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Minimum International Norms For Managing Space Traffic, Space Debris, and Near Earth Object Impacts

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**MINIMUM INTERNATIONAL NORMS FOR MANAGING
SPACE TRAFFIC, SPACE DEBRIS, AND NEAR
EARTH OBJECT IMPACTS¹**

PAUL B. LARSEN*

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¹ This article is founded on three earlier published research papers by the author, which will be cited:

- (1) Paul B. Larsen, *Space Traffic Management Standards*, 83 J. AIR L. & COM. 359 (2018) [hereinafter Larsen, *Space Traffic Management Standards*];
- (2) Paul B. Larsen, *Solving the Space Debris Crisis*, 83 J. AIR. L. & COM. (forthcoming Nov. 2018) [hereinafter Larsen, *Solving the Space Debris Crisis*];
- (3) Paul B. Larsen, *International Regulation of Near Earth Objects (NEOs)*, 67 ZLW 104 (2018) [hereinafter Larsen, *NEOs*].

It also addresses U.S. Space Policy Directive 3 (the Directive). See Memorandum on National Space Traffic Management Policy, 83 Fed. Reg. 28,969 (June 18, 2018) [hereinafter U.S. Space Policy Directive 3]. The Directive was developed by the Presidential Space Council, which was chaired by the Vice President and signed by the President on June 18, 2018. See also Justin Bachman, *Why Space Desperately Needs a Traffic Cop*, BLOOMBERG BUS. WK. (May 10, 2018), <https://www.bloomberg.com/news/articles/2018-05-10/why-low-earth-orbit-desperately-needs-a-traffic-cop> (last visited Oct. 16, 2018); Glenn Peterson et al., *Space Traffic Management in the Age of New Space*, AEROSPACE CORP. (Apr. 19, 2018), https://aerospace.org/sites/default/files/2018-05/SpaceTrafficMgmt_0.pdf [<https://perma.cc/W7RS-9BRX>].

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I. INTRODUCTION: CIVIL TECHNICAL NORMS FOR OUTER SPACE ACTIVITIES

“NEW SPACE” ARRIVED with the sudden prospect of thousands of small satellites being launched into orbit and the realization that space traffic management (STM), space debris, and Near-Earth Object (NEO) problems need to be resolved so that New Space activities can be safe.² Present-day commercial activities in outer space are changing the way we function extraterrestrially.³ Earth and our space-related infrastructure are threatened by traffic congestion, collisions with satellites and space debris, and NEOs.⁴ Technical norms must be developed so that commercial opportunities in outer space

² Peterson et al., *supra* note 1, at 2–3.

³ See Gbenga Oduntan, *Aspects of the International Legal Regime Concerning Privatization and Commercialization of Space Activities*, 17 *GEO. J. INT’L AFF.* 79 (2016).

⁴ See *Asteroids and Space Debris Come Together for the First Time*, EUR. SPACE AGENCY (June 13, 2018), http://www.esa.int/Our_Activities/Operations/Asteroids_and_space_debris_come_together_for_the_first_time [https://perma.cc/5H4P-GEBS].

can be realized and enlightening scientific exploration can continue.

Outer space is unique because no country can claim it; only international agreements can coordinate all the moving parts. This article examines the nature of those moving parts and proposes an international coordinating structure to establish and maintain technical international customs. Section I segregates economic and military issues from areas that are within the purview of the proposed technical norms. Section II states the benefits of technical norms. Section III explains the proposed norms. Section IV lists the individual stakeholders that will benefit from this proposition. Section V is a resumé of existing applicable international regulations affecting the proposed norms. Section VI describes possible models for a legal framework that could manage the necessary international norms. Finally, after discussing four potential models for managing the new customers, section VII recommends the International Civil Aviation Organization's (ICAO) model for organizing international technical norms.

Uniform norms for outer space activities received a significant boost when the United States issued U.S. Space Policy Directive 3 (the Directive) on June 18, 2018.⁵ The Directive recognizes the need for safety norms to protect growth and innovation in the commercial outer space sector.⁶ It will immediately affect American development of uniform STM and management of space debris. However, the Directive also supports ultimate international norms and standards⁷ and recommends technical guidelines, standards, behavior norms, risk assessments, and in-orbit collision avoidance service.⁸ It commits the United States to:

[d]evelop STM standards and best practices. As the leader in space, the United States supports the development of operational standards and best practices to promote safe and responsible behavior in space. A critical first step in carrying out that goal is to develop U.S.-led minimum safety standards and best practices to coordinate space traffic. U.S. regulatory agencies should, as appropriate, adopt these standards and best practices in do-

⁵ U.S. Space Policy Directive 3, *supra* note 1, at 28,969.

⁶ *Id.*

⁷ *See id.* at 28,970.

⁸ *See id.* at 28,971.

mestic regulatory frameworks and use them to inform and help shape international consensus practices and standards.⁹

It is emphasized that this article is about establishing *international technical safety norms*. These are norms to be implemented by countries world-wide so that everybody will be operating under the same rules to make outer space operations safer. The norms would not interfere with existing space law. For example, economic space exploitation would continue to be regulated by existing national laws and multilateral and bilateral treaties because economic exploitation of outer space is a separate issue from STM, space debris, and NEOs. This approach conforms with the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty)¹⁰ distinction between exploration of outer space and economic exploitation. Exploration is unrestricted, whereas other uses, including economic exploitation, are constrained.¹¹

The fundamental division between exploration and economic exploitation was not only established in the Outer Space

⁹ *Id.* The need for standardized international outer space practices has previously been considered in the context of international transparency of space situational awareness information. See David A. Koplow, *The Fault Is Not in Our Stars: Avoiding an Arms Race in Outer Space*, 59 HARV. INT'L. L.J. 331, 377–78 (2018). In particular, note the section entitled “Precedents for Shared SSA in Arms Control.” See *id.* at 379–82.

¹⁰ The relevant space law treaties include:

- (1) Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].
- (2) Convention on Registration of Objects Launched into Outer Space, Nov. 12, 1974, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter UN Registration Convention].
- (3) Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention].
- (4) Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 [hereinafter Rescue and Return Agreement].
- (5) Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 3 [hereinafter Moon Agreement].

¹¹ See generally FRANCIS LYALL & PAUL B. LARSEN, *SPACE LAW: A TREATISE* 54, 64 (2d ed. 2018).

Treaty;¹² exploitation was made subject to a separate international treaty by Article 11 of the 1979 Moon Agreement (Moon Agreement), which declared the Moon and celestial bodies subject to a special economic regulation.¹³ Although the Moon Agreement has been adopted by only eighteen states, putting economic exploitation into a separate category reflects the states' rationale expressed in the Outer Space Treaty and the Moon Agreement negotiations.¹⁴ The proposed international technical norms regarding space debris, space traffic, and NEO threat prevention, on one hand, and economic exploitation, on the other, may be viewed as separate explications of the Outer Space Treaty and the Moon Agreement.¹⁵

How do we know a civil outer space regime would work? All international transport of goods by air and sea depend on civilian treaties.¹⁶ Civilian regulation is the most effective method to manage space issues. Relevant to the establishment of civil outer space norms is an important precedent established in 1944, during World War II. At that time, the United States convened an international diplomatic conference in Chicago for the purpose of coordinating post-war international aviation.¹⁷ Because of the ongoing war, most aviation at that time was for military purposes.¹⁸ It was not possible for the nations convened in Chicago in 1944 to conduct any negotiations about military aviation;¹⁹ thus, the negotiations in Chicago were limited to civil aircraft as evidenced by Article 3 of the Chicago Convention.²⁰ The war

¹² Article II of the Outer Space Treaty maintains that restriction on appropriation of celestial bodies is basically a restriction on exploitation. *Id.* at 54–56; STEPHEN HOBE ET AL., COLOGNE COMMENTARY ON SPACE LAW VOL. I 49 (2009).

