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Profit or Safety: Where Is Outer Space Headed?

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PROFIT OR SAFETY: WHERE IS OUTER SPACE HEADED?

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ABSTRACT

The space powers (the U.S., the European Space Agency (ESA), China, and Russia) are now preparing national space traffic regimes with insufficient regard for the Outer Space Treaty's (OST) agreed "Principles Governing the Activities of States in Exploration and Use of Outer Space." The rapidly growing traffic of satellites, resulting in space debris, and the scarcity of radio frequencies and related orbits create obvious dangerous situations. States, including the U.S., agreed in the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) on twenty-one Guidelines for Long-Term Sustainability of Space, some of which relate to space traffic management (STM). UNCOPUOS is also beginning work on common STM practices. Yet the United States' space management policy—pronounced in two White House policy statements by former-President Trump—anchors U.S. STM policy on a "light touch" management, which diverges from ongoing STM efforts in the UNCOPUOS, the ESA, and the Russo-Chinese outer space alliance. The two White House policy statements assign U.S. STM policy leadership to the Department of Commerce (DOC) based on the management of traffic data provided by private industry and government sources. The DOC

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contracted with the National Academy of Public Administration (NAPA) for a study of and recommendations on best STM management. NAPA's report accepted the two White House policy statements and made recommendations accordingly but with insufficient consideration of international space law, guidelines, and subsequent policy priorities.

This Article analyzes the NAPA Report, criticizing it for inadequate consideration of international space law and failure to adequately consider the interests of all stakeholders—in particular the science and astronomy communities. The NAPA Report pays insufficient attention to important government policies on climate change, energy, astronomy, and national security, which are top priorities of the current administration. The Article recommends adherence to applicable international law. It stresses that space traffic safety by the Federal Aviation Administration (FAA) is more important than space traffic promotion by DOC. It recommends (1) separating FAA regulation of operational management of safety in space from the promotion of the space commerce industry and (2) assigning a different administration in the Department of Transportation (DOT) to handle economic regulation and promotion. Doing so would adopt a separation policy similar to the one applied in air commerce. It then recommends the establishment of an international outer space agency to supervise international space traffic rules of the road. Finally, this Article suggests that U.S. commercial space policy decisions be made in the context of related U.S. policies on science, astronomy, climate change, and renewable solar energy.

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I. INTRODUCTION

THIS ARTICLE TAKES AN international view of outer space traffic management (STM) based on the Outer Space Treaty (OST),[1] which is binding on all states,[2] in contrast to the

[1] Relevant treaties include the following:

- Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, *opened for signature* Jan. 27, 1967, 18 T.I.A.S. 2410, 610 U.N.T.S. 205 [hereinafter OST].
- Convention on Registration of Objects Launched into Outer Space, *opened for signature* Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention].
- Convention on the International Liability for Damage Caused by Space Objects, *opened for signature* Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention].
- Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, *opened for signature* Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119.
- Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, *opened for signature* Dec. 18, 1979, 1363 U.N.T.S. 3 [hereinafter 1979 Moon Agreement].

[2] *See* Francis Lyall & Paul B. Larsen, Space Law: A Treatise 50 (2d ed. 2017) (arguing that the principles in OST are now customary and therefore binding on all states); The Board of Directors of the International Institute of Space Law (IISL) has also stated:

> [T]here is growing importance for national regulators responsible for the authorization and continuing supervision of outer space activities to give careful consideration to the interests of all stakeholders, including the scientific community and the public, regarding the consequences of authorizing such activities for the future ex-

National Academy of Public Administration (NAPA) report's unilateral STM.[3]

Currently, outer space faces a safety crisis, which must be resolved.[4] An annual average of 12.5 known collisions resulting in space debris occur every year, with half occurring due to satellites orbiting in low Earth orbit (LEO).[5] Why? Because states do not bother to remove their debris and defunct satellites.[6] The International Space Station (ISS) was even recently impacted by space debris.[7] Orbits, particularly LEO, are becoming increasingly congested and unsafe due to increased commercial traffic

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> ploration and peaceful uses of outer space, including the Moon and other celestial bodies. . . . [And] to ensure compliance with the Outer Space Treaty (OST).

Int'l Inst. of Space L., Statement by the Board of Directors of the International Institute of Space Law (IISL) on the Consideration of the Interests of the Public and Other Stakeholders in the Authorization and Continuing Supervision of Commercial Space Activities (July 19, 2021) [hereinafter IISL Statement], https://iislweb.space/wp-content/uploads/2021/07/IISL_Statement_Authorization_and_continuing_supervision_2021.pdf [https://perma.cc/F6LE-ENNG].

[3] *See* NAT'L ACAD. OF PUB. ADMIN., SPACE TRAFFIC MANAGEMENT: ASSESSMENT OF THE FEASIBILITY, EXPECTED EFFECTIVENESS, AND FUNDING IMPLICATIONS OF A TRANSFER OF SPACE TRAFFIC MANAGEMENT FUNCTIONS 1, 7 (2020) [hereinafter NAPA REPORT], https://napawash.org/uploads/NAPA_OSC_Final_Report.pdf [https://perma.cc/26HE-GHHB] (identifying the report's commission from Congress was to identify a U.S. agency to handle STM matters); *see also Outcomes of the European Space Traffic Management Conference, 7 July 2021: "Fostering a European Approach on Space Traffic Management*," SPACEWATCH.GLOBAL [hereinafter *European STM Report*], https://spacewatch.global/wp-content/uploads/2021/07/STM_Outcome.pdf [https://perma.cc/KN3Q-BDYH].

[4] NAPA REPORT, *supra* note 3, at 1, 7.

[5] ESA'S ANNUAL SPACE ENVIRONMENT REPORT, EUR. SPACE AGENCY 4 (2021), https://www.esa.int/Safety_Security/Space_Debris/ESA_s_Space_Environment_Report_2021 [https://perma.cc/JTZ6-2X3C]; *see* Tereza Pultarova, *SpaceX Starlink Satellites Responsible for Over Half of Close Encounters in Orbit, Scientist Says*, SPACE.COM (Aug. 18, 2021), https://www.space.com/spacex-starlink-satellite-collision-alerts-on-the-rise [https://perma.cc/C9SA-RL4J].

[6] ESA'S ANNUAL SPACE ENVIRONMENT REPORT, *supra* note 5; *see, e.g.*, NAPA REPORT, *supra* note 3, at 20–21 (recalling a famous satellite collision involving a defunct satellite).

[7] Denise Chow, *Space Junk Damages International Space Station's Robotic Arm*, NBC NEWS (June 1, 2021, 11:27 AM), https://www.nbcnews.com/science/space/space-junk-damages-international-space-stations-robotic-arm-rcna1067 [https://perma.cc/4WSJ-QW7Q].

and unmanaged space debris.[8] Experts predict that collisions in outer space will occur with increasing frequency.[9]

A unilateral piecemeal approach dominates current U.S. policy[10] rather than an international effort to establish norms within the international community. An example is NASA's agreement with SpaceX (and its Starlink spacecraft) in 2021 to avoid collisions between only Starlink and NASA satellites.[11] Another example is the United States' use of multiple bilateral accords with individual space powers, even though other major space powers have not joined.[12] Equally troubling is the current U.S. policy approach that tracks space traffic but leaves full re-

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[8] "LEO . . . is the most congested orbit," and includes well-known space objects such as the International Space Station. Pascal Hansens, *Space Debris, Orbit Congestion: When Space Needs a Highway Code*, EURANET PLUS (July 22, 2021), https://euranetplus-inside.eu/space-debris-orbit-congestion-when-space-needs-a-highway-code/ [https://perma.cc/PD3X-T3AW]; *LEO Economy FAQs*, NASA, https://www.nasa.gov/leo-economy/faqs [https://perma.cc/YE5G-K6LT] (Feb. 25, 2021); Joey Roulette, *Debris from Test of Russian Antisatellite Weapon Forces Astronauts to Shelter*, N.Y. TIMES, https://www.nytimes.com/2021/11/15/science/russia-anti-satellite-missile-test-debris.html [https://perma.cc/3NFK-39RL] (Nov. 16, 2021).

[9] NAPA REPORT, *supra* note 3, at 8; Göktuğ Karacalioğlu, *Impact of New Satellite Launch Trends on Orbital Debris*, SPACE SAFETY MAG. (June 5, 2016), https://www.spaceflightinsider.com/missions/earth-science/impact-new-satellite-launch-trends-orbital-debris/ [https://perma.cc/HDG6-7WCX]. Current regulation of space traffic can be summarized as: "For right of way, the regulatory framework is please don't crash your satellite, and really please don't crash it into someone else." Jeff Foust, *From Space Traffic Awareness to Space Traffic Management*, SPACENEWS (Oct. 20, 2021) (quoting Ruth Stilwell, Executive Director of Aerospace Policy Solutions), https://spacenews.com/from-space-traffic-awareness-to-space-traffic-management/ [https://perma.cc/C62H-K8FH].

[10] *See generally* Space Policy Directive-2, Streamlining Regulations on Commercial Use of Space, 83 Fed. Reg. 24,901 (May 24, 2018) [hereinafter Space Policy Directive-2], https://www.govinfo.gov/content/pkg/FR-2018-05-30/pdf/2018-11769.pdf [https://perma.cc/8ENU-S3XX]; Space Policy Directive-3, National Space Traffic Management Policy, 83 Fed. Reg. 28,969 (June 18, 2018) [hereinafter Space Policy Directive-3], https://www.govinfo.gov/content/pkg/FR-2018-06-21/pdf/2018-13521.pdf [https://perma.cc/VCV9-DRJ5].

[11] NONREIMBURSABLE SPACE ACT AGREEMENT BETWEEN THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AND SPACE EXPLORATION TECHNOLOGIES CORP FOR FLIGHT SAFETY COORDINATION WITH NASA ASSETS (2021) [hereinafter NASA AGREEMENT WITH SPACEX], https://www.nasa.gov/sites/default/files/atoms/files/nasa-spacex_starlink_agreement_final.pdf [https://perma.cc/N28Q-LG3S].

[12] *See, e.g.*, NASA, THE ARTEMIS ACCORDS: PRINCIPLES FOR COOPERATION IN THE CIVIL EXPLORATION AND USE OF THE MOON, MARS, COMETS, AND ASTEROIDS FOR PEACEFUL PURPOSES (2020) [hereinafter THE ARTEMIS ACCORDS], https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf [https://perma.cc/JAA6-BXZB] (showing only nine state signatories); *see also* Ruth Stilwell & Christian Zur, *Conjunction Risk Drives Need for Information Sharing*, SPACENEWS (Apr. 21, 2021), https://spacenews.com/op-ed-

sponsibility to avoid collisions on commercial satellite operators.[13] Notably, China,[14] Russia,[15] and other space powers[16] do not accept U.S. policy.

The central point of this Article is that non-sovereign outer space is inherently international. One nation cannot control all traffic—most space objects, whether commercial or space debris, are not under U.S. control.[17] Therefore, the U.S. needs to cooperate with other states to establish international traffic norms within the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) instead of focusing on individualistic objectives.[18] Perhaps a new civilian United Nations (U.N.) subagency for outer space will need to be created to appease the non-sovereignty element of outer space.

Presently, the U.S. is at a space policy crossroad. All parties involved[19]—whether commercial, scientific, or military—agree on the need for outer space rules of the road.[20] The Trump administration issued several White House policy statements assigning the Department of Commerce (DOC) as the lead within the U.S. government based on a "light touch" data management regulation of space traffic.[21] The light touch policy essentially expresses economist Milton Friedman's philosophy that the purpose of business is "to use its resources and engage in activities

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conjunction-risk-drives-need-for-information-sharing/ [https://perma.cc/9GUJ-WM6J].

[13] *See* Space Policy Directive-3, *supra* note 10, § 4.

[14] *See* Mark Whittington, *The New Race to the Moon: The Artemis Alliance vs. the Sino-Russian Axis*, THE HILL: OPINION (Mar. 28, 2021, 11:00 AM), https://thehill.com/opinion/technology/545280-the-new-race-to-the-moon-the-artemis-alliance-vs-the-sino-russian-axis [https://perma.cc/AX7T-9H4N].

[15] *Id.*

[16] *See* THE ARTEMIS ACCORDS, *supra* note 12.

[17] Dave Mosher & Samantha Lee, *More Than 14,000 Hunks of Dangerous Space Junk Are Hurtling Around Earth—Here's Who Put It All Up There*, BUS. INSIDER (Mar. 29, 2018, 8:29 AM), https://www.businessinsider.com/space-junk-debris-amount-statistics-countries-2018-3 [https://perma.cc/5NFW-3EN9].

[18] *See* IISL Statement, *supra* note 2.

[19] The NAPA Report considers too few stakeholders. *See* discussion *infra* Section IV.E.4. For comparison, *see* Paul B. Larsen, *Outer Space: How Shall the World's Governments Establish Order Among Competing Interests?*, 29 WASH. INT'L L.J. 1, 4–16 (2019).

[20] C. Todd Lopez, *There Must Be Rules for How We Use Space, Defense Leaders Say*, U.S. DEP'T OF DEF. (May 6, 2021), https://www.defense.gov/News/News-Stories/Article/Article/2598395/there-must-be-rules-for-how-we-use-space-defense-leaders-say/ [https://perma.cc/VD7T-PX87].

[21] *See* Space Policy Directive-2, *supra* note 10, § 4.

designed to increase its profits"[22] rather than assume social responsibilities. Such an approach involves maximum self-government by commercial space[23] with minimum oversight by the DOC.[24]

With congressional approval, the DOC requested NAPA to study and evaluate the organizational change proposed by the Trump administration.[25] The NAPA Report, issued at the end of 2020, is based on and supports the Trump administration's policies.[26] Many of its conclusions are troublesome: it assumes that commercial promotion is the government's most important objective in regulating space commerce;[27] it considers STM as a U.S. management issue and not as an international coordination issue governed by the 1967 OST and other space law treaties;[28] and it recommends legislative delegation of overall STM

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[22] Milton Friedman, *A Friedman Doctrine—The Social Responsibility of Business is to Increase Its Profits*, N.Y. TIMES (Sept. 13, 1970), https://www.nytimes.com/1970/09/13/archives/a-friedman-doctrine-the-social-responsibility-of-business-is-to.html [https://perma.cc/XBW8-D66G]; *cf. infra* note 268 and accompanying text.

[23] The term "commercial space" in this Article refers to the non-governmental commercial operators engaged in business in outer space.

[24] *See* Kevin O'Connell, Director, Off. of Space Com., U.S. Dep't of Com., Keynote Address at the 13th Annual Eilene M. Galloway Memorial Symposium: Advancing Space Commerce: What Does "Light Touch, Permissive Regulation" Mean? (Dec. 5, 2018).

[25] NAPA REPORT, *supra* note 3, at 1, 8–10.

[26] *See id.* at 9–10, 34–35. The NAPA Report was issued in 2020. Consequently, it fails to consider important subsequent space traffic developments, such as the November 16, 2021, intentional collision of a Russian antisatellite missile with an old Russian satellite, which added thousands of additional space debris pieces to the already congested outer space traffic. *See* Andrew E. Kramer, *Russia Acknowledges Antisatellite Missile Test That Created a Mess in Space*, N.Y. TIMES (Nov. 16, 2021), https://www.nytimes.com/2021/11/16/world/europe/russia-antisatellite-missile-test.html [https://perma.cc/8J92-A8T8]. Holger Krag, Head of ESA's Space Safety Programme, states that the Russian weapon test in outer space "will not only more than double the long-term collision avoidance needs for missions in orbits with similar altitudes, but will furthermore significantly increase the probability of potentially mission-terminating collisions at lower altitudes." *When Debris Disaster Strikes*, EUR. SPACE AGENCY (Nov. 18, 2021), https://www.esa.int/Safety_Security/Space_Debris/When_debris_disaster_strikes [https://perma.cc/JD4F-TUFW].

