the primary flaw with an international system. Although it could effectively address the issue of trust, significant political will is required to create such a system, and there is no indication that the United States or any other nation active in this area is interested in pursuing this option. In a 2018 review of global Space Situational Awareness activities, the Institute for Defense Analysis concluded that "most governments see SSA first and foremost as a critical national security function, and military organization interests are likely to remain dominant in this area."[70] Given this focus, the creation of an international cooperative regime will be a significant challenge.

C. Multi-Polar Space Situational Awareness System

A third possibility is a multi-polar SSA system in which nations, regions, or commercial entities develop and maintain an independent SSA capability, providing satellite operators with multiple sources of SSA information. Such a system might incorporate some level of international cooperation, such as data standardization and interoperability, to improve SSA more generally.

Such a system may look similar to the Global Navigation Satellite System (GNSS) sector. The United States was the leader in GNSS capabilities and made the signal from its military-owned Global Positioning System (GPS) constellation freely available.[71] Eventually, a handful of other nations developed independent GNSS systems: Russia's GLONASS, China's Beidou, and Europe's Galileo.[72] There are also regional augmentation systems as well as a vast array of commercial value-added services built on the data provided by these systems.[73] The International GNSS Service (IGS), a voluntary federation of entities across 100 countries, operates a global network of GNSS ground stations, data centers, and data analysis centers to provide access to data and data products based on all major global and regional satellite navigation systems.[74]

While the United States currently operates the most advanced SSA system, other nations are developing or improving their own SSA capabilities. The

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[69] *Id.*

[70] LAL ET AL., *supra* note 14, at 79.

[71] Thuy Mai, *Global Positioning System History*, NASA (Aug. 7, 2017), https://www.nasa.gov/directorates/heo/scan/communications/policy/GPS_History.html.

[72] LAL ET AL., *supra* note 14, at 57.

[73] International Committee on GNSS, *Providers' Forum*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, https://www.unoosa.org/oosa/en/ourwork/icg/providers-forum/principles.html (last visited Feb. 21, 2020).

[74] GARY JOHNSTON ET AL., *The International GNSS Service*, *in* SPRINGER HANDBOOK OF GLOBAL NAVIGATION SATELLITE SYSTEMS 967–82 (2017).

Russian Academy of Sciences operates the International Scientific Optical Network, and the Russian military also operates a space surveillance system.[75] China maintains an SSA system and has explored expanding its efforts in co-operation with other nations.[76] Europe has also announced plans to develop a space surveillance and tracking system.[77] In addition to national activities, a number of companies have begun to collect independent SSA observations.[78] ExoAnalytics, for example, operates more than 200 ground-based telescopes around the world.[79] If these entities continue to improve their SSA capabilities and increase their information-sharing efforts, they could rival the United States as a source of global SSA data.

Access to multiple independent sources of SSA data would help to alleviate issues of trust. If the multiple data providers agreed on the likelihood of a collision, a satellite operator could be confident in the need for a maneuver. Of course, if the various providers produced conflicting information, this would pose a challenge for the operator. It would also pose significant issues in determining liability in the event that a collision does occur. However, if a non-governmental or intergovernmental body were able to combine data sources and investigate the differences, it may be possible to improve the situation. Awareness of differences may also encourage standardization and improvements across data providers.

A multi-polar Space Situational Awareness system does not fully address the need for trusted data to avoid collisions and determine liability, at least in the near-term. However, such a system seems achievable given current global trends, and would allow for the possibility of greater interoperability and standardization in the future. As such, it offers a practical middle-ground compared to a U.S.-centric or international SSA system.

V. CONCLUSION

Space situational awareness is critical for enabling safe and sustainable activities in space. It is needed for protecting and deterring attacks on military assets and for avoiding unintentional collisions that can destroy spacecraft and create debris that endangers others long into the future. Despite the importance of SSA, it is not directly addressed in the Outer Space Treaty, nor in any other legally binding international agreement. However, the use and sharing of SSA data is well-aligned with the spirit of the treaty and is incentivized by international agreements regarding liability for damage to space assets.

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[75] LAL ET AL., *supra* note 14, at 28.
[76] *Id.* at 29.
[77] *Id.* at 72–73.
[78] *Id.* at 29.
[79] *Id.*

The United States military currently operates the most advanced SSA system in the world, and national law and policy have repeatedly encouraged and increased SSA data sharing requirements. As of 2019, the United States had committed to maintain an openly available public catalog of space objects and conduct conjunction analysis for all operational space assets. In addition, it had signed 100 agreements to facilitate enhanced data sharing with a variety of entities.

Moving forward, new actors and new technologies are likely to lead to large increases in the number of space objects in orbit. At the same time, increasing reliance on space assets, particularly by the military, makes these objects potential targets in the event of a conflict. All of these trends increase the importance of timely, accurate SSA information. This Article examined three possible regimes for future SSA data provision: a U.S.-centric SSA system, an international SSA system, and a multi-polar SSA system. Each of these systems presents strengths and weaknesses, reflecting the difficult balance among national security concerns, trust and transparency, economic resources, and political will.

Ultimately, a multi-polar system seems most likely to emerge, given current trends. Conflicting information may pose challenges to international coordination and the conduct of international law in the near term. However, international efforts to address these differences and facilitate interoperability could ultimately lead to improved SSA information for all.