¹³ Moon Agreement, *supra* note 10, art. 11; LYALL & LARSEN, *supra* note 11, at 176–82; STEPHEN HOBE ET AL., COLOGNE COMMENTARY ON SPACE LAW VOL. II 394–95 (2013).

¹⁴ See Moon Agreement, *supra* note 10, at 22; Outer Space Treaty, *supra* note 10, 610 U.N.T.S. at 206–207.

¹⁵ See Convention on International Civil Aviation, Dec. 7, 1944, 61 Stat. 1180, 15 U.N.T.S. 295 [hereinafter Chicago Convention]. The Chicago Convention also left economic issues outside of that Convention.

¹⁶ See, e.g., Convention for the Unification of Certain Rules for International Carriage by Air, May 28, 1999, T.I.A.S. 13,038, 2242 U.N.T.S. 309 [hereinafter Montreal Convention].

¹⁷ PAUL B. LARSEN ET AL., AVIATION LAW: CASES, LAWS AND RELATED SOURCES 36–39 (2d ed. 2012) (discussing the Chicago Convention).

¹⁸ See *id.*

¹⁹ See *id.*

²⁰ Chicago Convention, *supra* note 15, 15 U.N.T.S. at 298. The separation of civil and military activities affected by the Chicago Convention is actually broader than just civil and military aircraft because the separation in Article 3(a) is be-

had spurred great technological developments in aviation, resulting in large, dependable airplanes.²¹ It was apparent that a post-war world market for global air transport had emerged.²² States had anticipated the Chicago Conference to be a forum for establishing order in this marketplace.²³ However, the then-British Commonwealth, which spanned the globe, controlled the post-war marketplace for international air transportation.²⁴ The United States possessed the aviation technology for exploiting the world marketplace because the U.S. development of larger bomber airplanes could be adapted to serve as commercial airplanes.²⁵ Aviation was the main issue left for negotiation, but because the United Kingdom wanted to delay negotiation of international air routes until it could recover economic strength after the war,²⁶ successful negotiation of economic exploitation failed in Chicago in 1944.²⁷ However, the conference negotiation did result in the very successful Chicago Convention and in the creation of the ICAO, the members of which created international standards for a safe international civil aviation network.²⁸ The states participating in the Chicago Conference created the ICAO to establish international technical norms for aviation in the form of international standards and recommended practices.²⁹ These standards and procedures were produced by experts in the Air Navigation Commission and, once approved by the ICAO Council, became international mandatory standards.³⁰ However, individual states retained the

tween civil and state aircraft. Article 3(b) importantly defined state aircraft as “[a]ircraft used for military, customs and police services.” If the same separation language were to be used in any new regime for outer space, that would categorize satellites operated by NASA and other government authorities, including ESA, as civil satellites.

²¹ See LARSEN ET AL., *supra* note 17, at 36–38.

²² See *id.* at 37.

²³ See *id.* at 38.

²⁴ See *id.* at 37.

²⁵ See *id.* at 39.

²⁶ See *id.* at 37.

²⁷ See *id.* at 39; see also Chicago Convention, *supra* note 15, at 15 U.N.T.S. at 320–22.

²⁸ See *Minutes of the First Plenary Meeting*, INT’L CIVIL AVIATION ORG. (Jan. 6, 1950), <https://www.icao.int/assembly-archive/Session4/A.4.MIN.1.P.EN.pdf> [<https://perma.cc/YJY2-7G8C>].

²⁹ Chicago Convention, *supra* note 15, art. 37; LARSEN ET AL., *supra* note 17, at 56, 58.

³⁰ See LARSEN ET AL., *supra* note 17, at 56.

right to file deviations from international standards as provided in Article 38 of the Chicago Convention.³¹

Separating military from civil uses is now common practice for international commercial enterprises.³² The International Maritime Organization (IMO) does not regulate maritime military activities.³³ The International Telecommunication Union (ITU) also does not regulate military radiofrequencies or their related orbital slots.³⁴ The ITU's military exception may be the most relevant precedent for discussion of outer space norms because the ITU's civil regulations apply in outer space and are acceptable to military authorities.

Separation of military uses of outer space from its civil uses leaves military uses to international regulation in the United Nations (UN) Disarmament Commission and other UN committees, as well as to multilateral and bilateral arrangements outside of the UN, in addition to national regulation. It also leaves military operators free to use whatever regulations are developed for civil space at their discretion. Experience shows that military users appreciate the greater safety that results from using the uniform international air navigation standards.³⁵ In fact, the military is also threatened by unregulated space activities that lead to military traffic collisions with other space objects and space debris. Any improvement in civilian traffic rules and space debris avoidances would diminish interferences with military operations. Order in outer space would also leave military operations free to follow civilian traffic rules, as has actually happened in military aviation, maritime traffic, and space telecommunication.

II. BENEFITS OF INTERNATIONAL NORMS

A. PUBLIC SAFETY BENEFIT

Commercial space operations are more vulnerable than military activities. They need regulatory protection from threatening

³¹ *Id.*; Chicago Convention, *supra* note 15, art. 38.

³² See LARSEN ET AL., *supra* note 17, at 41–42.

³³ Convention on the Intergovernmental Maritime Consultative Organization, Mar. 6, 1948, 9 U.S.T. 61, 289 U.N.T.S. 48 [hereinafter IMO Convention].

³⁴ See Constitution of the International Telecommunication Union, *reprinted in* COLLECTION OF THE BASIC TEXTS ADOPTED BY THE PLENIPOTENTIARY CONFERENCE, <http://search.itu.int/historyDigitalCollectionDocLibrary/5.21.61.en.100.pdf> [<https://perma.cc/WC8J-JMAX>] [hereinafter ITU Constitution].

³⁵ See Michel Bourbonniere & Louis Haeck, *Military Aircraft and International Law: Chicago Opus 3*, 66 J. AIR L. & COM. 885, 888 (2001).

elements, such as space debris from collision with other satellites. Moreover, uncertainties raised by NEOs threaten all commercial satellites, regardless of their nationality. As governments authorize more launches of commercial satellites, potential for damage to and interference with current space operations grows.³⁶ These dangers are greatest for the United States, which has the most exposure in terms of space investment and technology.³⁷

Loss of satellites from collisions can be financially ruinous. Operators need to know where other satellites and space debris are located in outer space. Operators need to have exclusive radio frequencies and orbital slots for safe navigation and control of their satellites. Space traffic management and rules of the road for outer space are now necessary for safe operations in outer space.³⁸

Commercial operators do not have policing powers in outer space. Only states can establish and enforce STM under current rules. Only states can manage and provide exclusive radiofrequencies and orbital slots free of interferences. Only states can save operators from the growing dangers of collisions with space debris. However, states do not have exclusive sovereignty in outer space; therefore, they need to coordinate and cooperate with other states and to arrange for uniform international norms so that national regulations do not conflict with operators authorized by other nations.

B. EFFICIENCY

International norms are needed for efficient commercial operations in outer space. Coordinated international standards would be more efficient and less confusing than would one hundred different sets of norms set by individual national agencies. The ability to operate without interference from other operators and free from space debris will create better results for organiza-

³⁶ Outer Space Treaty, *supra* note 10, art. VI.