[27] NAPA REPORT, *supra* note 3, at 3, 63 (stating that in selecting a regulatory agency, "a core objective is to grow the space commercial marketplace").

[28] *See generally id.* at 85–103 (capabilities based on functional and technical competency, organizational leadership and capacity, partnerships, and stakeholders and customers).

functions to the DOC.[29] The delegation has not happened yet because the implementation of the presidential orders requires legislative authority and budget authority, which Congress has not provided.[30]

The situation is confusing because the U.S. is a member of UNCOPUOS, which recently issued its Guidelines for Long-Term Sustainability of Space (LTS Guidelines) addressing space traffic.[31] The U.S., China, Russia, and virtually all other states have agreed and accepted the new guidelines, which this Article discusses.[32] UNCOPUOS is now beginning to work on the STM issue.[33] The light touch policy recommended in the NAPA Report would only have a national effect, whereas the UNCOPUOS guidelines are the international rules of the road.[34] Thus, the NAPA Report, which is still waiting on congressional action, is at odds with the U.S. international position in UNCOPUOS.

How did outer space become such a dangerous, ungoverned environment? In 1967, at the time of the OST, burgeoning nongovernmental traffic was not anticipated.[35] That shocking in-

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[29] *See id.* at 3. The NAPA Report assumes that the rest of the world will go along with and will adopt such a regulatory policy. *See id*; *see also* discussion *infra* Section III.D.2.

[30] *See* NAPA REPORT, *supra* note 3, at 4; *see also* OST, *supra* note 1, art. VI.

[31] *See* discussion *infra* Section III.C.1.a.

[32] Press Release, Off. for Outer Space Affs., Guidelines for the Long-Term Sustainability of Outer Space Activities of the Comm. on Peaceful Uses of Outer Space Adopted, U.N. Press Release UNIS/OS/518 (June 22, 2019), https://www.unoosa.org/oosa/en/informationfor/media/2019-unis-os-518.html [https://perma.cc/G7BV-2XHS]. *See generally* Jeff Foust, *Long-Awaited Space Sustainability Guidelines Approved by UN Committee*, SPACENEWS (June 28, 2019), https://spacenews.com/long-awaited-space-sustainability-guidelines-approved-by-un-committee/ [https://perma.cc/79FL-J9KX].

[33] *See* Comm. on the Peaceful Uses of Outer Space, Legal Subcomm. on Its Sixtieth Session, Annotated Provisional Agenda, ¶12, U.N. Doc. A/AC.105/C.2/L.317 (Apr. 12, 2021) [hereinafter UNCOPUOS Adoption]. Furthermore, the UNCOPUOS Legal Subcommittee, at its 2021 session, will have informal consultations on use of space resources led by Andrzej Misztal (Poland) and Steven Freeland (Australia). *Id.* at Annotations, ¶14. The panel discussion of the European space agencies' leaders with their North American counterparts at the 36th Space Symposium, held on August 23, 2021, in Colorado Springs, indicated that European leaders favor development of international STM standards within the United Nations framework. Marc Boucher, *Space Agency Leaders Meet in Colorado Springs*, SPACEQ (Sept. 1, 2021), https://spaceq.ca/space-agency-leaders-meet-in-colorado-springs/ [https://perma.cc/XN2T-9P2W].

[34] *Cf.* NAPA REPORT, *supra* note 3, at 3.

[35] *See* Matt Weinzierl & Mehak Sarang, *The Commercial Space Age Is Here: Private Space Travel Is Just the Beginning*, HARV. BUS. REV. (Feb. 12, 2021), https://

crease occurred in the last couple of decades, outstripping slow governmental traffic management.[36] Now the risk of collision in outer space is a common situation.[37] The drastic increase of commercial space traffic and the current prospect of further growth, combined with growing space debris, severely strain and endanger all space traffic. Commercial operators have a strong interest in the safety of their space objects. However, how can they protect their space objects when they do not control space objects belonging to other commercial, military, and governmental operators?[38] An even greater cause of concern is that no state has control over space debris orbits. Although the U.S. Air Force is tracking some, most are unidentified.[39]

Comprehensive management of issues such as collision threats and outer space safety is not contrary to space commerce objectives, but it is in the self-interest of commercial space operators. Management of the entire compendium of moving parts in outer space should be part of a central body that does not favor individual operators or groups of operators to ensure safety objectives maintain their integrity. Currently, UNCOPUOS is the only civilian body to organize that task, especially since UNCOPUOS placed STM on its agenda.

Part II of this Article describes how our current crisis in overcrowded, almost unregulated outer space. Part III examines the

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hbr.org/2021/02/the-commercial-space-age-is-here [https://perma.cc/W42G-Y7ML].

[36] *See generally* John M. Logsdon, *Space Exploration: Commercial Space Transportation*, ENCYCLOPEDIA BRITANNICA, https://www.britannica.com/science/space-exploration/Commercial-space-transportation [https://perma.cc/C7AN-5MDH] (Oct. 25, 2021).

[37] NAPA REPORT, *supra* note 3, at 1; *see also* Paul B. Larsen, *Minimum International Norms for Managing Space Traffic, Space Debris, and Near Earth Object Impacts*, 83 J. AIR L. & COM. 739, 777 (2018).

[38] *See* NAPA REPORT, *supra* note 3, at 15; Larsen, *supra* note 37, at 748–49; *see also* Marlon E. Sorge, William H. Ailor & Ted J. Muelhaupt, *Space Traffic Management: The Challenge of Large Constellations, Orbital Debris, and the Rapid Changes in Space Operations*, SPACE AGENDA 2021, Sept. 2020, at 2 [hereinafter SPACE AGENDA 2021], https://aerospace.org/sites/default/files/2020-09/Sorge_STM_20200915.pdf [https://perma.cc/4F77-D3WN]; U.N. Off. for Outer Space Affs., Guidelines for the Long-Term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space 1 (2021) [hereinafter LTS Guidelines], https://www.unoosa.org/res/oosadoc/data/documents/2021/stspace/stspace79_0_html/st_space79E.pdf [https://perma.cc/WG4W-3TJG]; discussion *infra* Section III.C.1.a.

[39] *See* NAPA REPORT, *supra* note 3, at 15; *Space Debris and Human Spacecraft*, NASA, https://www.nasa.gov/mission_pages/station/news/orbital_debris.html [https://perma.cc/3UNH-SW4N] (May 27, 2021).

United States' and other states' efforts to be safe and commercially viable at the same time. Part IV compares different management approaches. Part V looks at the most effective way to establish STM in the near future. Finally, Part VI concludes by summarizing the largest and most essential pieces that should shape the New Space policy.

II. THE CURRENT CRISIS

A. Growth of Commercial Space Activities

New Space, as modern outer space has become known, is characterized by a drastic increase in the number of space objects in orbit.[40] The growth is an international development: the European Space Agency (ESA) reports that there are currently more than 170 million space objects larger than one millimeter in orbit.[41] Of these, 670,000 are larger than one centimeter, and 29,000 of these objects are larger than ten centimeters.[42] Orbiting satellites are registered in the registry established by the U.N. under the Registration Convention.[43] The U.N. Office for Outer Space Affairs (UNOOSA) reported 5,774 individual objects registered with the U.N. in orbit (2,666 of which are active) as of the end of March 2020.[44] Of these, 1,454 are listed as commercial.[45] That number has subsequently increased, primarily by SpaceX and OneWeb's launch of many small satellites.[46] The number of registered objects rose almost 16% between 2019 and 2020.[47] Prospectively, SpaceX has permission to launch 42,000 satellites, and China reportedly plans to launch thousands of satellites.[48] Some predictions estimate 20,000 new satellites will

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[40] *See* Glenn Peterson, Marlon Sorge & William Ailor, *Space Traffic Management in the Age of New Space*, Aerospace Corp. 5 (Apr. 2018), https://aerospace.org/sites/default/files/2018-05/SpaceTrafficMgmt_0.pdf [https://perma.cc/C9UV-TL4T]; NAPA Report, *supra* note 3, at 28.

[41] *How Many Space Debris Objects Are Currently in Orbit?*, Eur. Space Agency, https://www.esa.int/Safety_Security/Clean_Space/How_many_space_debris_objects_are_currently_in_orbit [https://perma.cc/KF3Y-KK46].

[42] *Id.*

[43] *See* Registration Convention, *supra* note 1, arts. III–IV.

[44] *How Many Satellites Are Orbiting the Earth in 2020?*, Pixalytics (May 27, 2020), https://www.pixalytics.com/satellites-orbiting-earth-2020/ [https://perma.cc/6U6C-VG2U].

[45] *Id.*

[46] *See id.*

[47] *See id.*

[48] Irene Klotz, *Burgeoning LEO Belt*, Aviation Wk. & Space Tech., Mar. 9–22, 2020, at 54; Timiebi Aganaba, Assistant Professor, Sch. for the Future of Innova-

be in orbit by 2030.[49] These increases relate to commercial satellites, with most expected to be in LEO.[50]

U.S. Air Force Combined Space Operations Center (CSpOC) tracking is the primary tool for preventing collisions.[51] Presently, it can track thousands of large space objects and warn operators of prospective collisions.[52] The orbiting objects' maximum speed of 18,000-miles-per-hour leaves very little time to avoid impacts.[53] With rising close encounter reports,[54] collisions of space objects—such as the 2009 collision of Iridium 33 with Cosmos 2251[55]—is likely to occur more frequently.

Furthermore, the number of countries authorizing commercial satellites is rising.[56] Operators are therefore subject to different national oversight and operating rules.[57] One recent

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tion in Soc'y, Ariz. State Univ., Spotlight Talk Speaker at Secure World Foundation Summit for Space Sustainability, Panel 2: Megaconstellations—The Train Left the Station. Now What? (June 22, 2021) (transcript available at https://swfound.org/media/207226/panel-2-transcript.pdf [https://perma.cc/X5QP-DSU6]). OneWeb, now U.K.- and India-owned, will launch 648 satellites by June 2022. Jen DiMascio & Irene Klotz, *OneWeb Rolling Out Broadband Service in UK, Canada and Alaska*, AVIATION WK. & SPACE TECH., July 12–25, 2021, at 42.

[49] *See, e.g.*, Klotz, *supra* note 48, at 54.

[50] *See* Aganaba, *supra* note 48, at 1; *see also* Stephen Garber & Marissa Herron, *How Has Traffic Been Managed in the Sky, on Waterways, and on the Road? Comparisons for Space Situational Awareness (Part 1)*, SPACE REV. (June 8, 2020), https://www.thespacereview.com/article/3961/1 [https://perma.cc/9SAL-HC7U].

[51] *See* Garber & Herron, *supra* note 50.

[52] *See* Sandra Erwin, *U.S. Military Keeps Sharp Eyes on Orbit as Congestion Grows*, SPACENEWS (Nov. 3, 2020), https://spacenews.com/u-s-military-keeps-sharp-eyes-on-orbit-as-congestion-grows [https://perma.cc/LY9B-LG4X]; discussion *infra* Section II.C.

[53] Chow, *supra* note 7.

[54] *See, e.g.*, *Two Satellites in Close Shave over US City of Pittsburgh*, BBC (Jan. 30, 2020), https://www.bbc.com/news/world-us-canada-51299638 [https://perma.cc/D2GZ-HB4Q]; Pultarova, *supra* note 5.

[55] *See generally* Brian Weeden, *2009 Iridium-Cosmos Collision Fact Sheet*, SECURE WORLD FOUND. 1, https://swfound.org/media/6575/swf_iridium_cosmos_collision_fact_sheet_updated_2012.pdf [https://perma.cc/G4XB-U8LA] (Nov. 10, 2010).

[56] *See, e.g.*, Brian Kim, *With Restrictions Lifted, South Korea Launches $13B Space Power Scheme*, DEFENSE NEWS (Sept. 6, 2021), https://www.defensenews.com/space/2021/09/06/with-restrictions-lifted-south-korea-launches-13b-space-power-scheme/ [https://perma.cc/VG79-VEPX]; Nick Flaherty, *UK Aims to Be First European Country for Space Launches*, EENEWS EUROPE (May 24, 2021), https://www.eenewseurope.com/news/uk-aims-be-first-european-country-space-launches [https://perma.cc/85BH-VJUS]; Thomas Erdbrink & Christina Anderson, *In Sweden's Far North, a Space Complex Takes Shape*, N.Y. TIMES, https://www.nytimes.com/2021/05/23/world/europe/sweden-space-arctic-satellites.html [https://perma.cc/69JS-W26G] (June 10, 2021).

[57] *See* SPACE AGENDA 2021, *supra* note 38, at 3.

example is the uncontrolled deorbiting of a twenty-three-ton Chinese launch rocket piece and its debris landing unexpectedly near the Maldives.[58] States dealing with loosely regulated space activities face more challenging issues with non-regulated New Space activities, such as operators extending the lives of satellites in orbit.[59] A variety of activities in orbit makes space traffic even more complex and thus more difficult to manage.

Furthermore, states are not prepared to supervise the New Space activities in outer space. The U.S. is an example of a state that has not yet fully organized management of commercial space activities. While the U.S. Air Force CSpOC tracks civilian space objects, the Department of Defense (DOD) prefers that a civilian U.S. government authority be charged with tracking civilian outer space activities.[60] Although private tracking of space activities does occur, private companies do not have the authority to enforce established operational rules.

B. Space Debris and Commercial Space

Space debris is the greatest danger to commercial space.[61] Several situations contribute to its existence. New launches result in rocket debris caused by the launch and collisions with non-maneuverable, dead, and fragmented satellites.[62] Military conjunctions, such as the intentional collision of a Chinese satellite with a Chinese antisatellite weapon in 2007, also cause debris.[63] The primary danger of debris collision with a spacecraft is closely followed by the secondary effect of a collision creating more debris, as illustrated by the Iridium-Cosmos 2251 collision

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[58] Steven Lee Myers & Kenneth Chang, *China Says Debris from Its Rocket Landed Near Maldives*, N.Y. Times, https://www.nytimes.com/2021/05/08/science/china-rocket-reentry-falling-long-march-5b.html [https://perma.cc/ET7G-SPM5] (June 16, 2021).

[59] Devin Coldewey, *Another Milestone for In-Space Servicing as Northrop Grumman Gives Aging Satellite New Life*, TechCrunch (Apr. 12, 2021, 4:21 PM), https://techcrunch.com/2021/04/12/another-milestone-for-in-space-servicing-as-northrop-grumman-gives-aging-satellite-new-life/ [https://perma.cc/RAK4-WFRR].

[60] Garber & Herron, *supra* note 50; *see* discussion *infra* Section IV.E.1 (NAPA Report's failure to consider essential implementation of the OST).

[61] *See* NAPA Report, *supra* note 3, at 37. The danger of collision in outer space has recently doubled. *Tracking Space Debris Is a Growing Business*, The Economist, https://www.economist.com/science-and-technology/tracking-space-debris-is-a-growing-business/21804756 [https://perma.cc/57HQ-FWUK] (Sept. 16, 2021).

[62] *About Space Debris*, Eur. Space Agency, https://www.esa.int/Safety_Security/Space_Debris/About_space_debris [https://perma.cc/F5A5-K8DM].