³⁷ U.S. Space Policy Directive 3, *supra* note 1, at 28, 969–70; Koplou, *supra* note 9, at 382.

³⁸ See U.S. Space Policy Directive 3, *supra* note 1, at 28, 969–70; Koplou, *supra* note 9, at 332. Experts predict that there could be up to 27,000 operating satellites in outer space in the next ten years. Irene Klotz, *Small Satellites, Big Data*, AVIATION WK. & SPACE TECH., July 30–Aug. 19, 2018, at 48, 49; Yousaf Butt, Opinion, *Avoiding Traffic Pileups in Outer Space*, N.Y. TIMES (Mar. 19, 2018), <https://www.nytimes.com/2018/03/19/opinion/space-race-regulation.html> (last visited Oct. 16, 2018); see Irene Klotz, *Space Cop*, AVIATION WK. & SPACE TECH., May 7–20, 2018, at 19.

tions doing business in space. States could organize efficient commercial environments in outer space by coordinating and cooperating with other states. Operators in regulated outer space would be free from having to negotiate terms with a variety of other commercial operators because there would already be an agreed-upon, worldwide standard.

C. CONFLICT PREVENTION

Article II of the Outer Space Treaty specifically outlaws claims of exclusive appropriation.³⁹ Each state has an equal legal right to operate in outer space,⁴⁰ so no state can be the exclusive user by excluding other states and their operators from also using celestial bodies. Nevertheless, conflicts and occasional assertions of exclusive use occur.⁴¹ Conflicts lead to delays and to possible loss of and damage to space objects. Only coordination and cooperation among states will result in establishing conflict-free environments in which operators can conduct profitable businesses.

D. COMMERCIAL OPERATORS' NEEDS FOR ORDER IN OUTER SPACE

The current shift from military to commercial space enterprises has made the operators of the commercial endeavors apprehensive about heavy-handed governmental regulation.⁴² On the one hand, commercial space operators require “agile, transparent, and internationally coordinated rule-making to make it sustainable.”⁴³ Too much regulation can kill the commercial revolution.⁴⁴ On the other hand, the current launches and planned launches of thousands of commercial satellites threaten collisions among satellites and with space debris. Commercial operators have come to appreciate government regulation of

³⁹ Outer Space Treaty, *supra* note 10, art. II.

⁴⁰ *Id.* arts. I, II.

⁴¹ See, e.g., Dominic Basulto, *How Property Rights in Outer Space May Lead to a Scramble to Exploit the Moon's Resources*, WASH. POST (Nov. 18, 2015), https://www.washingtonpost.com/news/innovations/wp/2015/11/18/how-property-rights-in-outer-space-may-lead-to-a-scramble-to-exploit-the-moons-resources/?utm_term=.c291643a6abe [<https://perma.cc/4TPF-R56C>].

⁴² Outer Space Treaty, *supra* note 10, arts. I, II; Butt, *supra* note 38; Paul B. Larsen, *Berlin Space Protocol: Update*, 64 ZLW 361, 361–62 (2015).

⁴³ Butt, *supra* note 38.

⁴⁴ Outer Space Treaty, *supra* note 10, arts. I, II; Butt, *supra* note 38; see generally Larsen, *Berlin Space Protocol*, *supra* note 42, at 361–62.

space traffic and reduction of debris dangers.⁴⁵ The collision danger led a 2018 study by the Aerospace Corporation to conclude that “[t]o facilitate the envisioned New Space activity and maintain a safe operating environment for everyone in space, the issues of establishing an effective next-step STM conjunction assessment system must be addressed as soon as possible.”⁴⁶

The question is how to develop internationally-needed regulation without killing the many valuable start-up enterprises now fueling the commercial revolution. Again, the Chicago Convention shows the way. At the conference, there were active industry experts not only advising but also actually negotiating through working groups.⁴⁷ Perhaps most valuable for the aviation industry was the participation and contributions of the then-general counsel for Pan-American Airlines, John Cobb Cooper.⁴⁸ Through industry participation, the commercial enterprises were able to not only contribute but also guide the formation of the new Convention on International Civil Aviation. A similar infusion of active commercial guidance will be needed for a corresponding new regime establishing norms on space debris and STM, so that the many dangers that threaten commercial space operations can be avoided.

E. WHERE TO BEGIN

It is important to note that, while this discussion is about international space traffic norms, the actual implementation of international, uniform norms would be by the individual states. Negotiation of a separate treaty to establish international norms

⁴⁵ Outer Space Treaty, *supra* note 10, arts. I, II; Butt, *supra* note 38; *see generally* Larsen, *Berlin Space Protocol*, *supra* note 42. The Department of Defense operates a comprehensive outer space tracking system able to track objects larger than ten centimeters in diameter. Koplou, *supra* note 9, at 373. This tracking information is available to civilian satellite operators. *See id.* at 374–75. This tracking capability is currently being improved to track ten times more space objects. *Id.* at 373.

⁴⁶ Peterson et al., *supra* note 1, at 9.

⁴⁷ *See* Int’l Civil Aviation Org., List of Delegates, <https://www.icao.int/Chicago-Conference/Pages/Chicago-conference-delegates.aspx> [<https://perma.cc/C7GR-U2J6>].

⁴⁸ *See Minutes of the First Plenary Meeting*, *supra* note 28. Pan-American Airlines was the major U.S. international air carrier at that time. *See Pan American World Airways, Inc.*, ENCYCLOPEDIA BRITANNICA, <https://www.britannica.com/topic/Pan-American-World-Airways-Inc> [<https://perma.cc/YFB3-BSU5>]. Professor Cooper later founded the Institute of Air and Space Law at McGill University. Obituary, *John Cooper, 79, Air Lawyer, Dies: Pan Am Executive Devised Code for Outer Space*, N.Y. TIMES, July 24, 1967, at 26. He also wrote a foundational book air law book, *The Right to Fly*, in 1947. *Id.*

for space debris, space traffic, and NEO defense would very likely begin in the UN Committee on the Peaceful Use of Space (COPUOS) Legal Committee. It would be approved by the full committee then finalized by a diplomatic conference. Alternatively, the new regime could become a protocol to the Outer Space Treaty the same way the 2012 Berlin Space Protocol became a protocol to the Cape Town Convention.⁴⁹ The result would be a protocol that would only become binding on parties to it. However, all the space-interested states would want to ratify as soon as possible in order to gain the advantages of the new safety norms. Consequently, traffic in outer space would become orderly, the debris problem would become less urgent, and the Kessler Syndrome prospect of foreclosure of access to outer space would disappear.

III. THE SCOPE OF INTERNATIONAL TECHNICAL REGULATION OF CIVIL SPACE ACTIVITIES

The following section will discuss establishment of international operating norms for STM, space debris, and NEOs.

A. INTERNATIONAL NORMS FOR CIVIL STM⁵⁰

Travel in outer space is highly dangerous. One danger is the tremendous speed at which space objects move.⁵¹ Available assistance is minimal, and collisions are likely to be catastrophic. There are currently no uniform norms for traffic in outer space.⁵² With increasing traffic and more obstacles to navigate around, indications are that travel in outer space may eventually

⁴⁹ Larsen, *Berlin Space Protocol*, *supra* note 42, at 362–63, 365–66.

⁵⁰ For a more detailed discussion, see Larsen, *Space Traffic Management Standards*, *supra* note 1.