[63] *Space Debris Mitigation*, Space Safety Mag., https://www.spacesafetymagazine.com/space-debris/mitigation/ [https://perma.cc/V2UD-S3G9].

in 2009.[64] After the collisions, the debris remains in orbit and perpetuates the cycle.[65] Space operators have had to incorporate safety procedures in response to these conditions. For example, on April 24, 2021, a SpaceX spacecraft transporting four astronauts to the ISS was suddenly ordered to prepare for collision with space debris.[66]

Although current international space debris guidelines[67] cannot control the increase in debris—especially from collisions that create more and ever-smaller debris swarms[68]—the UNCOPUOS Space Debris Guidelines (2007 Space Debris Guidelines)[69] are generally enforced by individual states. In the U.S., the 2007 Space Debris Guidelines are applied and supplemented by NASA.[70] They are required for commercial operators by the Federal Aviation Administration (FAA), the National Oceanic and Atmospheric Administration (NOAA), and for licensing commercial satellites by the Federal Communications Commission (FCC).[71] The U.S. has strengthened the UNCOPUOS guidelines by its Orbital Debris Mitigation Standard

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[64] *See* Weeden, *supra* note 55.

[65] *See id.*

[66] *See* Chow, *supra* note 7.

[67] U.N. Off. for Outer Space Affs., Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (2010), https://www.unoosa.orgpdf/publications/st_space_49E.pdf [https://perma.cc/J7Y5-K9NW] [hereinafter 2007 Space Debris Guidelines]; *see* Paul B. Larsen, *Solving the Space Debris Crisis*, 83 J. AIR L. & COM. 475, 478 (2018) (discussing the Inter-Agency Space Debris Coordination Committee's Space Debris Mitigation Guidelines).

[68] This phenomenon is also known as the Kessler Syndrome, which states that space debris of critical mass will fragment in further collisions leading to a cascading chain of activities. Donald J. Kessler & Burton G. Cour-Palais, *Collision Frequency of Artificial Satellites: The Creation of a Debris Belt*, 83 J. GEOPHYSICAL RSCH. 2637, 2637 (1978).

[69] The Space Debris Guidelines: (1) limit the amount of debris released under normal operations; (2) minimize potential break-ups and consequent debris; (3) limit probability of accidental collision; (4) discourage intentional destruction of space objects; (5) reduce debris from stored energy; (6) limit long-term presence of defunct satellites in orbit; and (7) limit long-term interference of defunct spacecraft with geosynchronous Earth orbit. 2007 Space Debris Guidelines, *supra* note 67, at 2–4.

[70] *See Orbital Debris Management & Risk Mitigation*, NASA, https://www.nasa.gov/pdf/692076main_Orbital_Debris_Management_and_Risk_Mitigation.pdf [https://perma.cc/GFZ9-HSJG].

[71] *See* Space Policy Directive-3, *supra* note 10, § 6; *see also* DANIEL MORGAN, CONG. RSCH. SERV., R45416, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION (Nov. 29, 2018), https://sgp.fas.org/crs/space/R45416.pdf [https://perma.cc/CVB6-A8BC].

Practices (ODMSP), updated and improved in 2019.[72] U.S. government operators are required to comply with the ODMSP.[73] Furthermore, the FCC recently proposed that commercial operators be required to post a bond to ensure payment for potential damages caused by debris from that operator's launched satellites.[74]

Commercial operators can only do their best to avoid large, identified debris. Commercial operators cannot resolve the debris problem because they cannot control outer space, the space objects of other operators, the vast amount of small but dangerous space debris, or remove debris from outer space without authority from the owners of debris.[75] Resolution of the debris problem requires active international and national government regulation at multiple levels. One space power (such as the U.S.) authorizing commercial satellite operations can reduce the danger or amount of space debris through mitigation or incentives for their operators. However, controlling space debris of unknown origin and debris caused by operators authorized by other governments requires expedited international coordination in UNCOPUOS.

C. Tracking Traffic in Space

Tracking space objects is currently the most basic form of space traffic control and is essential for space commerce operational safety.[76] Tracking identifies prospective "conjunctions" (close approaches) of space objects in orbit.[77] The DOD is the

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[72] The 2019 ODMSP places quantitative limits on the amount of debris that may be released during operations, establishes preferred disposal methods for space objects in LEO and different methods for disposal in GEO, and establishes special deorbit operating practices for large constellation and other classes of operations. *See* NASA, U.S. Government Orbital Debris Mitigation Standard Practices, November 2019 Update 1 (2019), https://orbitaldebris.jsc.nasa.gov/library/usg_orbital_debris_mitigation_standard_practices_november_2019.pdf [https://perma.cc/YZ52-97FY].

[73] *Id.*

[74] *See* Mitigation of Orbital Debris in the New Space Age, 85 Fed. Reg. 52,422, 52,444 (Aug. 25, 2020) (to be codified at 47 C.F.R. pts. 5, 25, and 97); *cf.* Liability Convention, *supra* note 1.

[75] *See Space Debris: The Legal Issues*, Royal Aeronautical Soc'y, https://www.aerosociety.com/news/space-debris-the-legal-issues/ [https://perma.cc/HM9R-H2NC] ("Another State, or the private entity of another State, may not touch, interfere with or remove a space object without the launching State's consent.").

[76] *E.g.*, Space Policy Directive-3, *supra* note 10, § 5(a)(ii).

[77] Peterson et al., *supra* note 40, at 3.

most extensive tracker of space objects,[78] whereas the ESA and several other countries conduct less sophisticated tracking.[79] Both U.S. and foreign space commerce depend on DOD tracking services.[80] The U.S. Air Force CSpOC tracks about 23,000 large objects in outer space[81] and makes tracking information available to civilian operators.[82]

Comprehensive civilian STM will require extensive traffic data sharing; it will need to monitor national traffic and space traffic originating in other countries.[83] Such international sharing of traffic data will require traffic control observatories with data bank facilities.[84] It will also require radar observation and a traffic control organization to process the data.[85] Furthermore, the management and control of space commerce traffic will require civilian government functions rather than the for-profit arrangement used by commercial traffic data collection and sharing entities.[86] As stated by the Aerospace Center for Space Policy and Strategy, "[w]ithout a process for rapidly incorporating and disseminating STM service data, it will not be possible to maintain safe space operations in the dynamic environment of the near future."[87] Established civilian space traffic control must draw traffic data from all possible sources such as the military, nongovernmental, and commercial sectors. Thus, incorporating pri-

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[78] *See* Garber & Herron, *supra* note 50.

[79] *See id.*

[80] *See id.*; *see also Tracking Space Debris Is a Growing Business*, *supra* note 61.

[81] Garber & Herron, *supra* note 50.

[82] *Id.* The U.S. Air Force maintains a website, space-track.org, for exchange of satellite maneuvers. *See* NASA AGREEMENT WITH SPACEX, *supra* note 11, art. 2.

[83] *See* Garber & Herron, *supra* note 50 (listing the various organizations around the world that provide SSA information with different coverage).

[84] *See* SPACE AGENDA 2021, *supra* note 38, at 5. For example, LeoLabs, a firm in Silicon Valley, now operates several tracking satellites and sells tracking information, including to private satellite operators. *See Tracking Space Debris Is a Growing Business*, *supra* note 61.

[85] *See* SPACE AGENDA 2021, *supra* note 38, at 5.

[86] *Id.*; *see also* Garber & Herron, *supra* note 50.

[87] SPACE AGENDA 2021, *supra* note 38, at 5. The U.S. Air Force's tracking capability is improving; the technology is being upgraded so that the Air Force will be able to track close to ten times more objects. *See* Mike Gruss, *Good (Space) Fences Make for Good (Orbital) Neighbors*, SPACENEWS (Sept. 19, 2016), https://spacenews.com/good-space-fences-make-for-good-orbital-neighbors/ [https://perma.cc/5MSE-3P84]; *see also* Sandra Erwin, *Space Fence Surveillance Radar Site Declared Operational*, SPACENEWS (Mar. 28, 2020), https://spacenews.com/space-fence-surveillance-radar-site-declared-operational/ [https://perma.cc/6Q92-6NSC].

vate data collection into the data banks will be an important task.[88]

D. Priority of Scientific Exploration

The foundation for commercial use of outer space is the exploration of the universe.[89] The preamble to the OST clarifies that the authors' primary objective was to explore outer space, with commercial use being their secondary objective.[90] In Article I of the OST, the states agreed that "[t]here shall be freedom of scientific investigation in outer space, including the moon and other celestial bodies, and States shall facilitate and encourage international co-operation in such investigation."[91] By that plain language, the states expressed their intention to make astronomical explorations and improve their understanding of the universe. Consequently, all uses of outer space must allow for continued exploration of outer space.

Astronomers' and scientists' needs must be taken into consideration in regulating other outer space activities. Ground telescopes must have unhindered views of outer space to capture proper images.[92] Astronomers have complained that the lights of large commercial satellite constellations disturb their

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[88] *See* Garber & Herron, *supra* note 50; *see also Tracking Space Debris Is a Growing Business*, *supra* note 61 (summarizing several sources of commercial tracking of satellites and debris).

[89] *See Commercial Opportunities for Space Exploration*, Eur. Space Agency, https://www.esa.int/About_Us/Business_with_ESA/Business_Opportunities/Commercial_Opportunities_for_Space_Exploration [https://perma.cc/XLC7-5W5F] ("Commercial partnership plays a growing role in the exciting ESA vision for space exploration."). *See generally* Larsen, *supra* note 19, at 13–15 (discussing multiple reasons why scientists' and astronomers' continuing role in space exploration is important).

[90] *See* OST, *supra* note 1, pmbl.

[91] *Id.* art. I; *see* IISL Statement, *supra* note 2.

[92] *See* Alexandra Witze, *How Satellite 'Megaconstellations' Will Photobomb Astronomy Images*, Nature (Aug. 26, 2020), https://www.nature.com/articles/d41586-020-02480-5 [https://perma.cc/C8PR-FJKZ].

> Communicating with distant spacecraft is difficult. The signals that pass between the spacecraft and ground stations are very weak and because of the large distances, it takes them a long time to travel between the two. It can take up to 24 minutes for a signal to travel between Earth and Mars, for example, and almost an entire day to receive a signal sent by NASA's Voyager 1—a spacecraft that has travelled beyond the edge of the Solar System.

Deep Space Communication and Navigation, Eur. Space Agency, https://www.esa.int/Enabling_Support/Preparing_for_the_Future/Discovery_and_Preparation/Deep_space_communication_and_navigation [https://perma.cc/66RS-TCKM].

view of outer space.[93] A recent study published by the U.K. Royal Astronomical Society[94] states that the recent orbits of mega constellations—such as the SpaceX deployment of more than a thousand satellites for Internet access—has increased the brightness of the night sky by 10% over its natural level, thus presenting a significant threat to astronomy.[95] The brightness increase affects 40% of ultra-wide imaging exposures.[96] The reflectivity of satellites varies; some satellites are highly reflective due to thermal management, whereas others absorb heat and are less reflective.[97] The effect of radiance will quickly increase as thousands more satellites are put into orbit.[98] In the past, astronomers tended to build observatories in remote places such as Chile and Australia[99] to escape the interfering city lights. But the light effect of mega-constellations in outer space cannot be avoided;[100] it affects all ground-based observatories regardless of where they are located.[101]

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[93] Witze, *supra* note 92; *cf.* Jeff Foust, *Can Satellite Megaconstellations Be Responsible Users of Space?*, SPACENEWS (Sept. 3, 2019), https://spacenews.com/can-satellite-megaconstellations-be-responsible-users-of-space/ [https://perma.cc/RLN6-C82A] (reporting the different ways commercial satellite companies are trying to address sustainability concerns). The President of the American Astronautical Society has expressed concerns about SpaceX small satellite constellations blocking astronomical observations. *Id.*

[94] Miroslav Kocifaj, Frantisek Kundracik, John C. Berentine & Salva Bará, *The Proliferation of Space Objects Is a Rapidly Increasing Source of Artificial Night Sky Brightness*, 504 MONTHLY NOTICES ROYAL ASTRONOMICAL SOC'Y L40 (2021).

[95] *Id.* at L43. The natural level of brightness is the critical "red-line" standard established by the International Astronomical Union for earth-based astronomical observation. *Id.*

[96] *Id.* at L40.

[97] *See id.* at L42.

[98] *See id.* at L44.

[99] *See Controlling Light Pollution*, INT'L ASTRONOMICAL UNION, https://www.iau.org/public/themes/light_pollution/ [https://perma.cc/BSW3-CABS].

[100] *See* Alfredo Carpineti, *Artificial Space Objects Are Bringing Light Pollution to Most of the Planet*, IFLSCI. (Mar. 30, 2021, 1:57 PM), https://www.iflscience.com/space/artificial-space-objects-are-bringing-light-pollution-to-most-of-the-planet/ [https://perma.cc/WC4J-CYR3].

[101] *See id.*; U.N. OFF. FOR OUTER SPACE AFFS., DARK AND QUIET SKIES FOR SCIENCE AND SOCIETY: REPORT AND RECOMMENDATIONS 68 (2021), https://www.iau.org/static/publications/dqskies-book-29-12-20.pdf [https://perma.cc/CJ38-ZB55]. The feedback received after the "Dark and Quiet Skies Conferences for Science and Society" are scheduled to be presented to COPUOS meetings in February of 2022. *See Dark and Quiet Skies: An Opportunity to Make Your Voice Heard Around the World*, INT'L DARK-SKY ASS'N (Aug. 12, 2021), https://www.darksky.org/dark-and-quiet-skies-an-opportunity-to-make-your-voice-heard-around-the-world/ [https://perma.cc/Y5XN-3VK2].

Many conditions and situations on Earth can only be observed from telescopes in outer space. A clear view of the Earth from outer space is important for scientists to observe and measure occurrences like climate conditions that are otherwise undetectable.[102] The rising climate change concern requires monitoring to comply with the Paris Agreement and U.S. climate change policy.[103] Projects related to climate change, like renewable energy, can overlap with outer space activities. For instance, the U.S. Department of Energy has done extensive research on deploying solar-powered satellites into orbit to collect solar energy and channel the solar energy via microwaves down to footprints on Earth.[104] Thus, U.S. national policies on climate change and renewable sources of energy must be weighed in policy decisions regarding space commerce.

Astronomers must search the universe for planets suitable for human habitation as various threats point to the probability that the Earth will become uninhabitable.[105] The Earth has repeatedly been impacted by different-sized asteroids and will be struck again at some unknown time in the future.[106] NASA actively looks for asteroids and identifies the largest ones with the hope of avoiding major collisions.[107] Nevertheless, the Earth continues to be impacted by small, unanticipated asteroid strikes.[108]

Astronomers voice their interests and act primarily through their governments and organizations, such as the International Astronomical Union, the Committee on Space Research, and

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[102] *See, e.g.*, J.R. Elliot, R.J. Walters & T.J. Wright, *The Role of Space-Based Observation in Understanding and Responding to Active Tectonics and Earthquakes*, 7 NATURE COMMC'NS (Dec. 22, 2016), https://www.nature.com/articles/ncomms13844.pdf [https://perma.cc/44FQ-9V5F].

[103] Paul B. Larsen, *Climate Change Management in the Space Age*, 45 WM. & MARY ENV'T L. & POL'Y REV. 103, 110 (2020).

[104] FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE 269–70 (1st ed. 2009); *see also* CARL Q. CHRISTOL, PRC ENERGY ANALYSIS CO., U.S. DEP'T OF ENERGY, SATELLITE POWER SYSTEMS (SPS) INTERNATIONAL AGREEMENTS 123 (1978).

[105] Threats include climate change, asteroid strikes, or other catastrophes. *See, e.g.*, Casey Dreier, *Why an Asteroid Strike Is like a Pandemic*, SCI. AM. (July 25, 2021), https://www.scientificamerican.com/article/why-an-asteroid-strike-is-like-a-pandemic/ [https://perma.cc/5XGR-43B8] (stating that astronomers use telescopes to watch for potentially destructive asteroids).

[106] *See id.*

[107] *Id.*; *see also Planetary Defense Coordination Office*, NASA, https://www.nasa.gov/planetarydefense/overview/ [https://perma.cc/N9TA-6DUS] (Mar. 14, 2019).

[108] Dreier, *supra* note 105.

the International Astronautical Federation.[109] Astronomers coordinate findings and recommendations through the UN-COPUOS Scientific and Technical Subcommittee.[110] Astronomers and scientists also rely on their governments to protect and assert their rights to explore outer space under the Outer Space Treaty.[111]

E. Tension Between Space Commerce and Environmental Protection

The current environmental impact assessment for outer space use is not effective. It is recognized that the quality of life and the health of present and future generations of human beings requires environmental protection and that the outer space environment is living space.[112] In recent years, a "general international duty towards the preservation and conservation of the environment . . . is developing."[113] However, in the U.S., formal environmental impact statements by reviewing agencies (which are required for activities on Earth) are not required for launch approval of commercial activities in outer space.[114] For an effective environmental assessment for outer space, it will need to be implemented domestically by all agencies with related interests:

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[109] *See generally About the IAU*, Int'l Astronomical Union, https://www.iau.org/administration/about/ [https://perma.cc/33WS-94AP]; *COSPAR Charter*, Comm. on Space Rsch., https://cosparhq.cnes.fr/about/charter/ [https://perma.cc/V47V-FQ8F] (Apr. 19, 2019); *History and Missions*, Int'l Astronautical Fed'n, https://www.iafastro.org/about/history-and-missions.html [https://perma.cc/K3TU-8572].

[110] *See* Comm. on the Peaceful Uses of Outer Space, Sci. & Tech. Subcomm., Recommendations to Keep Dark and Quiet Skies for Science and Society, ¶¶ 1, 20, U.N. Doc. A/AC.105/C.1/2021/CRP.17 (Apr. 19, 2021) (workshop and conference to discuss astronomy community's concerns).

[111] *Id.* ¶¶ 20, 64.

[112] *Cf.* Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, ¶ 29 (July 8) (noting States' responsibility for activities in its control to respect the environment because it is an interconnected living space). Note that preservation of outer space for future generations is one of the objectives of the UNCOPUOS Guidelines for the Long-Term Sustainability of Outer Space Activities. Comm. on the Peaceful Uses of Outer Space, Guidelines for the Long-Term Sustainability of Outer Space Activities, ¶¶ 5–6, 8, U.N. Doc. A/AC.105/L.318/Add.4 (June 19, 2019).

[113] Lyall & Larsen, *supra* note 2, at 248–49; *see also* LTS Guidelines, *supra* note 38, ¶¶ 10, 20; IISL Statement, *supra* note 2. *See generally* ESA's Annual Space Environment Report, *supra* note 5.

[114] *See* L.E. Viikari, *Environmental Impact Assessment and Space Activities*, 34 Advances Space Rsch. 2363, 2364 (2004).

NASA, the FAA, the FCC,[115] NOAA, and the DOD. Currently, an interagency working group is chaired by the DOC.[116]

On the international level, implementing the 2007 Space Debris Guidelines by the U.S. and the other space powers was a start. Improved international guidelines are being developed in UNCOPUOS,[117] which means commercial operators will eventually adjust to environmental requirements. The pressing question is whether that can happen quickly enough to preclude a major collision disaster.

Undoubtedly, Earth and outer space require more protection from space debris. The outer space environment suffers from the increasing traffic of satellites and related space debris.[118] But space debris is not only a problem in outer space because more and more space debris is falling on the Earth.[119] One recent example was the uncontrolled debris of a Chinese booster rocket that landed near the Maldives in the Indian Ocean.[120] Another example is the SpaceX debris that crashed in the state of Washington and other areas.[121] Falling debris is also an issue during launches when debris from rockets land on property adjoining launch pads.[122]

The environmental risks raise the question of who should be considering environmental side effects when authorizing space launches. The current environmental situation of outer space

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[115] *See* Mitigation of Orbital Debris in the New Space Age: Report and Order and Further Notice of Proposed Rulemaking, F.C.C. 20-54 ¶ 20 (Apr. 24, 2020), https://docs.fcc.gov/public/attachments/FCC-20-54A1.pdf [https://perma.cc/BF7M-4RNJ] [hereinafter 2020 FCC Notice of Proposed Rulemaking on Mitigation of Orbital Debris].

[116] NAPA REPORT, *supra* note 3, at 55.

[117] Recommendations to Keep Dark and Quiet Skies for Science and Society, *supra* note 110.

[118] *E.g.*, SPACE AGENDA 2021, *supra* note 38, at 3.

[119] *See, e.g.*, Myers & Chang, *supra* note 58 (covering uncontrolled re-entries of rockets or booster stages of rockets).

[120] *Id.*

[121] *Id.*; Antonia Noori Farzan, *From a Texas Dental Office to the Canadian Tundra, Here's Where Space Debris Has Crashed to Earth*, WASH. POST (May 25, 2021, 12:02 AM), https://www.washingtonpost.com/science/from-a-texas-dental-office-to-the-canadian-tundra-heres-where-space-debris-has-crashed-to-earth/2021/05/21/bb1bf46e-b992-11eb-96b9-e949d5397de9_story.html [https://perma.cc/NU9L-A2LW].

[122] Evidently, the noise and debris from a new SpaceX launch facility in Texas was not considered adequately by the FAA when it authorized its operation. *See* Edgar Sandoval & Richard Webner, *A Serene Shore Resort, Except for the SpaceX 'Ball of Fire'*, N.Y. TIMES, https://www.nytimes.com/2021/05/24/us/space-x-boca-chica-texas.html [https://perma.cc/6CTX-97RD] (May 26, 2021).

requires governmental regulation as well as bottom-up coordination.[123] So far, environmental consequences tend to be weighed inadequately by authorizing governmental authorities. In the case of the Chinese rocket debris crash into the Indian Ocean, it is the responsibility of the Chinese government to assure environmental protection from its space debris anywhere around the world.[124] Yet, some in the space industry criticized the Chinese government's recklessness in handling the mission and crash.[125] In the U.S., the FAA considers the environmental consequences for commercial launches.[126] Still, some may suggest that the Environmental Protection Agency should have a role in protecting the environmental quality of outer space. For example, should launch licensing (currently handled by the FAA) include an environmental impact assessment that aims to prevent further space debris accumulation in outer space?

F. Should Promotion of Commercial Space Be Left to Industry?

Many space trade associations have been formed to promote commercial space by providing joint industry contributions to safety, environment, and business regulations.[127] The associations tend to state their purpose is to promote best practices among individual members of the industry.[128] The associations represent a variety of stakeholders.[129] The Space Data Association, for example, is an international association of large, established organizations such as Eutelsat, Inmarsat, Intelsat, and SES.[130] Government agencies such as NASA, DLR (Germany),

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[123] *See* NAPA Report, *supra* note 3, at 16; IISL Statement, *supra* note 2.

[124] China is liable for damage caused. *See* Liability Convention, *supra* note 1, art. II.

[125] *See* Meyers & Chang, *supra* note 58.

[126] *See, e.g.*, Fed. Aviation Admin., Draft Environmental Assessment for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station 1 (2020), https://www.faa.gov/space/environmental/nepa_docs/media/SpaceX_Falcon_Program_Draft_EA_508.pdf [https://perma.cc/T2L5-Q9VF].

[127] Larsen, *supra* note 37, at 765–67.

[128] *See, e.g.*, *Space Debris, Mitigation & Sustainability*, Satellite Indus. Ass'n, https://sia.org/policy/space-debris-mitigation-sustainability/ [https://perma.cc/ZMK8-85L2]; *Welcome to the Space Data Association*, Space Data Ass'n, https://www.space-data.org/sda/ [https://perma.cc/6CZ4-K8HS].

[129] *See* Garber & Herron, *supra* note 50.

[130] *Participants*, Space Data Ass'n, https://www.space-data.org/sda/participants/ [https://perma.cc/P9PF-3JGP].

and NOAA are also members.[131] The Space Data Association distributes data from the Air Force CSpOC and other sources to its subscribing members.[132] The Commercial Smallsat Spectrum Management Association includes small satellite operators sharing and representing their members' issues.[133] The Consortium for Execution of Rendezvous and Sensing Operations seeks to establish voluntary industry norms for servicing satellites in their orbits.[134] The Space Safety Coalition includes space companies and government entities seeking to promote operational safety and avoid collisions.[135] Promotion of the entire commercial space industry would consist of national and foreign businesses, which is what the DOC intends to do.[136] Even though there are numerous associations, none of them represent the entire space commerce industry. Thus, space commerce is divided into many different interests, does not speak with one voice, and cannot manage a crisis that ultimately involves all outer space stakeholders.[137]

III. THE LAW APPLICABLE TO COMMERCIAL SPACE

Outer space is inherently international because of its non-sovereign character. The OST is a government-to-government agreement.[138] Non-government entities are permitted to participate in space activities, but their governments are essentially still responsible for their actions.[139] Thus, the national governments are liable for the activities of their commercial operators.[140] This

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[131] *Id.*

[132] *See* Garber & Herron, *supra* note 50.

[133] *See Smallsat Industry Leaders*, COMMERCIAL SMALLSAT SPECTRUM MANAGEMENT ASSOCIATION, https://cssma.space/ [https://perma.cc/9LCV-H9MV].

[134] *About*, CONSORTIUM FOR EXECUTION OF RENDEZVOUS & SERVICING OPERATIONS, https://www.satelliteconfers.org/about-us/ [https://perma.cc/9MHT-UVUS].

[135] SPACE SAFETY COAL., https://spacesafety.org/ [https://perma.cc/WM3E-Q58D]. The Space Safety Coalition publishes *Best Practices for the Sustainability of Space Operations*. *See Best Practices for the Sustainability of Space Operations*, SPACE SAFETY COAL. (Sept. 16, 2019), https://spacesafety.org/wp-content/uploads/2021/04/Endorsement-of-Best-Practices-for-Sustainability_v40.pdf [https://perma.cc/MP5G-DW7N].

[136] *See* 51 U.S.C. § 50702(d)(2), (6).

[137] *See generally* Larsen, *supra* note 37, at 765–67 (examples of different commercial groups' preferences of regulations and regulatory authorities). There is currently no agreement among satellite operators on STM to avoid collisions. *See* Foust, *supra* note 9.

[138] *See* OST, *supra* note 1, art. XIII.

[139] *See id.* art. VI.

[140] *Id.* arts. VI–VII.

nationally assumed risk is huge and is increasing with every new space commerce activity. On the other hand, the risk assumption is also an incentive for the authorizing governments to assure commercial operators' compliance with strict safety standards.[141]

The OST establishes the order governing exploration and uses of outer space.[142] The OST evidences the 1967 parity between the U.S. and Russia, which were the only two space powers at the time.[143] The non-space powers readily accepted this arrangement in the 1967 OST[144] because it gave them time to recover economically after World War II. Based on the OST, states also entered into the Agreement on Rescue and Return of Astronauts, the Liability Convention, and Registration Convention.[145] Additionally, as of July 2019, eighteen (mostly developing) states are parties to the 1979 Moon Agreement.[146] Furthermore, the states in a separate treaty obligation belong to the International Telecommunication Union (ITU).[147] Article 44 of the ITU Constitution provides that "radio frequencies and any associated orbits, including the geostationary-satellite orbit, are limited natural resources and that they must be used rationally, efficiently and economically."[148]

The state parties' obligation to the OST indirectly subjected non-governmental space enterprises to the space treaties.[149] After the adoption of the treaties, commercial space became increasingly active and now constitutes most of the activities in space.[150] This Section aims to show that their respective govern-

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[141] *See id.*; Liability Convention, *supra* note 1, arts. II–III; LYALL & LARSEN, *supra* note 2, at 96–97; IISL Statement, *supra* note 2.

[142] *See* OST, *supra* note 1, art. I.

[143] *E.g.*, LYALL & LARSEN, *supra* note 2, at 52.

[144] *See id.* at 52.

[145] *Id.* at 75.

[146] Louis de Gouyon Matignon, *The 1979 Moon Agreement*, SPACE LEGAL ISSUES (July 17, 2019), https://www.spacelegalissues.com/the-1979-moon-agreement/ [https://perma.cc/P3VW-VH4E].

[147] *See* Constitution of the International Telecommunication Union, Dec. 22, 1992, T.I.A.S. No. 97-1026, 1825 U.N.T.S. 330 [hereinafter ITU Constitution].

[148] *Id.* art. 44(2).

[149] OST, *supra* note 1, art. VI; *see also* LYALL & LARSEN, *supra* note 2, at 414. As mentioned previously, that decision came almost as an afterthought because the states at that time evidently expected that most outer space activities would be conducted by states.

[150] Tina Highfall, Patrick Georgi & Dominique Dubria, *Measuring the Value of the U.S. Space Economy*, 99 SURV. CURRENT BUS., Dec. 2019, at 1, 4 (The Space Foundation had "reported global space activity . . . with commercial space reve-

ments' treaty obligations form the legal basis for commercial space and that commercial space activities place heavy duties on their states.

A. International "Hard Law": the Outer Space Treaty Article VI Establishes Government Authority and Continuing Oversight over Commercial Space

Article VI of the OST places international responsibility on each state party to ensure treaty compliance by authorized governmental and non-governmental entities.[151] Each government administers its treaty responsibilities by conditioning its permission to non-governmental operators on their compliance with the OST and other legal obligations.[152] This is usually done by national laws and regulations or directly imposing the treaty obligations on authorized non-governmental operators.[153] The most effective way to enforce the treaty obligations would be to implement them through national licensing laws that express those obligations.[154] Furthermore, the authorizing governments must continue to monitor and supervise their authorized private operators to ensure they stay within the scope of their government-granted permission.[155]

B. U.S. "Hard Laws" Regulate Use of Outer Space by Commercial Entities

National states have adopted varying laws and regulations on the use of outer space. In the U.S., the U.S. Commercial Space Launch Act authorizes commercial launches and reentries from outer space subject to the U.S's safety, public health, and national security interests.[156] The U.S. Commercial Space Launch Competitiveness Act authorizes U.S. citizens engaged in commercial recovery of space resources to own and sell any space

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nues representing 79 percent of total space activity."); *see also* Lyall & Larsen, *supra* note 2, at 416.

[151] *See* OST, *supra* note 1, art. VI.

[152] *But see* 2020 FCC Notice of Proposed Rulemaking on Mitigation of Orbital Debris, *supra* note 115, ¶¶ 135–139 (requesting further comments on alternatives to alleviate weight of liability on the U.S. government).

[153] *See* Lyall & Larsen, *supra* note 2, at 416.

[154] *See id.* Licensing laws would answer IISL's call for authorities to consider "whether there are adequate mechanisms in place to ensure compliance with the [OST]." IISL Statement, *supra* note 2.

[155] *See* Lyall & Larsen, *supra* note 2, at 416.

[156] Commercial Space Launch Act § 2(7), 51 U.S.C. § 50901(a)(7).

resource obtained.[157] All of these laws are specifically made subject to the terms of the OST to avoid any conflict.[158]

Article II of the OST provides that neither states nor their authorized non-governmental operators may appropriate outer space—including the Moon and celestial bodies—by use, occupation, or any means whatsoever.[159] In other words, "the states cannot authorise non-governmental entities to appropriate outer space celestial bodies. The states cannot grant any rights which they themselves do not possess."[160] Accordingly, the ITU recognizes that commercial space operators cannot own frequencies and associated orbits.[161] They can only receive permission to use frequencies and associated orbits, which is subject to forfeiture if they violate the terms of their permission.[162] Applying the same principle most broadly, Article I of the OST grants the right to use outer space on the conditions that it: (1) be "for the benefit" of all countries; (2) be "in the interests of all countries"; (3) be recognized as "the province of all mankind"; (4) be explored and used "by all States without discrimination of any kind, on a basis of equality and in accordance with international law"; and (5) offer "free access to all areas of celestial bodies."[163]

Thus, there are issues with the U.S. Commercial Space Launch Competitiveness Act's legitimacy. First, it is contrary to Article II of the OST and its prohibition on the appropriation of celestial bodies.[164] Second, the other eighteen states who are parties to the 1979 Moon Treaty challenge the grant of ownership by the Act. Article 11 of the Moon Treaty states that the Moon "is the common heritage of mankind," subject to international regulation that is yet to be established.[165] As commercial activities begin to lean towards individual-centric goals rather than established global values, the OST and other international

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[157] U.S. Commercial Space Launch Competitiveness Act § 402(a), 51 U.S.C. § 51303.