⁵¹ See Mark Garcia, *Space Debris and Human Space Craft*, NAT'L AERONAUTICS & SPACE ADMIN. (Aug. 7, 2017), https://www.nasa.gov/mission_pages/station/news/orbital_debris.html [<https://perma.cc/M249-K7LZ>].

⁵² Peterson et al., *supra* note 1. Most of the traffic is non-navigable space debris. *Id.* Note also the collision of the commercial U.S. Iridium satellite with the defunct Russian Cosmos satellite and the destruction of the Chinese Fengyun IC weather satellite by a Chinese ASAT weapon. See Becky Iannotta & Tariq Malik, *U.S. Satellite Destroyed in Space Collision*, SPACE.COM (Feb. 11, 2009), <https://www.space.com/5542-satellite-destroyed-space-collision.html> [<https://perma.cc/QWT3-ZHNE>]; Leonard David, *China's Anti-Satellite Test: Worrisome Debris Cloud Circles Earth*, SPACE.COM (Feb. 2, 2007), <https://www.space.com/3415-china-anti-satellite-test-worrisome-debris-cloud-circles-earth.html> [<https://perma.cc/52KL-NHP7>].

become impossible unless uniform traffic norms are established.⁵³

The advantage of international STM norms is that all navigable traffic would use the same uniform traffic rules. International STM is in constant need of updating. These norms would have to be administered, analyzed, and supplemented by knowledgeable experts as traffic conditions change. The result would be greater safety.⁵⁴

Traffic in outer space is increasing drastically in the New Space age. There are currently more than 1,200 functional satellites in orbit.⁵⁵ Estimates of satellites to be launched into orbit in the immediate future range up to 27,000 satellites.⁵⁶ Most of the new launches are expected to be in low Earth orbit.⁵⁷ The amount of space debris in orbit is also increasing rapidly. There is estimated to be close to 1 million debris objects in orbit, of which only approximately 23,000 are currently being tracked, although new tracking technology now being deployed will increase tracking capability four-fold.⁵⁸ The point is that the total of outer space traffic congestion is increasing rapidly.

For new launches to be safely orbited, new international STM is urgently needed. Individual states supervise the traffic that they authorize,⁵⁹ and while states may try to track the space objects⁶⁰ launched by other states, current tracking technology still leaves some space objects untracked. For example, when the re-

⁵³ The Kessler Syndrome predicts the foreclosure of outer space unless the current trend in space debris is reversed. See Donald J. Kessler & Burton G. Cour-Palais, *Collision Frequency of Artificial Satellites: The Creation of a Debris Belt*, 83 J. GEOPHYSICAL RES. 2637, 2637 (1978). According to the Kessler Syndrome, space debris of critical mass will fragment in further collisions, leading to cascading chain activity. See Donald J. Kessler et al., *The Kessler Syndrome: Implications to Future Space Operations*, 33RD ANNUAL AAS GUIDANCE AND CONTROL CONFERENCE, at 2 (Feb. 6–10, 2010) <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.394.6767&rep=rep1&type=pdf> [<https://perma.cc/PQ7Y-XTL8>].

⁵⁴ The need for safety standards and norms for outer space activities is stressed by the U.S. Space Policy Directive 3, *supra* note 1, at 28,969.

⁵⁵ See Andrew Lavender, *How Many Satellites Are Orbiting the Earth in 2018?*, PIXALYTICS LTD. (Aug. 22, 2018), <https://www.pixalytics.com/sats-orbiting-the-earth-2018/> [<https://perma.cc/6NLC-BG5M>].

⁵⁶ Klotz, *Small Satellites, Big Data*, *supra* note 38, at 49.

⁵⁷ *Id.* at 49–50.

⁵⁸ See Mike Gruss, *Good (Space) Fences Make for Good (Orbital) Neighbors*, SPACE NEWS (Sept. 19, 2016), <https://spacenews.com/good-space-fences-make-for-good-orbital-neighbors/> [<https://perma.cc/N2WT-EVGT>].

⁵⁹ Outer Space Treaty, *supra* note 10, art. VI.

⁶⁰ The term “space objects” is here used to include both functioning satellites and space debris.

sponsible state lacks the capability to track objects, it may simply warn space operators to avoid the general location of its existing, known space objects. Additionally, some objects are so small that they cannot be safely tracked.⁶¹

Below is a tentative list of potential civil uniform international space traffic norms (Standards and Procedures).⁶² Eventually, STM experts would establish a list based on actual needs:

- (1) Communication procedures;
- (2) Launch procedures;⁶³
- (3) Navigation procedures;⁶⁴
- (4) Standards for safety zones;⁶⁵
- (5) Space traffic control procedures;⁶⁶
- (6) Procedures regarding navigable traffic interaction with non-navigable objects such as space debris;
- (7) Operational licensing procedures;⁶⁷
- (8) Standards streamlining registration;⁶⁸
- (9) Information procedures regarding space flight conditions;
- (10) Records requirements;
- (11) Standards for navigational aids;
- (12) Search and rescue procedures;
- (13) Accident investigation procedures;
- (14) ITU coordination of radio frequencies and related orbital slots;
- (15) Customs and immigration; and
- (16) Other norms appropriate to traffic in space.

It is apparent from the variety of subjects that several expert subcommittees would need to be formed to generate norms. That

⁶¹ Swarm Technologies launched untrackable, small satellites without the Federal Communications Commission's authorization. See Butt, *supra* note 38; see also discussion *infra* note 82.

⁶² See Larsen, *Space Traffic Management Standards*, *supra* note 1, at 385.

⁶³ This was suggested by The Hague Space Resources Governance Working Group. See *Final Report*, THE HAGUE SPACE RESOURCES GOVERNANCE WORKING GRP. 8–15 (Dec. 18, 2017), https://www.universiteitleiden.nl/binaries/content/assets/rechtsgeleerdheid/instituut-voor-publiekrecht/lucht—en-ruimterecht/space-resources/final-report_the-hague-space-resources-governance-working-group-7-6-18.pdf [<https://perma.cc/6R7L-6DUW>].

⁶⁴ See *id.*

⁶⁵ See *id.*

⁶⁶ Space traffic norms will need to distinguish navigation in space from navigation on celestial bodies. Reference is also made to the Outer Space Treaty Article IX requirement to pay due regard to others in outer space. *Id.*

⁶⁷ See *id.*

⁶⁸ U.S. Space Policy Directive 3, *supra* note 1, at 28,971.

became the accepted procedure of the ICAO, IMO, and ITU in drafting standard practices.

B. INTERNATIONAL NORMS FOR REDUCED SPACE DEBRIS
GENERATION AND FOR REMOVAL OF OLD DEBRIS⁶⁹

The space debris dilemma is in desperate need of international resolution⁷⁰ in order to preserve continued access to outer space.⁷¹ At the moment, there is no solution in sight for reducing existing, accumulated debris that continues to expand at the rate explained by the Kessler Syndrome.⁷² Despite the Inter-Agency Space Debris Coordination Committee's (IADC)⁷³ voluntary space debris guidelines, new additions of debris cannot be avoided. The IADC guidelines, while recommended by COPUOS, are now technically enforced by the individual states but are not applied uniformly or enforced well. Existing space regulations do not sufficiently deter generation of additional debris.⁷⁴ The existing trend of increasing conjunctions in outer space is illustrated by the collision of the commercial satellite, U.S. Iridium, with the defunct Russian Cosmos satellite, as well as the destruction of the Chinese Fengyun IC weather satellite by a Chinese ASAT weapon.⁷⁵ Those conjunctions produced massive amounts of new debris that in turn increased the danger of satellite collisions with other space objects.⁷⁶

The wave of new commercial activity in outer space is generated by the New Space initiatives relating primarily to small satellites. Small satellite systems are being launched for satellite communication (for example, internet access) and reconnais-

⁶⁹ For detailed discussion, see Larsen, *Solving the Space Debris Crisis*, *supra* note 1.