[158] *Cf.* Paul B. Larsen, *Is There a Legal Path to Commercial Mining on the Moon?*, PITT. L. REV. (forthcoming 2021) (on file with author).

[159] OST, *supra* note 1, art. II.

[160] LYALL & LARSEN, *supra* note 2, at 416 & n.24 (expressing the ancient Roman legal maxim *nihil dat qui non habet* (no one can give what they do not have)).

[161] *See* ITU Constitution, *supra* note 147, art. 44(2).

[162] *See id.* arts. 6, 39.

[163] OST, *supra* note 1, art. I.

[164] *Id.* art. II ("Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.").

[165] 1979 Moon Treaty, *supra* note 1, art. 11(1), (5).

agreements should be the ruler to measure a proposed regulation's or legislation's compatibility with the international policy and scheme.

C. International Soft Law-Making Organizations

1. UNCOPUOS

UNCOPUOS is the international forum for discussion and resolution of outer space issues,[166] other than military issues.[167] UNCOPUOS operates by a consensus and represents all the space powers and developing countries.[168] The existing five space law treaties were all negotiated in UNCOPUOS.[169] After the conclusion of the last treaty, the 1979 Moon Agreement, UNCOPUOS focused on adopting soft law instruments—most of which were adopted as U.N. General Assembly Resolutions.[170] In 2015, U.N. General Assembly Resolution 70/1 adopted seventeen broad goals leading to sustainable economic, social, and environmental world development.[171] To implement the U.N. resolution, UNCOPUOS adopted the LTS Guidelines, which contain many provisions that improve outer space safety of commercial space operations as described below.[172]

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[166] *See COPUOS History*, U.N. Off. for Outer Space Affs. https://www.unoosa.org/oosa/en/ourwork/copuos/history.html [https://perma.cc/UFC3-N8ZA].

[167] Military issues are discussed in the U.N. Disarmament Commission in Geneva. *See* Rep. of the Disarmament Comm'n: Review of the Implementation of the Recommendations and Decisions Adopted by the General Assembly at its Tenth Special Session, U.N. Doc. A/51/182/Rev.1, at 53 (June 9, 1999) (Guidelines and Recommendations for Objective Information on Military Matters); *United Nations Disarmament Commission*, U.N. Off. for Disarmament Affs., https://www.un.org/disarmament/institutions/disarmament-commission/ [https://perma.cc/E5J9-5JWY].

[168] *See* Lyall & Larsen, *supra* note 2, at 14–18. UNCOPUOS is supported by the UNOOSA, which supports the Committee and its legal and technical subcommittees, administers the space law treaties, maintains the registry of space law objects, and administers the Disaster Charter as well as UN-SPIDER. *See Roles and Responsibilities*, U.N. Off. for Outer Space Affs., https://www.unoosa.org/oosa/en/aboutus/roles-responsibilities.html [https://perma.cc/4ZC8-CWHU].

[169] *See Committee on the Peaceful Uses of Outer Space*, U.N. Off. for Outer Space Affs., https://www.unoosa.org/oosa/en/ourwork/copuos/index.html [https://perma.cc/MBS7-RRX6]; sources cited *supra* note 1 (list of the five treaties).

[170] *See, e.g.*, UNCOPUOS Adoption, *supra* note 33, ¶ 11 (referring to U.N. GAOR, 75th Sess. Supplement 20, ¶ 11, U.N. Doc. A/75/20 (Oct. 12, 2020)).

[171] G.A. Res. 70/1, ¶ 18 (Sept. 25, 2015).

[172] *See* Peter Martinez, *UN COPUOS Guidelines for the Long-Term Sustainability of Outer Space Activities: Early Implementation Experiences and Next Steps in COPUOS*, *in* Proceedings of the 71st International Astronautical Congress (IAC) – The

a. Guidelines for Long-Term Sustainability of Space Relating to Space Traffic Management

The LTS Guidelines are currently the only internationally agreed guidelines for establishing long-term economic stability and order in the outer space marketplace.[173] They build on the existing international legal framework, particularly the OST.[174] All the space powers—the U.S., China, Russia—and the developing nations adopted the LTS Guidelines by consensus.[175] Therefore, the LTS Guidelines represent the consequences of New Space. They represent a shared understanding by all parties. They are voluntary guidelines, but all states agreed to adopt them as national rules to the extent feasible and practicable.[176] When they are adopted and enforced by individual states, the LTS Guidelines will make outer space more economically secure for space commerce and improve safety, for example, through safe STM.[177] Moreover, the LTS Guidelines are forward-looking and allow for updates as New Space develops. The following LTS Guidelines provisions relate to commercial space. They provide that the states will:

1. maintain regulatory guidelines to improve the long-term sustainability of commercial space safety, reliability, liability, and related cost;[178]

2. adopt and enforce U.N. space debris mitigation guidelines, minimize environmental impact of human activities, minimize cost of compliance with government regulations, and seek input from advisory groups;[179]

3. enable and supervise compliance by commercial space activities with LTS Guidelines, establish uniform safety and reliability

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CYBERSPACE EDITION, 12-14 OCTOBER 2020 (2020), https://swfound.org/media/207080/iac2020_e341_lts_guidelines_early_implementation_experiences.pdf [https://perma.cc/2UWA-GC84].

[173] LTS Guidelines, *supra* note 38. Note strong endorsement of the LTS Guidelines by the European Space Traffic Management Conference July 2021. *European STM Report*, *supra* note 3, at 3.

[174] *See* LTS Guidelines, *supra* note 38, at 3.

[175] In 2019, the U.S. and all the other members of the Committee for Peaceful Uses of Outer Space agreed on the existing LTS Guidelines. *See* Foust, *supra* note 32.

[176] LTS Guidelines, *supra* note 38, at 4.

[177] UNCOPUOS Adoption, *supra* note 33, ¶ 12; SPACE AGENDA 2021, *supra* note 38, at 2.

[178] *See* LTS Guidelines, *supra* note 38, at 9–10 (Guideline A.1).

[179] *See id.* at 10–11 (Guideline A.2).

procedures, promote long-term sustainability of space, and encourage data sharing by commercial entities.[180]

4. allocate radiofrequencies and related orbits to commercial space equitably, rationally, and efficiently as required by ITU Constitution Articles 44 and 45[181] and ensure removal of defunct commercial space objects from orbits;

5. arrange space object registration of commercial space objects prior to launch as required by the Registration Convention and by U.N. General Assembly resolutions 1721 B (XVI) and 62/101, including eventual removal of commercial space objects at the end of service;[182]

6. monitor space traffic and exchange space safety-related data with other governments and the UNOOSA[183] regarding governmental as well as non-governmental space traffic and make assessments of collision dangers, consequent loss of life, damages, and environmental deterioration;[184]

7. perfect and promote the accuracy of satellite tracking and sensing techniques and the distribution of collected data using uniform standards;[185]

8. perfect and promote space debris tracking and the distribution of collected data using uniform standards;[186]

9. evaluate and continually assess, as part of the governmental authorization process required by Article VI of the OST, the collision dangers of all maneuverable space objects;[187]

10. encourage the assessment of collision dangers before authorizing launches as well as collect and exchange related information about collision dangers using uniform standards;[188]

11. collect and promote the collection of weather information and its impact on space activities, and adopt government policies supporting space weather forecasting;[189]

12. establish practices for collection, reporting, and researching weather information, and encourage satellite operators to participate;[190]

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[180] *See id.* at 11–13 (Guideline A.3).

[181] *See id.* at 13–14 (Guideline A.4); *see also* ITU Constitution, *supra* note 147, arts. 44–45.

[182] *See* LTS Guidelines, *supra* note 38, at 14–16 (Guideline A.5).

[183] *See id.* at 19–20. The LTS Guidelines recommend establishment of a databank in UNOOSA. *See id.*

[184] *See id.* (Guideline B.1).

[185] *See id.* at 20–21 (Guideline B.2).

[186] *See id.* at 21 (Guideline B.3).

[187] *See id.* at 21–22 (Guideline B.4).

[188] *See id.* at 22–23 (Guideline B.5).

[189] *See id.* at 23–25 (Guideline B.6).

[190] *See id.* at 25–26 (Guideline B.7).

13. promote the design of space objects—particularly small space objects—so that they can easily be tracked and avoided;[191]
14. adopt procedures for managing the uncontrolled reentry of space objects, share information, and provide assistance before, during, and after such events;[192]
15. adopt precautions to avoid damaging space objects when sending laser beams through outer space;[193]
16. include the private sector in their promotion of international cooperation and capacity building;[194]
17. include non-governmental entities that will share their experiences with developing countries in maintaining long-term sustainability of outer space activities;[195]
18. include education, training, sharing of information and technology, and disaster management in capacity building of commercial space;[196]
19. include commercial space operators in outreach to developing countries to give educational seminars, distribute guidelines, and explain available services and regulations, including space debris mitigation, complying with ITU rules on harmful interference, and avoiding environmental damages;[197]
20. encourage commercial space to conduct business in support of sustainable scientific and technical research on outer space;[198] and
21. encourage commercial space to prevent collisions in outer space and to consider new ways of controlling and mitigating space debris in the long term.[199]

b. Evaluation of Guidelines for Long-Term Sustainability of Space Relating to Space Traffic Management

Stability generally encourages investments.[200] Hence, space commerce would benefit from stable, long-term economic conditions created by a safe operational environment uninter-

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191 *See id.* at 27 (Guideline B.8).

192 *See id.* at 27–29 (Guideline B.9).

193 *See id.* at 29 (Guideline B.10).

194 *See id.* at 31 (Guideline C.1).

195 *See id.* (Guideline C.2).

196 *See id.* at 32 (Guideline C.3); *see also* Paul B. Larsen, *The Oso Landslide: Disaster Management Law in the Space Age*, 40 WM. & MARY ENV'T L. & POL'Y REV. 335, 356–57 (2016) (providing that the Sendai conference participants can assist States in disaster risk reduction).

197 *See* LTS Guidelines, *supra* note 38, at 33–34 (Guideline C.4).

198 *See id.* at 37 (Guideline D.1).

199 *See id.* at 38 (Guideline D.2).

200 *See How the IMF Promotes Global Economic Stability*, INT'L MONETARY FUND (Mar. 8, 2021), https://www.imf.org/en/About/Factsheets/Sheets/2016/07/

rupted by collisions. Long-term economic stability is an objective that all stakeholders can agree on. The European Space Traffic Management Conference agreed that:

> Europe should work on the implementation of the existing voluntary LTS guidelines adopted by UNCOPUOS and could develop standards and good practices; this development would be gradual and incremental and should be based on the principle of reciprocity, so as not to penalize the competitiveness of the European space industry, and taking into account strategic issues as well.[201]

The LTS Guidelines are intended to implement and supplement the existing international legal framework established by the OST and other space law treaties and guidelines, such as the 2007 Space Debris Guidelines.[202] The LTS Guidelines include: (1) safety rules for authorizing commercial operations; (2) use of radio frequencies; (3) safety standards for outer space operations; (4) shared information about space debris; (5) assessment of collision risks; (6) shared weather information; (7) tracking of space objects; (8) information about possible uncontrolled reentry of defunct satellites; (9) cautions about possible laser beams disturbing satellite orbit; (10) provisions for education and assistance to developing states (capacity building); and (11) support for scientific research and development. The U.S. joined in the consensus to implement the voluntary LTS Guidelines to the extent practicable and feasible.[203] The U.S. should regularly refer to these in its administrative and legislative actions.

D. Current U.S. Commercial Space Regulations Relating to Space Traffic Management: Soft Law

Article VI of the OST includes non-governmental entities among the possible authorized users of non-sovereign outer

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27/15/22/How-the-IMF-Promotes-Global-Economic-Stability [https://perma.cc/WY49-AKB6].

[201] *See European STM Report*, *supra* note 3, at 3.

[202] *See* LTS Guidelines, *supra* note 38, at 10 (Guideline A.2).

[203] *See, e.g.*, Nicole Shampaine, Deputy Chief, U.S. Mission to Int'l Orgs. in Vienna, National Statement at the Committee on the Peaceful Uses of Outer Space 56th STSC (Feb. 11, 2019), https://vienna.usmission.gov/national-statement-at-the-committee-on-the-peaceful-uses-of-outer-space-56th-scientific-and-technical-subcommittee/ [https://perma.cc/8YVM-7THS] ("The United States hopes that States can begin voluntarily implementing [the LTS Guidelines] to the greatest extent practicable, consistent with their respective needs, conditions, and capabilities").

space.[204] When the U.S. permits non-governmental entities to do business in non-sovereign space, it agrees to make non-governmental entities subject to international space law provisions and continually supervise their compliance with the OST.[205]

1. Department of Transportation

As commercial space activities became significant in outer space in the 1970s and 1980s,[206] Congress adopted the 1984 Commercial Space Launch Act to administer commercial space access and supervise commercial space activities.[207] The Act gave the Department of Transportation (DOT) authority to license commercial launches subject to the OST terms and supervise their activities for actual compliance.[208] However, under 51 U.S.C. § 50901, the DOT legal authority is limited to: "[O]versee[ing] and coordinat[ing] the conduct of commercial launch and reentry operations, issu[ing] permits and commercial licenses and transfer[ing] commercial licenses authorizing those operations, and protect[ing] the public health and safety, safety of property, and national security and foreign policy interests of the United States."[209]

The Act also authorized the DOT with inspection and approval of payloads,[210] implementation of the OST,[211] promotion of safety in outer space,[212] and advancement of space commerce.[213] The DOT eventually redelegated its functions under the Commercial Space Launch Act to the FAA.[214] Safety admin-

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[204] OST, *supra* note 1, art. VI.

[205] *See id.*

[206] *See generally Origins of the Commercial Space Industry*, FED. AVIATION ADMIN., https://www.faa.gov/about/history/milestones/media/commercial_space_industry.pdf [https://perma.cc/V6HC-HD7E].

[207] Commercial Space Launch Act, 51 U.S.C. §§ 50901–50923.

[208] *See id.* § 50901(b)(3).

[209] *Id.*

[210] *See* 14 C.F.R. § 405.1 (2021). Payloads are reviewed to determine range safety certification, launch manifesting, launch commit criteria development, predicted tracking, pre-launch coordinates, post-launch early orbit determination, collision avoidance, prelaunch vetting and safety, including predicted conjunctions during launch windows, launches, and initial spacecraft orbit spatial allocation. *See id.* § 431.51(a); § 450.43(i); 51 U.S.C. § 50904(b).

[211] *See* 51 U.S.C. § 50919(e)(1).

[212] *See id.* § 50901(b)(3).

[213] *See id.* § 50901(b)(1)–(2).

[214] *See About the Office of Commercial Space Transportation*, FED. AVIATION ADMIN., https://www.faa.gov/about/office_org/headquarters_offices/ast/ [https://perma.cc/LUK5-WW7G] (Aug. 10, 2021, 6:06 PM).

istration was a natural task for the FAA because it already implemented safety regulations for aviation activities.[215] However, the task of promoting the outer space business was unusual.[216] Rapid technological growth, such as the repeated use of space launch rockets and greater availability of financial resources in the New Space Age, brought a significant increase in applications for launches.[217] The volume of FAA licensing activities has significantly increased during the New Space Age.[218] Whether the FAA has adequately separated its safety function from its business promotion functions and whether it has been given the resources to adequately impact the industry are important given the trajectory of commercial space.

The Commercial Space Launch Act did not provide the DOT authority to regulate commercial activities in outer space, such as mining on the Moon, which is currently an active business issue.[219] The U.S. Commercial Space Launch Competitiveness Act provides that:

> A United States citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States.[220]

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[215] *Safety First: Federal Aviation Administration*, U.S. DEP'T OF TRANSP., https://www.transportation.gov/briefing-room/safetyfirst/federal-aviation-administration [https://perma.cc/R5B7-S95Q] (May 2, 2018).

[216] *Cf. id.* ("The FAA regulates and encourages the U.S. commercial space transportation industry."). Bilateral and multilateral air service agreements are administered by a special division in the Office of the DOT Secretary, the Office of the Assistant Secretary for Aviation and International Affairs. *See Air Service Agreements*, U.S. DEP'T OF TRANSP., https://www.transportation.gov/policy/aviation-policy/international-relations/air-service-agreements [https://perma.cc/N3UN-Y72N] (Sept. 1, 2017).

[217] *See* Louis de Gouyon Matignon, *The History of Reusable Launch Systems*, SPACE LEGAL ISSUES (May 29, 2019), https://www.spacelegalissues.com/the-history-of-reusable-launch-systems/ [https://perma.cc/U8DL-3ME3]; Weinzierl & Sarang, *supra* note 35.

[218] The FAA Associate Administrator for Commercial Space Transportation reports that FAA licensing activities have increased 1,000% from 2012 to 2020 and expects this rate of increase to continue. NAPA REPORT, *supra* note 3, at 75.

[219] *See* Larsen, *supra* note 158, at 3–4 (stating that the United States', Europe's, and China's lunar mining efforts include consultation with commercial satellite operators).

[220] U.S. Commercial Space Launch Competitiveness Act § 402(a), 51 U.S.C. § 51303.

The Commercial Space Launch Competitiveness Act only authorized ownership.[221] It did not grant new licensing authority to the DOT to cover mining activities, for example. Thus, the Act did *not* authorize mining at designated locations on the Moon.

2. Department of Commerce

In the Land Remote Sensing Commercialization Act of 1984 and the Land Remote Sensing Policy Act of 1992,[222] Congress gave the DOC NOAA authority to license and oversee commercial remote sensing activities, subject to the receipt of launch authority from DOT FAA and use of radio frequencies by the FCC.[223] The DOC is otherwise primarily focused on promoting business, including commerce.[224] Some stakeholders expressed their concerns with the DOC favoring space business promotion over safety.[225] Under the Trump administration, the DOC became a strong advocate for the commercial space industry within the government.[226] White House policy statements asked Congress to pass laws authorizing the DOC to regulate STM.[227] The NAPA Report strongly supports the White House initiative, but Congress has not provided adequate funding for STM by the DOC.[228] Moreover, the Biden administration is expanding its re-

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[221] *See id.*

[222] Land Remote-Sensing Commercialization Act of 1984, 15 U.S.C. §§ 4201–4292 (repealed 1992); Land Remote Sensing Policy Act of 1992, Pub. L. No. 102-555, 106 Stat. 4163 (codified, as amended, at 51 U.S.C. § 60101 et seq.).

[223] *See* NAPA REPORT, *supra* note 3, at 22 (explaining briefly how the Land Remote-Sensing Policy Act empowered the DOC); MORGAN, *supra* note 71, at 1, 12.

[224] *See* NAPA REPORT, *supra* note 3, at 75.

[225] *See id.* at 98.

[226] *See* Space Policy Directive-2, *supra* note 10; Space Policy Directive-3, *supra* note 10.

[227] *See* Space Policy Directive-3, *supra* note 10.

[228] *See* NAPA REPORT, *supra* note 3, at 102; 51 U.S.C. § 50702(a) (establishing the Office of Space Commerce in the Department of Commerce in law approved August 6, 2021). Congress is not ready to assign responsibility for STM to the DOC. *See* Marcia Smith, *Senate Appropriators "Extremely Disappointed" with NOAA's Execution of STM Pilot Program*, SPACEPOLICYONLINE.COM (Oct. 19, 2021, 1:09 AM), https://spacepolicyonline.com/news/senate-appropriators-extremely-disappointed-with-noaas-execution-of-stm-pilot-program/ [https://perma.cc/3PG8-25FP]. Congress appropriated funding for a DOC STM pilot program in the Senate Appropriation Bill for 2022, but the bill also expressed that the Committee is "extremely disappointed" with the execution of the pilot program and recommends improved oversight. *See id.* The House has not acted yet.

view of the NAPA Report, so the U.S. government regulation of STM remains in flux.[229]

NOAA's National Environmental Satellite, Data, and Information Service collects and distributes weather information from outer space.[230] The New Space Age has also brought a significant increase of applications to NOAA.[231] The DOC has established an Office of Space Commerce (OSC) within NOAA, with an objective to promote U.S. space commerce.[232] The OSC is directed "to develop STM technical prototypes, initiate an open architecture data repository, and perform STM demonstrations and experiments."[233] However, the OSC has not been moved from NOAA into the Office of the Secretary of Commerce and has not been fully funded by Congress as of the time of writing.[234]

3. Federal Communications Commission

The Communications Act establishes the independent FCC and implements the ITU Treaties.[235] The FCC allocates radio frequencies to commercial satellites in accordance with regulations established under federal law.[236] The FCC must also make findings of public interest and distribute frequencies to quali-

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[229] *See* Scott Pace, *NOAA Is Stalling U.S. Space Traffic Management*, SPACENEWS (June 18, 2021), https://spacenews.com/op-ed-noaa-is-stalling-u-s-space-traffic-management/ [https://perma.cc/3T67-RC4J]; Sandra Erwin, *Lawmakers Ask Biden Administration to Keep Oversight Committees in the Loop on Space Activities*, SPACENEWS (Mar. 6, 2021), https://spacenews.com/lawmakers-ask-biden-administration-to-keep-oversight-committees-in-the-loop-on-space-activities/ [https://perma.cc/36MM-QNSG].

[230] *What We Do*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.nesdis.noaa.gov/about/what-we-do [https://perma.cc/D6RQ-C924].

[231] *Cf.* NOAA BLUE BOOK: FY2022, NAT'L OCEANIC & ATMOSPHERIC ADMIN. 75 (2021) (NOAA streamlined its regulations in 2020 to reduce processing timeline and improve U.S. competitiveness.).

[232] *See* 51 U.S.C. § 50702(a), (c); NAPA REPORT, *supra* note 3, at 75.

[233] 116 CONG. REC. H7930 (daily ed. Dec. 21, 2020) (statement of House Appropriations Committee Chairwoman Lowey).

[234] *See* Marcia Smith, *Office of Space Commerce Wins Bigger Budget in FY2021, But Will Remain in NOAA*, SPACEPOLICYONLINE.COM, https://spacepolicyonline.com/news/office-of-space-commerce-wins-bigger-budget-in-fy2021-but-will-remain-in-noaa/ [https://perma.cc/ABT8-VN5L] (Dec. 22, 2020, 12:13 AM).

[235] *See* Communications Act of 1934 § 1, 47 U.S.C. § 151; *see also id.* § 303(n), (r).

[236] *See, e.g.*, *id.* § 331(a).

fied applicants accordingly.[237] The FCC recently finalized rules to manage space traffic as well.[238]

4. National Aeronautics and Space Administration

NASA's legislative assignment is to engage in civilian government activities[239] and only regulates civilian government space traffic.[240] Many of its activities are increasingly subcontracted to space commerce operators like SpaceX, and NASA exercises influence and control through subcontracting.[241] However, NASA does not regulate space commerce.

5. Department of Defense

The DOD regulates military space activities.[242] It operates the Global Positioning System that serves both civilian and military users.[243] The U.S. Air Force tracks all large space objects, whether functional or space debris, and the DOD provides valuable collision warnings to civilian users.[244] However, the U.S. Air Force's core mission should be to prevent collisions with military space objects. Tracking objects and warning civilian commercial space operators of potential conjunctions is costly and beyond its national security mission. The tracking service provided to the private sector is not inherently within the scope of the DOD's national security functions, except that it serves to avoid collisions with the increasing number of DOD satellites in LEO.[245]

DOD tracking of space objects related to national security would continue even if civilian space tracking were transferred to a civilian operator. Funding for space object tracking is part

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[237] *See id.* §§ 301, 307.

[238] Mitigation of Orbital Debris in the New Space Age, *supra* note 74; *see also* Paul B. Larsen, *Space Traffic Management – The Bin Cheng Model*, 44 J. SPACE L. 483, 494–95 (2020).

[239] *See generally* 51 U.S.C. § 20112 (setting out the functions of NASA).

[240] *See id.*; *see also* NAPA REPORT, *supra* note 3, at 94.

[241] *See, e.g.*, Christian Davenport, *Elon Musk's SpaceX Wins Contract to Develop Spacecraft to Land Astronauts on the Moon*, WASH. POST (Apr. 16, 2021, 6:18 PM), https://www.washingtonpost.com/technology/2021/04/16/nasa-lunar-lander-contract-spacex/ [https://perma.cc/3DWV-6KVT].

[242] *See* Erwin, *supra* note 52.

[243] U.S. GOV'T ACCOUNTABILITY OFF., GAO-21-145, GPS MODERNIZATION: DOD CONTINUING TO DEVELOP NEW JAM-RESISTANT CAPABILITY, BUT WIDESPREAD USE REMAINS YEARS AWAY 3 (2021).

[244] *See* sources cited *supra* notes 81–82 and accompanying text.

[245] *See* NAPA REPORT, *supra* note 3, at 71–72. Commercial space is sensitive to the DOD's fixation on classified tracking. *See id.* at 4.

of and would remain a part of the DOD operating budget provided by Congress.[246] However, if the DOD would like to transfer the monitoring of commercial space objects over to a civilian agency,[247] it would have to overcome Congress's reluctance to provide funding for an expensive, separate, major civilian tracking service.[248] Thus, the DOD remains heavily involved in tracking space objects for the safety of both civilian and military objects.[249] The DOD subcontracts many space activities and influences space commerce through contracting,[250] but the DOD does not regulate space commerce.

6. Department of State

The Department of State is primarily responsible for administering and enforcing U.S. treaty obligations under the space law treaties.[251] It oversees the registration of non-governmental satellites into the international registry established by the Registration Convention.[252] The State Department also represents the U.S. in international organizations such as UNCOPUOS,[253] but it does not regulate domestic space commerce.

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[246] *Id.* at 81.

[247] *See id.* at 3.

[248] The Air Force requested additional appropriation for the Space Force, thereby indicating the renewal of CSpOC rather than the opposite. *See* Frank Wolfe, *U.S. Space Force Requests $800M Increase in R&D, $456M More for Acquisition*, VIA SATELLITE (June 1, 2021), https://www.satellitetoday.com/government-military/2021/06/01/u-s-space-force-requests-800m-increase-in-rd-456m-more-for-acquisition/ [https://perma.cc/AQD6-P6WY]. The 2021 Consolidated Appropriations Act appropriated $10 million for the DOC Office of Space Commerce to (1) initiate STM pilot program; (2) develop STM prototypes; (3) initiate open architecture bank; and (4) perform STM demonstrations and experiments. S. COMM. ON APPROPRIATIONS, 116TH CONG., DIVISION B—COMMERCE, JUSTICE, SCIENCE, AND RELATED AGENCIES APPROPRIATIONS ACT 41 (Comm. Print. 2021).

[249] *See* NAPA REPORT, *supra* note 3, at 1.

[250] *See generally Contracts for Aug. 7, 2020*, U.S. DEP'T OF DEF., https://www.defense.gov/News/Contracts/Contract/Article/2305454/ [https://perma.cc/33QC-39QV].

[251] *See* NAPA REPORT, *supra* note 3, at 25.

[252] *See id.*

[253] *Id.*

IV. THE FUTURE: U.S. GOVERNMENT COMMERCIAL SPACE POLICY

A. Policy Formation: First Steps

The rapidly changing environment means that the U.S. should form a new U.S. policy on safety in outer space. The New Space Age's growth of outer space congestion makes all interested stakeholders acutely aware of the increasing danger of collisions.[254] A similar safety situation existed in aviation in 1956 at the time of the Grand Canyon collision between two major passenger airlines.[255] It was not until after that catastrophe that better aviation traffic oversight emerged. But why wait for that to happen in space traffic? At the moment, there is an urgent need to establish collision avoidance rules and provide traffic oversight for outer space.

Outer space is inherently international because it is non-sovereign. This particular characteristic emphasizes the need for clear international rules of the road. The OST covers the management of authorized space objects in orbit.[256] Soft law international guidelines such as the 2007 Space Debris Guidelines and the LTS Guidelines are valuable only if (1) they are kept up to date as traffic increases and (2) states diligently adopt them as mandatory domestic regulations. Hesitation and delays in adopting international space traffic rules cause individual states—like the U.S.—and groups of states to prepare diverging regulations for their space traffic. For example, the ESA is already working on STM for Europe.[257] The other two major space powers, China and Russia, are increasingly moving toward their versions

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[254] *See* discussion *supra* Section II.A.

[255] The Federal Aviation Administration and the National Transportation Safety Board were established by Congress after the Grand Canyon collision between TWA and United Airlines passenger airplanes in order to update the U.S.'s "antiquated air traffic control system." Eileen Bjorkman, *The Tragic Mid-Air Plane Crash That Changed the American Aviation Industry Forever*, Time (Sept. 1, 2020, 12:00 PM), https://time.com/5885096/airplane-collision-history [https://perma.cc/8ZS8-HQYH]. There were 127 mid-air collisions in the U.S. between 1948 and 1955. *Id.*

[256] *See* OST, *supra* note 1, art. VI ("The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty.").

[257] *See, e.g.*, *European STM Report*, *supra* note 3, at 2; ESA's Annual Space Environment Report, *supra* note 5, at 8.

of STM.[258] The United States' separate views of space traffic motivated the 2020 NAPA Report to seek funding for STM from Congress.[259] Diverging national and international traffic rules are reminiscent of the United Kingdom's and former British Empire members' traffic rule to drive on the left side of the road. In contrast, other international and national rules provide for driving on the right side of the road. Likewise, the current budding rules pose a dangerous drift towards parallel but incompatible traffic rules for international space traffic.

The National Space Council (Council) established U.S. space policy.[260] The Council was revived in 2017 by the Trump administration, and the Biden administration has decided to renew the Council.[261] President Biden appointed Vice President Kamala Harris to chair the Council[262] and Chirag Parikh as the new Executive Secretary.[263] For its policy review, the Council will study past policies and make adjustments in accordance with the space policies of the new administration.[264]

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[258] *See generally* Brian G. Chow, *Space Traffic Management in the New Space Age*, STRATEGIC STUD. Q., Winter 2020, at 74. The diverging unilateral STM initiatives disregard the fact that "we face a crisis that must be urgently addressed in order to facilitate orbital safety and enhance commercial and research advances." NAPA REPORT, *supra* note 3, at 1.

[259] NAPA REPORT, *supra* note 3, at 7, 83.

[260] *See generally* Exec. Order No. 13,803, 82 Fed. Reg. 31,429 (June 30, 2017), *as amended by* Exec. Order No. 13,906, 85 Fed. Reg. 10,031 (Feb. 13, 2020) (reviving the National Space Council).

[261] Sandra Erwin, *Biden Administration to Continue the National Space Council*, SPACENEWS (Mar. 29, 2021), https://spacenews.com/biden-administration-to-continue-the-national-space-council/ [https://perma.cc/N7SG-KD6B]; Stephen Clark, *Biden Administration Renews Mandate for National Space Council*, SPACEFLIGHT NOW (Mar. 30, 2021), https://spaceflightnow.com/2021/03/30/biden-administrations-renews-mandate-for-national-space-council/ [https://perma.cc/WQU9-GA2H].