⁷⁰ U.S. Space Policy Directive 3, *supra* note 1, at 28,970. The Directive stresses the need to reduce space debris, stating that the U.S. Government Orbital Debris Mitigations Standard Practices are inadequate. Practices should be updated to meet current and future space operating environments. See Bachman, *supra* note 1.

⁷¹ Outer Space Treaty, *supra* note 10, art. I.

⁷² See Kessler et al., *supra* note 53, at 14.

⁷³ See generally Nicholas Johnson, *Origin of the Inter-Agency Space Debris Coordination Committee*, NAT'L AERONAUTICS & SPACE ADMIN., <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20150003818.pdf> [<https://perma.cc/8T6S-EY9N>]. The independent IADC is a committee of the thirteen countries most active in outer space. See INTER-AGENCY SPACE DEBRIS COORDINATION COMM., <https://www.iadc-online.org> [<https://perma.cc/6PDH-D9P9>].

⁷⁴ See Kessler et al., *supra* note 53, at 14.

⁷⁵ See Iannotta & Malik, *supra* note 52; see David, *supra* note 52.

⁷⁶ See David, *supra* note 52.

sance, as well as remote sensing and Earth observation.⁷⁷ The life span of these small satellites is very short (as little as one to two years), at which time the small satellites need to be de-orbited or sent into graveyard orbits and subsequently replaced. So, despite IADC's attempt at regulation, the amount of debris will increase due to inadequate policing and new generation of debris.⁷⁸

The wealth of new space business initiatives is creating great pressure from the space industry for speedy government grant of authorizations.⁷⁹ Some operators try to shortcut the licensing wait time by shopping around, comparing the policies of various countries and searching for the quickest issuance of governmental authorization.⁸⁰ Some states are tempted to become "flag of convenience" states because the space business can be lucrative, bringing not only wealth but also employment to small countries that have inadequate resources to supervise the space activities that they have authorized.⁸¹

A current international problem is that COPUOS has no decision-making authority. While it is presently the designated forum for international discussions of space debris problems, COPUOS is merely a committee of the UN General Assembly (UNGA) and can only make recommendations to the Assembly. That handicaps the ability of COPUOS to resolve the space debris problem. COPUOS is also disadvantaged by its use of consensus for making decisions and recommendations to the UNGA. COPUOS's space debris activity depends on the independent IADC,⁸² which means representatives from the thirteen most space-active countries must agree. International space debris decision-making is, therefore, weak. Furthermore, IADC lacks geographical distribution. Its guidelines are voluntary, so it has no enforcement authority. Finally, its space debris guidelines have not been amended since 2007,⁸³ so the IADC space debris guidelines are already out of date.

⁷⁷ See, e.g., Lavender, *supra* note 55.

⁷⁸ See David, *supra* note 53; Larsen, *Solving the Space Debris Crisis*, *supra* note 1.

⁷⁹ See Butt, *supra* note 38.

⁸⁰ See *id.*

⁸¹ See LYALL & LARSEN, *supra* note 11, at 517–18.

⁸² Johnson, *supra* note 73, at 71.

⁸³ See *IADC Space Debris Mitigation Guidelines*, INTER-AGENCY SPACE DEBRIS COORD. COMMITTEE (Sept. 2007), https://www.iadc-online.org/index.cgi?item=docs_pub [<https://perma.cc/B433-FH5B>].

COPUOS does not appear to be able to regulate the purely technical aspects of space debris, nor does it appear to be suited for such an undertaking.⁸⁴ COPUOS is unable to adopt or enforce mandatory norms and standards to regulate space debris to the extent necessary to resolve space debris problems.⁸⁵

Considering that the existing space debris decision-making fora are unable to resolve the problem, both governments and industry are beginning to look elsewhere for decision-making action. Because outer space is non-sovereign and individual states do not have legal authority to exercise sovereign control over policing of outer space, there is now a search for an international authority that can exercise the necessary policing. Considering the magnitude of the problem and the speed with which it is currently accelerating, there is no time to waste waiting for states to agree to an effective international regulation of space debris.

Particularly dangerous are errant commercial companies like Swarm Technologies⁸⁶ that are tempted to launch space objects without international coordination or authorization by their governments on the assumption that outer space is so big and open that there is room for doing business without conferring with the government and other interested organizations. Responsible commercial operators will necessarily opt for minimum government policing in outer space using internationally agreed norms. Those norms must be strong enough to reduce the space debris problem gradually rather than letting it grow beyond eventual possible solutions, which could end in foreclosure of all commercial and non-commercial space activities. Such a result would also disrupt continuing scientific exploration of outer space.⁸⁷

This tentative list of possible civil uniform international space debris norms is for illustration only and is based on the guidelines established by the IADC space debris experts:

⁸⁴ See Johnson, *supra* note 73, at 71.

⁸⁵ *Id.*

⁸⁶ See Butt, *supra* note 38.

⁸⁷ See Johnson, *supra* note 73, at 70–71; see Butt, *supra* note 38 (commenting on Swarm Technologies); see also Ian Christensen & Josh Wolny, *Insight: CubeSats and the FCC: The Sky is Not Falling*, SECURE WORLD FOUND. (Aug. 2, 2018), <https://swfound.org/news/all-news/2018/08/insight-cubesats-and-the-fcc-the-sky-is-not-falling> [<https://perma.cc/H4BJ-EWYA>] (discussing FCC regulation of applications for radio frequencies).

- (1) Limits on space debris during normal operations by satellites, launch rockets, and their component parts;
- (2) Limits on break-ups during operational phases;
- (3) Norms for diminishment of accidental debris-causing collisions in space;
- (4) Methods of tracking debris caused by collisions of space objects;
- (5) Prohibition or limitation of intentional destruction of space objects;
- (6) Required removal of the most dangerous debris;
- (7) Limits on post-mission break-ups resulting from stored energy;
- (8) Required deorbit from low earth orbits;
- (9) Required removal from geostationary orbit into graveyard orbits; and
- (10) Registration of known debris.

A number of different expert sub-groups would need to be established to adequately cover these topics.

C. INTERNATIONAL TECHNICAL PROTOCOLS TO PROTECT EARTH FROM THREATENING NEOs⁸⁸

Asteroids have, in past times, collided with and caused damage to Earth.⁸⁹ NEOs of many different sizes frequently reach Earth's atmosphere. While most NEOs burn up in the atmosphere, some reach Earth's surface and have caused great damage in the past.⁹⁰ For example, one NEO exploded over a city in Siberia in 2013.⁹¹ It would have caused considerably more damage if it had collided with Earth in a heavily-populated area, such as New York, London, or Beijing. Most asteroids orbit the Sun in the asteroid belt between Mars and Jupiter,⁹² and most NEOs can be watched in order to predict their paths. However,

⁸⁸ A NEO is any small Solar System body (asteroid) whose orbit can bring it into proximity with Earth. *NEO Basics*, NAT'L AERONAUTICS & SPACE ADMIN., <https://cneos.jpl.nasa.gov/about/basics.html> [https://perma.cc/NPZ2-8AJB] (last visited Sept. 5, 2018).