[262] Jasmine Wright, *Harris to Chair the National Space Council*, CNN, https://www.cnn.com/2021/05/01/politics/kamala-harris-chair-national-space-council/index.html [https://perma.cc/3ZW5-TALF] (May 1, 2021, 3:53 AM).

[263] *See* Jeff Foust, *Parikh Named Executive Secretary of National Space Council*, SPACENEWS (Aug. 2, 2021), https://spacenews.com/parikh-named-executive-secretary-of-national-space-council/ [https://perma.cc/6EGY-6S65].

[264] *See* NATIONAL SPACE POLICY OF THE UNITED STATES OF AMERICA 12 (2020), https://www.globalsecurity.org/space/library/policy/national/national-space-policy_20201209.pdf [https://perma.cc/J8R9-AKPD]; Marcie Smith, *National Space Council Priorities Begin to Emerge*, SPACEPOLICYONLINE.COM (Sept. 9, 2021, 10:45 PM), https://spacepolicyonline.com/news/national-space-council-priorities-begin-to-emerge/ [https://perma.cc/26UQ-TEFX].

B. The National Space Transportation Policy of the Obama Administration

The 2013 Policy Statement issued by President Obama acknowledged that compliance with U.S. law and regulations, treaties, and other international regulations is the foundation for U.S. regulation of commercial space.[265] Toward that objective, President Obama placed NASA in charge of space exploration, assigned the DOD with responsibility for national security, and charged the DOC with the regulation of remote sensing satellites and support for regulatory activities of other government agencies.[266]

The DOT bore many responsibilities under the policy statement. Among them, the DOT issued launch licenses; supervised non-governmental satellite launches and reentries; promoted commercial space; required licensed commercial operators to share liability risks with the U.S. government; promoted the establishment of international safety, interoperability standards, and recommended practices; and was tasked with developing orbital debris mitigation practices through its licensing procedures.[267]

C. The Trump Administration's Space Policy

The 2018 Trump White House Policy Directives favored a light touch of government regulation of space commerce.[268] White House Policy Directive-2 adopted streamlining commercial space decision-making by the DOT, DOC, DOD, NASA, and the FCC.[269] It intended to reorganize the DOC so it could take the lead in space commerce regulation.[270]

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[265] *See* National Space Transportation Policy, NASA 8 (2013), https://www.nasa.gov/sites/default/files/files/national_space_transportation_policy_11212013.pdf [https://perma.cc/ZL2A-ZR4M]. The policy was later modified by the National and Commercial Space Programs Act. 51 U.S.C. §§ 10101–71302.

[266] *See* National Space Transportation Policy, *supra* note 265, at 26.

[267] *Id.* at 5.

[268] *See, e.g.*, NAPA Report, *supra* note 3, at 2. Corporate social responsibility "should be viewed as a complement to, rather than a substitute for, increasingly effective government regulation." *See* Forest L. Reinhardt, Robert N. Stavins & Richard H. K. Vietor, *Corporate Social Responsibility Through an Economic Lens*, 2 Rev. Env't Econ. & Pol'y 219, 236 (2008).

[269] *See* Space Policy Directive-2, *supra* note 10, §§ 2(d), 3(b).

[270] *Id.* § 4.

White House Policy Directive-3 reinforced the policy proposal for the DOC to lead.[271] It prescribed that the DOC shall (1) maintain a database of space objects, (2) establish international data standards, (3) distribute space object tracking data to national and international operators, (4) improve the description of orbiting space objects, (5) establish standards for the assessment of possible collision dangers, and (6) develop operating guidelines for large constellations to be used in authorizing and supervising commercial space.[272] Furthermore, the Trump administration tasked the DOC to develop an Earth observation and preservation plan and distribute observed traffic data.[273]

D. The 2020 National Academy of Public Administration Report

The NAPA Report must be read with the knowledge that the policies it is based on are shifting.[274] The NAPA Report, ordered by the DOC and completed before the 2020 election, could not have considered the possible changes that the Biden administration might require. The NAPA Report recommends a light touch governmental regulation of commercial space,[275] views STM as "a data management function, rather than principally as a task of managing space traffic,"[276] and describes the study as "an independent, unbiased assessment."[277] The NAPA Report, having been prepared during the Trump administration, was strongly influenced by the two White House Policy Directives that had been previously adopted, which advocated for DOC to be the lead administrative agency.[278] The NAPA Report notably concludes with a request that Congress adopt legislation authorizing and funding the DOC to become the lead agency.[279]

The NAPA Report recognizes that present collision avoidance is insufficient.[280] Currently, satellite operators use Space Situa-

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[271] *See* Space Policy Directive-3, *supra* note 10, § 6(c).

[272] *See id.* §§ 5–6.

[273] *See id.*

[274] The NAPA Report was guided by the White House policy statements, treating them as thoroughly vetted within the administration. In reaching its conclusions, the NAPA Panel used the Institutional Analysis and Design framework. NAPA Report, *supra* note 3, at 13; *see also supra* note 26 and accompanying text.

[275] NAPA Report, *supra* note 3, at 2.

[276] *Id.* at 3.

[277] *Id.* at 2, 10.

[278] *Id.* at 35.

[279] *See id.* at 102. Congress has not supported the desired reorganization.

[280] *Id.* at 70.

tional Awareness to identify collision dangers.[281] Collision safety will require better tracking of both satellites and debris and the adoption of active STM services.[282] While recognizing that STM is urgently needed, the NAPA Report proposes to rely on private contractors for additional STM services, requiring the establishment of a "fee-for" service for activities beyond basic services.[283] The DOT and the FAA presently perform the collision avoidance management tasks but are limited under 51 U.S.C. § 50901.[284] If the NAPA Report recommendations were followed, FAA oversight at the licensing and oversight stages would be weakened by the DOC's promotional considerations.[285]

E. Evaluation of the NAPA Report

1. The NAPA Report's Failure to Recognize the Outer Space Treaty

The OST forms the legal basis for unilateral U.S. government STM, and unilateral national laws must comply with the OST.[286] Article VI of the OST commits all the states to ensure that commercial operators comply with the OST.[287] The OST places a long list of conditions on space activities by all operators.[288] Besides the space law treaties, the U.S. government has agreed to implement soft laws such as the 2007 Space Debris Guidelines and the LTS Guidelines to the most feasible and practicable extent.[289]

The NAPA Report did not mention other pertinent international arrangements. For example, it fails to mention the four Global Navigation Satellite Systems currently available for use—the U.S. Global Positioning Service, Russia's GLONASS, the European Union's Galileo, and China's BeiDou[290]—and their in-

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[281] *See id.* at 51. Space Situational Awareness requires an examination of satellites and space environments necessary for sustainable, safe, and stable operation. *See id.*

[282] *See id.* at 70.

[283] *See id.* at 78.

[284] *See* 51 U.S.C. § 50901(b)(3).

[285] DOC leadership would rely on risk management for space commercial market development. *See* NAPA Report *supra* note 3, at 96.

[286] *See* OST, *supra* note 1, art. VI; Lyall & Larsen, *supra* note 2, at 53 (explaining the OST).

[287] *Id.*

[288] *See id.* art I.

[289] 2007 Space Debris Guidelines, *supra* note 67; LTS Guidelines, *supra* note 38; *see also* supra note 203.

[290] Paul B. Larsen, *International Regulation of Global Navigation Satellite Systems*, 80 J. Air L. & Com. 365, 366–70 (2015).

teroperability.[291] Another example, the ITU treaties, and most fundamentally the ITU Constitution, regulate the use of radio frequencies and the avoidance of harmful interference when using radio frequencies to maneuver orbiting satellites.[292]

2. *NAPA's Failure to Consider Essential Implementation of the Outer Space Treaty*

The light touch space traffic management recommended by the NAPA Report fails to implement the outer space treaties fully. Congress has not implemented outer space commercial activities on celestial bodies. By its inaction, Congress has failed to select a U.S. government agency to authorize commercial activities in outer space, such as granting licenses to engage in mining at designated locations on the Moon. The legal problem is that Article II of the OST prohibits the national appropriation of outer space by claim of sovereignty, use, or any means whatsoever.[293] Congress now needs to adopt legislation granting a government agency the power to authorize commercial uses of outer space; however, such legislation must comply with the OST, and the U.S. implementing language must accord with the common interpretations of other states party to the OST.[294] The recent U.S. commercial confrontations with China and Russia over promising space technology make such conflicts likely.[295] The assertion of rights to exclusive mining sites on the Moon is another illustration of a potential conflict.[296] The NAPA Report did not consider conflicting STM regulations among states, yet these conflicts need to be resolved.

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[291] *See id.* at 403, 406, 409, 413.

[292] *See* ITU Constitution, *supra* note 147, arts. 44, 45.

[293] OST, *supra* note 1, art. II.

[294] "A treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose." Vienna Convention on the Law of Treaties, art. 31(1), May 23, 1969, 1155 U.N.T.S. 331, 340.

[295] *See, e.g.*, Greg Autry, *Beijing's Fight for the Final Frontier*, FOREIGN POL'Y (Apr. 2, 2019, 8:00 AM), https://foreignpolicy.com/2019/04/02/beijing-is-taking-the-final-frontier-space-china/ [https://perma.cc/97KM-VU4Z]; Clay Dillow, *America's Weapon in the US-Russia Space War*, CNBC, https://www.cnbc.com/2014/06/17/americas-weapon-in-the-us-russia-space-war.html [https://perma.cc/6TYM-G37S] (June 18, 2014, 12:44 PM).

[296] *See* Larsen, *supra* note 158, at 9.

3. The NAPA Report's Assumption That Promotion of Space Commerce Rather Than Safety in Outer Space Is the Most Important Element in Government Regulation

The NAPA Report envisions that the DOC, as lead agency, would act as an advocate for the space industry.[297] Consequently, the NAPA Report recommends that the DOC becomes the main U.S. government regulatory agency for outer space.[298] The NAPA Report recommends that STM regulation use a light touch approach consisting of traffic data management.[299]

If the light touch was put into practice, STM would depend on space commerce operators regulating themselves to the greatest possible extent.[300] Self-regulation invites multiple headaches. First, STM would likely be based on national and possibly international standards and recommended practices because of inevitable coordination with other space commerce operators worldwide. Questions then arise whether foreign space operators should be tracked. Would there be a consortium of private third-party operators of different nationalities? Second, tracking space objects would be accomplished using third-party contractors, and the individual entities would have to cover the cost of STM services.[301] The cost of private tracking (if possible) would be considerable, if not prohibitive. Third, though DOD tracking would continue, it would become solely directed at military targets. The perceived self-regulated STM scheme still faces the obstacle of Congress's approval to fund civilian tracking activities.

In sum, the Biden administration will likely have different priorities that will change the supporting foundation assumed by

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[297] NAPA REPORT, *supra* note 3, at 64 (indicating that the DOC will act "as an industry advocate within the Executive Branch."); *see also id.* at 83.

[298] *See id.* at 4.

[299] *See id.* at 2, 3. Interestingly, the NAPA Report expresses confidence that space data management will be encrypted, so that it will be secure from jamming and spoofing. *See id.* at 72. The recent Solar Winds experience with failed encryptions may undermine that experience. *See* Dina Temple-Raston, *A 'Worst Nightmare' Cyberattack: The Untold Story of the SolarWinds Hack*, NAT'L PUB. RADIO (Apr. 16, 2021, 10:05 AM), https://www.npr.org/2021/04/16/985439655/a-worst-nightmare-cyberattack-the-untold-story-of-the-solarwinds-hack [https://perma.cc/4RW5-QZAM]; *see also* Paul B. Larsen, *Will Harmful Interference Bring GPS Down?*, 86 J. AIR. L. & COM. 3, 41 (2021).

[300] NAPA REPORT, *supra* note 3, at 98 ("A minority of [stakeholders/experts] express concerns about the Department's lack of regulatory experience and its ability to balance regulatory (safety) and business promotion.").

[301] *See id.* at 78.

the NAPA Report. More importance should be given to the improvement of the congestive environment of outer space. Advocacy of, and support for, the policies recommended by the NAPA Report had the strong support of the former Secretary of Commerce, but the Department has new leadership. The NAPA Report's prevalence of commercial promotion over the critical and deteriorating outer space safety situation caused by the congestion in outer space should serve as sufficient cause for reevaluation of the policy.

4. Failure to Consider All Stakeholders

The NAPA Report recommends that the needs of all stakeholders must be taken into consideration in establishing new collision-avoidance management.[302] However, the study mainly focused on the needs of U.S. space commerce.[303] The NAPA Report appears to advocate for space commerce and discount all international and national interests of many stakeholders[304] such as astronomers and scientists.[305]

The NAPA Report also fails to mention the special rights of the developing countries that are protected under the OST.[306] It does not consider other countries' broad interests under the OST, the Liability Convention, or the Registration Convention. It acknowledges the international nature of outer space,[307] but it fails to acknowledge the soft law international regulations, such as the 2007 Space Debris Guidelines and the LTS Guidelines.

5. Competitive Interests Within the Space Commerce Industry

Information must be shared for successful STM, and the NAPA Report favors an open, "non-proprietary architecture" approach to traffic data in collective data banks.[308] This is difficult to arrange because proprietary information is valuable to the owners and must be protected. To illustrate, the 2021 agreement between NASA and SpaceX (Starlink) includes data shar-

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[302] *See id.* at 7–8.

[303] *See id.* at 47.

[304] For a more extensive discussion of stakeholders, see Larsen, *supra* note 19.

[305] *See* Larsen, *supra* note 19, at 13–15; discussion *supra* Section II.D. Note the priority of space exploration in Article I of the OST.

[306] *See* OST, *supra* note 1, art. I ("[Space exploration] shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.").

[307] NAPA REPORT, *supra* note 3, at 47–48.

[308] *Id.* at 71.

ing to avoid collisions and shares important STM information about satellite launch dates, target orbits, trajectories, and proximity to the ISS.[309] However, the agreement extensively restricts intellectual property and proprietary data rights from being shared.[310] Thus, parties in traffic sharing agreements will logically want to restrict STM-related information that contains essential business information. That means the data collected by the OST operators that goes to the essence of their business will not be shared. Therefore, competing commercial space operators cannot share much of their information.

STM information is currently collected and distributed to its subscribers by the Space Data Association, but the information does not satisfy the needs of effective international STM.[311] Nor can the commercial space operators be expected to establish and operate a sophisticated space-object tracking operation like the one the DOD currently manages. An experienced, technically knowledgeable, and neutral government agency like the FAA is best equipped to develop a tracking operation. The advantage of an independent body that is not subject to competition considerations will become increasingly apparent as satellites begin to collide as they are predicted to do.[312]

6. The NAPA Report's Confusion About Likelihood of Collisions in Outer Space

The NAPA Report concludes that a collision in outer space is "unlikely."[313] That conclusion conflicts with many stakeholders' views that outer space is in a crisis and that collision with space debris is highly probable.[314] It is known that space debris will frequently collide with other space debris.[315] Furthermore, colli-

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[309] *See* NASA AGREEMENT WITH SPACEX, *supra* note 11, art. 4.

[310] *See id.* art. 9. Proprietary data is defined as "[d]ata embodying trade secrets developed at private expense or commercial or financial information that is privileged or confidential, and that includes a restrictive notice." *Id.*

[311] Peterson et al., *supra* note 40, at 8 ("Current capabilities will be challenged to meet the demands of future space operators. Without sufficient data quality, the false alarm rates will be too high for an effective STM system to function.").

[312] *See* ESA'S ANNUAL SPACE ENVIRONMENT REPORT, *supra* note 5, at 3, 8.