⁸⁹ See, e.g., Brett Line, *Asteroid Impacts: 10 Biggest Known Hits*, NAT'L GEOGRAPHIC NEWS (Feb. 15, 2013), <https://news.nationalgeographic.com/news/2013/13/130214-biggest-asteroid-impacts-meteorites-space-2012da14/> [https://perma.cc/RD3E-FKDP].

⁹⁰ For detailed discussion, see Larsen, *NEOs*, *supra* note 1, at 104.

⁹¹ *Id.* at 104, 107.

⁹² See Matt Williams, *What Is the Asteroid Belt?*, UNIVERSE TODAY (Aug. 23, 2015), <https://www.universetoday.com/32856/asteroid-belt/> [https://perma.cc/UYR5-3HS7].

intergalactic celestial bodies, such as the one that entered the solar system in 2017,⁹³ cannot be predicted. NEOs are being observed by the United States,⁹⁴ Russia, Japan, China, the UK, Canada, India, and other states. Each of these countries is primarily searching for NEOs that threaten their national interests. Unnecessary duplication of national preventive efforts may occur due to lack of coordination when several states focus on common NEO dangers. For example, one state may merely wish to shift the collision danger from its state over to an adjoining state, thereby adversely impacting a neighboring nation rather than working together to protect both countries' interests. Since most national space activities are inherently dual use, tracking and many other preventive activities occur through military agencies. The use of military weaponry, such as atomic bombs, may be needed in the future to deflect NEOs,⁹⁵ and this may invite international military conflict. Military space technology is developing very quickly and may result from unilateral national space activities, but this also raises issues of technology transfers.

Individual national planning and actions regarding threatening NEOs can easily lead to conflicts when several states decide to act to meet NEO threats. States may perceive NEOs differently. For example, the United States has plans to seize an asteroid and place it in orbit around the Moon for observation and scientific study.⁹⁶ Other states may have different plans for the same asteroids and may challenge the legal right of the United States to appropriate a particular asteroid.⁹⁷

International worldwide protocols to avoid NEOs are necessary. Joint strategies would be more economical and efficient. Transparency is needed to avoid mistaken assumptions about

⁹³ See *Small Asteroid or Comet "Visits" from Beyond the Solar System*, NAT'L AERONAUTICS & SPACE ADMIN. (Oct. 26, 2017), <http://www.nasa.gov/feature/jpl/small-asteroid-or-comet-visits-from-beyond-the-solar-system> [<https://perma.cc/J8UE-RWGB>].

⁹⁴ See *National Near-Earth Object Preparedness Strategy and Action Plan*, NAT'L SCI. & TECH. COUNCIL (June 2018), <https://www.whitehouse.gov/wp-content/uploads/2018/06/National-Near-Earth-Object-Preparedness-Strategy-and-Action-Plan-23-pages-1MB.pdf> [<https://perma.cc/DJ87-ZUCM>].

⁹⁵ NAT'L AERONAUTICS & SPACE ADMIN., NEAR-EARTH OBJECT SURVEY AND DEFLECTION ANALYSIS OF ALTERNATIVES 2, 20 (Mar. 2007), https://www.nasa.gov/pdf/171331main_NEO_report_march07.pdf [<https://perma.cc/GK78-R67A>].

⁹⁶ See *What Is NASA's Asteroid Redirect Mission?*, NAT'L AERONAUTICS & SPACE ADMIN., <https://www.nasa.gov/content/what-is-nasa-s-asteroid-redirect-mission> [<https://perma.cc/7KW2-G4QF>].

⁹⁷ Outer Space Treaty, *supra* note 10, art. II (prohibiting appropriation of celestial bodies).

other states' intentions because misapprehensions may lead to military engagements. This openness, especially about military actions, would lessen international tensions, and coordination between nations would lead to greater safety in outer space.

The UN has begun international coordination of national efforts to protect Earth from NEO dangers. COPUOS has formed two independent and unfunded international groups to advise it on NEO issues.⁹⁸ The first group is the International Asteroid Warning Network (IAWN), which is a group of experts, mainly astronomers and astronomic observatories.⁹⁹ IAWN members share observations individually as well as jointly. They generally assist governments in dealing with NEO impacts and provide NEO observations. They warn governments about impending NEO collisions with Earth and analyze the potential consequences of such collisions. The second group is the Space Mission Planning Advisory Group (SMPAG), which is another independent, unfunded COPUOS advisory group whose members are from national space agencies such as NASA, the DLR (German Space Agency), and the ESA (European Space Agency).¹⁰⁰ This group prepares plans for national and international action in the event of NEO impacts. It also prepares guidelines for mitigating future threats, such as NEO diversion.

Currently neither group has any decision-making authority.¹⁰¹ Except for joint international actions on international peace and security, such decision-making authority would be beyond the authority of the United Nations. Even if the IAWN or the SMPAG informs COPUOS of impending threats, the international community does not have an international regulatory framework for establishing norms that would prepare the world for NEO threats, how to meet such threats, diversion of NEOs, or recovery from NEO strikes. With no international coordination, such known threats could cause confusion about which divertive actions to take. Alternatively, the states could be motivated to agree on new legal norms for joint action against the

⁹⁸ Larsen, *NEOs*, *supra* note 1, at 123–25; *see also* UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, NEAR-EARTH OBJECTS AND PLANETARY DEFENCE 12 (2018), http://www.unoosa.org/documents/pdf/smpag/st_space_073E.pdf [<https://perma.cc/2PC2-5MWG>].

⁹⁹ NEAR-EARTH OBJECTS AND PLANETARY DEFENCE, *supra* note 98, at 12, 15.

¹⁰⁰ *Id.* at 13, 16; UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, IAWN SMPAG FACT SHEET 2, http://www.unoosa.org/documents/pdf/smpag/IAWN_SMPAG_Fact_sheet.pdf [<https://perma.cc/J8YU-KB4G>].

¹⁰¹ *See* NEAR-EARTH OBJECTS AND PLANETARY DEFENCE, *supra* note 98, at 14.

common danger. It is advisable for such standards and plans to be established well before the confusion of impending threats.¹⁰²

NEO threats, like STM and the dangers of space debris collisions, are essentially technical, non-military problems. While they are of global concern, they do not involve the appearance of military threats or confrontations from other states.¹⁰³ The actual management of NEO threats would require an international decision-making authority that would work with established protocols.

The world needs international planetary defense coordination and international norms in the form of protocols. Possible protocols for uniform international NEO defense should reflect the urgent, universal need for planetary defense. COPUOS is presently preparing voluntary and tentative plans for international coordination,¹⁰⁴ but there is no time to lose. Protocols could include:

- (1) NEO disaster management;
- (2) Emergency warning;
- (3) Agreed nomenclature for NEOs;
- (4) Public awareness of NEO dangers;
- (5) NEO response and recovery;
- (6) Procedures for dealing with different impacts of NEO strikes, whether on land or on water;
- (7) Diversion of NEOs; and
- (8) Establishment of thresholds for guiding states in making decisions and taking action.

D. OTHER INTERNATIONAL OUTER SPACE ISSUES POSSIBLY IN NEED OF TECHNICAL NORMS¹⁰⁵

If a decision is made to create a new international organization to establish international norms for essential technical space issues, such as STM, space debris, and NEO management, then the negotiating states should have the opportunity to make the international regulation as comprehensive as possible without transgressing into regulation of military and economic is-

¹⁰² Larsen, *NEOs*, *supra* note 1, at 109.

¹⁰³ *Id.* at 132, 136.

¹⁰⁴ See NEAR-EARTH OBJECTS AND PLANETARY DEFENCE, *supra* note 98, at 10–11.

¹⁰⁵ Note additional issues discussed in the U.S. Space Policy Directive 3, *supra* note 1, at 28, 970–75.

sues. The following space issues might be examined for that purpose.

1. *Remote Sensing*

Satellite remote sensing has become a New Space business activity that now occurs mainly through many small orbiting satellites.¹⁰⁶ Until recently, remote sensing was mainly used for military observation.¹⁰⁷ It is now also used for management of agriculture, disasters, climate observations, land planning, mining, and many other purposes.¹⁰⁸ Some norms were established by the UN in 1986 in the Principles Relating to the Remote Sensing of the Earth from Outer Space.¹⁰⁹ The UN Remote Sensing Principles are not binding. Some states, like the United States, have adopted extensive laws and regulations that often conflict with the UN Remote Sensing Principles, yet the military aspects of remote sensing remain strong. It is thus uncertain whether new norms for remote sensing fit within the framework of a new international civil regime.

2. *Environmental Pollution of Outer Space*¹¹⁰

Space pollution is currently subject to the international law treaties as well as customary terrestrial international environmental law,¹¹¹ such as the Precautionary Principle¹¹² and the existing UNGA Nuclear Power Source (NPS) Resolution.¹¹³

Space debris is often associated with environmental pollution.¹¹⁴ International environmental pollution in general could therefore easily become part of the scope of a new international

¹⁰⁶ See Herbert J. Kramer & Arthur P. Cracknell, *An Overview of Small Satellites in Remote Sensing*, 29 INT'L J. REMOTE SENSING 4285, 4286 (2008).

¹⁰⁷ See *id.* at 4287–89.

¹⁰⁸ See, e.g., Zhuokun Pan et al., *Remote Sensing of Agricultural Disasters Monitoring: Recent Advances*, 6 INT'L J. REMOTE SENSING & GEOSCIENCE 4, 4 (2017).

¹⁰⁹ See generally G.A. Res. 41/65 (Dec. 3, 1986). The Principles are dated: significant commercial remote sensing activities had not developed at the time of adoption in 1986, so the Principles were mostly considered for the national security aspects of remote sensing.

¹¹⁰ See generally LYALL & LARSEN, *supra* note 11, at 245–80.

¹¹¹ *Id.* at 245.

¹¹² See Paul B. Larsen, *Application of Precautionary Principle to the Moon*, 71 J. AIR, L. & COM. 295 (2006).

¹¹³ See G.A. Res. 47/68 (Feb. 23, 1993).

¹¹⁴ See Larsen, *Solving the Space Debris Crisis*, *supra* note 1; Outer Space Treaty, *supra* note 10, art. IX (requiring parties to the agreement to consult before causing “potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space”).

legal regime establishing international norms for the solution of space debris problems.

3. *Disaster Management: UN Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER)*¹¹⁵

Due to the lack of an international organization, management of the Disaster Charter for Outer Space has been relegated to the UN Office for Outer Space Affairs (UNOOSA).¹¹⁶ UNOOSA has become responsible for servicing the Disaster Charter and has established UN-SPIDER to maintain a global information and communication system, which provides countries that experience disasters with a central network to activate disaster assistance.¹¹⁷ A number of countries have dedicated disaster services, such as remote sensing, so they can provide relief immediately after disasters strike. UN-SPIDER maintains an electronic information portal, giving states immediate information about available disaster resources.

If an international space organization is established, it would be logical for that organization to house the UN-SPIDER communication network and to administer the disaster relief assistance functions in accordance with the standards developed by UN-SPIDER.¹¹⁸

4. *Search for Extraterrestrial Intelligence (SETI)*¹¹⁹

There continues to be active, international interest in finding evidence of life on other planets. Current exploration of Mars searches actively for SETI evidence.¹²⁰ Other planets and solar systems are also being examined. The search from Earth consists of passive listening for possible messages from both inside and outside the Solar System in addition to active pursuit of possible sources of communication in outer space. Protocols for commu-

¹¹⁵ *What Is UN-SPIDER?*, UNITED NATIONS OFF. FOR OUTER SPACE AFF., <http://www.un-spider.org/about/what-is-un-spider> [permalink unavailable] (last visited Sept. 8, 2018); LYALL & LARSEN, *supra* note 11, at 378–82.

¹¹⁶ G.A. Res. 61/110, ¶ 16 (Dec. 14, 2006).

¹¹⁷ *Id.* at ¶¶ 6–15.

¹¹⁸ See Paul B. Larsen, *The Oso Landslide: Disaster Management Law in the Space Age*, 40 WM. & MARY ENVTL. L. & POL'Y REV. 335, 357–60 (2016) (discussing UN-SPIDER as a part of UNOOSA).

¹¹⁹ See generally LYALL & LARSEN, *supra* note 11, ch. 17 (entitled “The Search for Extraterrestrial Intelligence (SETI)”).

¹²⁰ *Id.* at 498.

nication with extraterrestrials have been developed with the support of NASA and later by the International Astronautical Association.¹²¹ No international UN-related organization is presently charged with hosting these international activities, but an international space organization could become the logical forum for managing protocols for communication and encounters with extraterrestrial beings.

5. *Solar Power Satellite Systems*

Huge electrical solar power satellites located in geostationary orbit (GSO) could collect solar energy and convert it into microwave beams directed at designated reception stations on Earth.¹²² The potential disaster caused by downlinking the microwave beam outside of its intended target on Earth would require close monitoring of the scientific, technological, and legal aspects of solar power satellites. Thus, norms and standards for the construction of solar power satellites would become necessary.

Placing the huge solar power satellites in GSO at an altitude of 23,000 miles would require coordination with ITU¹²³ and with all current users of the GSO. Before placement into orbit, it would be important to resolve whether the solar power satellites were to be placed in orbit by individual states or by an international cooperative organization.

If Earth were starving for electricity, the production and distribution of power to the users would become important issues to be resolved. Distribution norms would need to be negotiated and would depend on whether the distribution would be a for-profit endeavor, much like a commercial electrical power company, or a public benefit distribution scheme designed for equal access for everyone on Earth. Consequently, solar power issues should be on the agenda of an international conference on new international operating norms for outer space.¹²⁴

6. *Other Civil Outer Space Subjects*

An inventory of other civil outer space subjects developed during formative negotiations would probably indicate other re-

¹²¹ *Id.* at 500–01.

¹²² Paul B. Larsen, *Current Legal Issues Pertaining to Solar Power Systems*, 16 *SPACE POL'Y* 139, 139–42 (2000).

¹²³ *Id.* at 140.

¹²⁴ *See generally id.*

lated problems that could be addressed with international norms. The UNOOSA, which was originally intended by the UNGA to service only the Committee for Peaceful Uses of Outer Space, has become the administrator of space subjects. UNOOSA administers the UN registry of space objects established by the Registration Convention. The diplomatic conference may find it expedient to assign such administrative functions to the international agency charged with establishing norms for outer space.

E. ADMINISTRATION

Continued administration and oversight of the new international norms for outer space would be important. Therefore, the expert commissions must be standing bodies.¹²⁵ It should be expected that the space commissions would each form subgroups on various aspects of space debris, traffic, defense against threatening NEOs, and other possible subjects of international norms for civil outer space activities.