[313] NAPA REPORT, *supra* note 3, at 54.

[314] *See, e.g.*, Kessler & Cour-Palais, *supra* note 68, at 2637, 2640; Roulette, *supra* note 8; Kramer, *supra* note 26; EUR. SPACE AGENCY, *supra* note 26.

[315] *See FAQ: Frequently Asked Questions*, EUR. SPACE AGENCY, https://www.esa.int/Safety_Security/Space_Debris/FAQ_Frequently_asked_questions [https://perma.cc/A6JZ-XVMG] (explaining the Kessler Syndrome, which states that space debris of critical mass will fragment in further collisions leading to a cascading chain of activities).

sions such as that of the Cosmos and Iridium satellites have already happened and indicate a higher probability of collision than the NAPA Report assumed.[316]

V. BEST WAY TO GO

A. The Fully Implemented Outer Space Treaty Is the Law

Following agreed-upon international laws that establish a rule-based order in outer space is beneficial and constitutionally required. Article VI of the U.S. Constitution provides that "all Treaties made, or which shall be made, under the authority of the United States, shall be the supreme Law of the Land."[317] Thus, the U.S. is obligated to observe the requirements of the OST and other international laws.[318] Despite references to the OST, the NAPA Report assumes that enforcement of treaty obligations is a matter of choice. However, it is the law—violations of the OST will lead to conflicting safety rules of the road and collisions in outer space. Other consequences include the risk that it could even lead to military engagements in outer space.[319] Outer space commerce will increasingly be subject to international guidelines and regulations, such as the 2007 Space Debris Guidelines, the LTS Guidelines, and future STM guidelines. When the guidelines are adopted as mandatory national regulations, they will require national enforcement. The department charged with legally authorizing and overseeing space commerce to ensure compliance with international law should be a neutral government agency and not a department preoccupied with promoting commerce.

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316 NAPA Report, *supra* note 3, at 37 ("While the expected value of destroyed wealth because of collisions is currently small because of the low probability of a collision, this price-tag can quickly become significant if future collisions result in runaway debris growth.").

317 U.S. Const. art. VI, cl. 2; *see also* Missouri v. Holland, 252 U.S. 416, 432 (1920). Treaties must be implemented by legislation unless they are clearly self-executing. Sei Fujii v. State, 242 P.2d 617, 620 (Cal. 1952).

318 *See, e.g.*, NAPA Report, *supra* note 3, at 22; IISL Statement, *supra* note 2.

319 The U.S. and other space powers now consider outer space to be a military domain. *See, e.g.*, William J. Broad, *How Space Became the Next 'Great Power' Contest Between the U.S. and China*, N.Y. Times, https://www.nytimes.com/2021/01/24/us/politics/trump-biden-pentagon-space-missiles-satellite.html [https://perma.cc/3792-6Q9R] (May 6, 2021).

B. New U.S. Legislation Required

The 1984 Commercial Space Launch Act only implements part of the OST Article VI authority to license non-governmental entities to use outer space.[320] The licensing of outer space activities is still to be authorized.[321] Therefore, new legislation should establish a separate government decision-maker other than the FAA to authorize and promote economic outer space licensing and supervision. In the interim, such authorization could be performed well by a separate DOT governmental office similar to the DOT office that handles airline economic issues.

In the long term, a separate space-business regulatory agency like the former Civil Aeronautics Board[322] may need to be charged with authorizing and supervising commercial uses of outer space, while the FAA maintains its authority to regulate launches and reentries. The regulatory agency would address growing commercial activities such as mining on celestial bodies.[323] Such authority should align with international law (particularly Article VI of the OST) in the same way the 1984 Commercial Space Launch Act did.[324]

C. FAA Regulation of Safety Enlarged

The FAA's responsibilities regarding space commerce safety regulation should be enlarged to include the supervision of traffic rules. Such responsibility should include the duty to track space objects if the decision is made to separate civilians from the military's (DOD) tracking of space objects. Space safety regulation should include safety issues relating to collisions between satellites and collisions between satellites and space debris. The possibility of space debris collision is a more serious issue because space debris cannot be maneuvered.

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[320] *See* Commercial Space Launch Act § 2(7), 51 U.S.C. § 50901(a)(7) (regulating launches, reentries, and services of non-governmental entities).

[321] Congress needs to authorize a government agency to license and supervise commercial space activities between launch and reentry. The authority should accord with applicable international law.

[322] *See generally A Brief History of the FAA*, Fed. Aviation Admin., https://www.faa.gov/about/history/brief_history/ [https://perma.cc/GJ7J-JQLN] (Jan. 4, 2017, 4:42 PM) (nothing that the Civil Aeronautics Board's responsibilities included "economic regulation of the airlines.").

[323] *See generally* Larsen, *supra* note 158, at 3–8.

[324] The new law should state that it complies with the international law obligations of the U.S. *See* Commercial Space Launch Act § 2(7), 51 U.S.C. § 50901(a)(7).

All economic-promoting regulations of commercial space should be removed from the FAA because of the inherent conflict between the safety and promotion of commerce.[325] The recent changes in the FAA safety regulations of launch and reentry operations,[326] which were changed to conform with the light touch policy of the Trump administration, also need to be reexamined.

Military space safety issues should remain outside and separate from the regulation of commercial space. International agreement on international safety rules for national military spacecraft would be complicated, if not impossible, to establish by negotiation. Dividing military and civil vehicles is a pragmatic solution demonstrated by the International Civil Aviation Organization (ICAO).[327]

Consequently, Congress should provide the FAA with the legal authority over all safety activities of commercial space operators. The FAA prioritizes safety. It focuses on the dangers of collision between space debris, other space traffic, and spacecraft's safe design and launch.[328] The FAA also manages the registration of space objects and the approval of payloads.[329] Safety is becoming the most important government function for nongovernmental operators because of the increasing congestion in LEO, in particular the growing collision dangers of space debris.[330] If the DOD must shift its tracking activities to a civilian agency, then the FAA is the agency with the most technical capa-

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[325] Outer space safety is often a matter of human survival as illustrated by the experience of the four astronauts on their way on a Space-X satellite to the Space station when they suddenly had to prepare for collision with space debris. *See* Kenneth Chang, *A Piece of Debris Whizzes Past the Crew Dragon*, N.Y. TIMES (Apr. 23, 2021), https://www.nytimes.com/2021/04/23/science/space-junk.html [https://perma.cc/FMB4-E3TZ].

[326] 14 C.F.R. § 450.169 (2021).

[327] *See ICAO*, INT'L CIVIL AVIATION ORG., https://www.icao.int/about-icao/Pages/default.aspx [https://perma.cc/K6Q2-EEU3]; *see also* ITU Constitution, *supra* note 147, art. 48 (allowing exclusion of military uses of radiofrequencies from ITU administration).

[328] *See generally* NAPA REPORT, *supra* note 3, at 123.

[329] *Payload Reviews*, FED. AVIATION ADMIN., https://www.faa.gov/space/licenses/payload_reviews [https://perma.cc/5BVZ-Z99M] (Jan. 28, 2020, 2:46 PM); NAPA REPORT, *supra* note 3, at 95 ("FAA leads space inter-agency coordination of registration and payload reviews.").

[330] The inherent conflict between joint regulation of safety and of commercial promotion is illustrated by the fiasco of the FAA taking business concerns into consideration in certifying the Boeing 737 MAX. *See* David Shepardson, *U.S. Audit Report Cites 'Weaknesses' in FAA Certification of Boeing 737 MAX*, REUTERS, https://www.reuters.com/article/us-boeing-737max/u-s-audit-report-cites-weaknesses-

bility for that task due to its experience with trafficking and collision avoidance maneuvers of airplanes. The FAA is the current administration's best choice to assume U.S. government leadership of STM, and the Council should therefore revisit this option.[331] What is needed is a separate FAA for outer space with the same responsibilities for space that the FAA has for control of air traffic.[332]

D. Adequate Budget Authority Provided by Congress

Managing the congestion and traffic crisis in outer space will require considerable government expenditures. Space commerce management at the national level is complicated because the territory is inherently international.[333] The NAPA Report proposes large-scale commercial space self-management and establishing an extensive fee-based system for private collision avoidance services.[334] Recall that the aviation experience with self-management of air traffic was disastrous;[335] the Grand Canyon aircraft accident triggered the establishment of the FAA.[336] Transferring that government response earlier is ideal because spacecraft and space objects travel faster than aircraft. Space traffic separation and collision avoidance are even more challenging than aviation traffic separation, and therefore calls for a central, knowledgeable body to regulate space activities proactively.

E. Environmental Protection of Outer Space

Outer space congestion—particularly the LEO congestion of space debris and prominent constellations of small satellites—and the scarcity of frequencies and orbits require more than the safety and economic oversight. It also requires environmental oversight similar to that provided by the Environmental Protection Agency over aviation. Environmental oversight may require environmental impact assessments of space and economic activi-

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in-faa-certification-of-boeing-737-max-idUSKBN2AO2P6 [https://perma.cc/6CD2-3PX7] (Feb. 24, 2021, 2:35 PM).

331 *See* NAPA Report, *supra* note 3, at 77. For recent U.S. Congressional development on the issue, see discussion *supra* note 228.

332 *See* Foust, *supra* note 9.

333 *See supra* notes 17–18 and accompanying text.

334 *See* NAPA Report, *supra* note 3, at 78.

335 *See* Bjorkman, *supra* note 255.

336 *See supra* note 255.

ties on celestial bodies.[337] Congress should legislate national oversight, and international bodies like UNCOPUOS must consider international protection of astronomical observations against space commerce activity.[338]

F. UNCOPUOS: Multilateral Versus Unilateral Space Traffic Management

By adopting the LTS guidelines, UNCOPUOS has begun to develop basic rules for the commercial exploitation of outer space. The UNCOPUOS Legal Subcommittee has started to discuss multilateral STM guidelines.[339] The 1979 Moon Treaty and ITU Radio Regulations would be useful precedents for the Subcommittee because they contain clear, detailed rules.[340] In the UNCOPUOS context, the Inter-Agency Space Debris Coordination Committee (IADC) international space debris mitigation guidelines could be a useful precedent for the similar coordination of international STM guidelines. The IADC authored the universally accepted 2007 Space Debris Guidelines.[341] The IADC is a coordination committee of thirteen major space powers, including the U.S. (NASA), Russia (the Roscosmos State Corporation for Space Activities (ROSCOSMOS)), China (the China National Space Administration (CNSA)), India (the Indian Space Research Organisation (ISRO)), and the ESA.[342] It is a small forum where the U.S., China, Russia, and the ESA can meet to negotiate specific space issues.[343] Since space debris is

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[337] *See supra* notes 159–160 and accompanying text.

[338] Several articles of the OST already provide environmental protection of outer space. *See* OST, *supra* note 1, arts. I, IV, IX.

[339] *See* UNCOPUOS Adoption, *supra* note 33, ¶ 12 ("The Subcommittee will consider the item on general exchange of views on the legal aspects of space traffic management . . . ."); Boucher, *supra* note 33.

[340] 1979 Moon Agreement, *supra* note 1 ("Taking into account the need to define and develop the provisions of these international instruments in relation to the moon and other celestial bodies, having regard to further progress in the exploration and use of outer space . . . ."); *see also id.* art. 11(5) ("State Parties to this Agreement hereby undertake to establish an international régime . . . to govern the exploitation of the natural resources of the moon . . . ."). An example provision in the ITU Constitution is that operators are only being assigned cleared radio frequencies. *See* ITU Constitution, *supra* note 147, arts. 1(2)(a), 14(2)(a), 44(2); Lyall & Larsen, *supra* note 2, at 210–18; *see also* Paul B. Larsen, *Space Traffic Management Standards*, 83 J. Air. L. & Com. 359, 369, 374 (2018).

[341] 2007 Space Debris Guidelines, *supra* note 67.

[342] *What's IADC*, Inter-Agency Space Debris Coordination Comm., https://iadc-home.org/what_iadc [https://perma.cc/GXG9-EEVF].

[343] *See id.*

the major STM issue, it could be considered within the scope of the IADC.

Although international standards are the goal, a lack of agreement among states will delay any issuance of a formal standard. The issue of diverging unilateral STM still threatens to manifest and cause conflicts and collisions. As the largest user of outer space, the U.S. has an excellent opportunity to influence the increasing number of foreign outer space users with its established STM practices and lead other countries to join in establishing a safe outer space business environment.

G. Establishment of an International Outer Space Agency

Space safety requires establishing a separate, international agency to coordinate and establish uniform international safety standards and recommended practices. UNCOPUOS is not an international regulatory agency capable of constant examination, establishment, and oversight of space safety guidelines for dealing with collision hazards in outer space. UNCOPUOS is a U.N. General Assembly Committee.[344] Its decisions are made by consensus, enabling one country to block even voluntary international rules such as space debris guidelines.[345] The present stalemate on the adoption of international STM guidelines regulating commercial exploitation of outer space resources impedes commercial activities and leads to military conflict. The absence of such an international agency leads states to issue unilateral regulations of outer space commercial activities. An international outer space agency similar to the ITU (which established intentional radio regulations and administered the International Frequency Registration Board) must be created. ICAO Standards and Recommended Practices for International Aviation would be a useful model for a spacecraft's orbiting nonsovereign outer space.[346] A separate international space safety agency that can make decisions quickly is needed, but UN-

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[344] *E.g.*, *Committee on the Peaceful Uses of Outer Space*, *supra* note 169.

[345] *See generally What Does It Mean When a Decision Is Taken "By Consensus"?*, U.N. Dag Hammarskjöld Libr., https://ask.un.org/faq/260981 [https://perma.cc/64Z6-FTLA] (Sept. 8, 2021).

[346] *See* Larsen, *supra* note 238, at 515–16; *The Need for an Integrated Regulatory Regime for Aviation and Space: ICAO for Space?*, *in* 17 Studies in Space Policy xii–xiii (Ram S. Jakhu, Tommaso Sgobba & Paul Stephen Dempsey eds., 2011).

COPUOS remains the international forum for multilateral STM decision-making until then.[347]

VI. CONCLUSIONS

The Presidential Space Council should reexamine the current drift toward unilateral rules of the road for non-sovereign outer space and should focus on negotiating common international rules of the road. Space traffic safety should be given precedence over the promotion of space commerce. The NAPA Report's recommendation to establish the light touch regulation of STM does not satisfy the current outer space safety. The responsibility of the FAA for space traffic safety should be reaffirmed and redefined to include other space safety responsibilities. The FAA's responsibility for promotion of space commerce should be reassigned to a different administration in the DOT, similar to the division of economics and safety in air transport. Space commerce industry must have a secure and safe space environment founded on rules-based order to compete fairly. However, non-governmental space commercial policy must be weighed in the context of other related U.S. national policy priorities. Fair competition for the space commerce industry must not result in the active governmental promotion of one stakeholder at the expense of other stakeholders. Science, astronomy, and the exploration of outer space must be given the attention it deserves.[348] New national priorities on climate change;[349] related solar energy options;[350] and policies on social, economic, and national security issues must also be weighed in establishing national STM policy.[351]

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[347] *See* UNCOPUOS Adoption, *supra* note 33, ¶ 12.

[348] *See* discussion *supra* Section II.D; *see also* Larsen, *supra* note 19, at 13–15 (discussing multiple reasons why scientists' and astronomers' continuing role in space exploration is important).

[349] *See* Exec. Order No. 14,008, 86 Fed. Reg. 7619, 7621 (Jan. 27, 2021); *see generally* Larsen, *Climate Change Management in the Space Age*, *supra* note 103, at 104.

[350] *See* LYALL & LARSEN, *supra* note 2, at 269–74.

[351] *See supra* Section II.F; *see also* Erwin, *supra* note 52.