IV. STAKEHOLDER IDENTIFICATION

The large variety of stakeholders in outer space regulation shows how important internationally uniform regulatory norms are. As the number of stakeholders grows, it is evident that the danger of collisions grows as well. The stakeholders are increasingly aware of the need for uniform international operating norms.

A. NATIONAL AND INTERNATIONAL GOVERNMENTS

International norms, such as the ICAO aviation standards, are established by intergovernmental compacts. After establishment, the norms are implemented and enforced by governmental agencies. The governments have a direct interest in outer space norms through their own use of outer space and are guardians of space-related public interests, such as the availability of national and international communication lines. National governments also benefit from the services of non-governmental civil outer space operators. The Directive will no doubt show the

¹²⁵ The ICAO Air Navigation Commission established subgroups on all the navigation-related problems referred to the Commission. *See* ICAO AIR NAVIGATION COMM'N, SPECIAL 200TH SESSION COMMEMORATIVE REVIEW 6 (Fall 2015), https://www.icao.int/about-icao/AirNavigationCommission/Documents/ANC-200_final_web.pdf [<https://perma.cc/8YNZ-JBCV>].

powerful impact that a national government may have on the creation of norms for outer space activities.¹²⁶

National governments also represent the interests of their military authorities in establishing possible international operating norms regulating non-governmental operators. That is so even if the military operators are not bound by international norms established for civil operators: the military operators will have to know the operating rules established for civil outer space traffic and will benefit from the resultant greater order in outer space. They may also use the international civil norms to the extent that they are in line with their interests. That was the lesson learned in aviation, maritime traffic, and civil satellite telecommunication. The military outer space operators benefit from reduction of collision dangers with space debris even though the military may reserve the right to cause more debris through military engagements.¹²⁷

Additionally, several international government authorities are interested in outer space norms that may affect them. The ITU presently regulates and applies its international norms to establish frequencies and related orbital slots of satellites navigating in outer space.¹²⁸ The ITU would have to coordinate its approval of orbital slots with new norms for space traffic, space debris, and NEOs. ICAO would be interested because non-sovereign outer space is not clearly delineated from air space, so ICAO norms would be relevant to outer space traffic through airspace. Furthermore, the jurisdiction of COPUOS would be redefined by any new international law establishing new norms for outer space. Preparatory international negotiations establishing outer space norms would likely take place in COPUOS. Creation of norms for outer space could also lead to renegotiation of some established space law, which would cause several states to hesitate to agree on renegotiation.¹²⁹

¹²⁶ U.S. Space Policy Directive 3, *supra* note 1.

¹²⁷ Because space technology is inherently dual use, military authorities will want their governments to prevent important military space technology from being shared in developing international norms for outer space traffic, space debris mitigation, and planetary defense against NEOs.

¹²⁸ See *Overview*, INT'L TELECOMM. UNION, <https://www.itu.int/en/about/Pages/overview.aspx> [<https://perma.cc/CJ7M-JFQ9>].

¹²⁹ These negotiations would also reinforce that the norms under consideration are of a technical nature and are not intended to lead to negotiation regarding economic exploitation of outer space.

B. NON-GOVERNMENTAL ENTITIES

The non-governmental entities are the major object and focus of new international norms for outer space. It is therefore most important that their special needs and situations be understood and expressed by their governments. Profit is the main motivation for the commercial operators, and a favorable business environment is necessary to make profit. That includes a safe, transparent, and predictable outer space. A fundamental aspect of private companies is that they are naturally oriented towards international business: they shift readily from one state to another depending on which state provides the best business climate, and they want their authorizing government to protect them from interference from operators authorized by other governments. In other words, they need internationally agreed-upon operating norms. They also want international action to stop and possibly reverse the increasing interferences from space debris. However, they do not want excessive international safety norms to restrict their economic exploitation activities.

A large number of start-up companies are venturing into business involving outer space operation,¹³⁰ and many do not appear to understand the applicable outer space legal framework.¹³¹ Thus, companies like Swarm Technologies¹³² may make erroneous assumptions, such as assuming that the Outer Space Treaty or the ITU's rules are inapplicable to them. Others are determined to change the existing framework to accommodate new technology, economics, and politics.¹³³

In addition, many commercial companies seek to establish trade associations to promote their interests in future governmental discussions about establishing new international outer space norms and regimes.¹³⁴ For example, the Space Data Association¹³⁵ consists of large established satellite operating companies like Intelsat, SES, and Eutelsat. These companies form trade associations and are well-established with a large number of satellites that have secure frequencies and orbital slots. They are pillars of the Satellite Industry Association and are inter-

¹³⁰ See Butt, *supra* note 36.

¹³¹ See *id.*

¹³² See *id.*

¹³³ See *About SIA*, SATELLITE INDUSTRY ASS'N, <https://www.sia.org/about/> [<https://perma.cc/P8XC-AWXA>].

¹³⁴ See *id.*

¹³⁵ See *Welcome to the Space Data Association*, SPACE DATA ASS'N, <http://www.space-data.org/sda> [<https://perma.cc/8ZC9-P49Z>].

ested in expanding and defending their existing interests against ideas that may threaten their business. These companies want maximum freedom to do business, but they also need order in outer space; however, order in outer space cannot be created by individual competing companies.

The Commercial Smallsat Spectrum Management Association is a group of new space operators¹³⁶ largely composed of companies controlling thousands of small satellites being or about to be launched. The names of the companies multiply and change as they merge and new companies appear. Blacksky, CICERO, EROS, OneWeb, Planet, Radarsat, Terra Bella, Northstar, Digital, Hawkey 30, and Kepler Communications are examples of small satellite companies.¹³⁷ These companies want to make room in outer space for their new operations and tend to favor an international regulatory authority that will establish order so that they can safely do business.¹³⁸

The Consortium for Execution of Rendezvous and Servicing Operations (CONFERS)¹³⁹ is directly interested in developing industry norms for servicing satellites in orbit. They are establishing voluntary standards for the satellite servicing industry. Airbus, Chandah Space Technologies, Intelsat General, Orbital ATK, and SSL (a unit of Maxar Technologies and XLCatlin) are the current participants in this association. They formed CONFERS at the invitation of the Defense Advanced Research Projects Agency. This group is of special interest in this study of outer space norms because the companies realized the need for uniformity and formed their own standards for the new satellite-servicing business.¹⁴⁰ This illustrates how space business needs diverse standards. Some standards, like those for satellite servic-

¹³⁶ See Caleb Henry, *Smallsat Companies Band Together in New Spectrum-Advocacy Organization*, SPACE NEWS (Sept. 22, 2017), <http://spacenews.com/smallsat-companies-band-together-in-new-spectrum-advocacy-organization/> [<https://perma.cc/Y2SV-JN72>] (discussing Commercial Smallsat Spectrum Management Association).

¹³⁷ See, e.g., *id.*

¹³⁸ Paul B. Larsen, *Small Satellite Legal Issues*, 82 J. AIR L. & COM. 275, 283–87 (2017).

¹³⁹ See Press Release, Consortium for Execution of Rendezvous and Servicing Operations, Industry Partners Help Establish Consortium for Satellite Servicing Standards (May 22, 2018), available at <https://www.satelliteconfers.org/wp-content/uploads/2018/05/CONFERS-Press-Release-05.23.18.pdf> [<https://perma.cc/E985-2JKE>] [hereinafter CONFERS Press Release] (discussing CONFERS).

¹⁴⁰ In-orbit satellite servicing business is expected to grow into a \$3 billion market over the next ten years. See Sandra Erwin, *In-Orbit Services Poised to Become Big Business*, SPACE NEWS 18, June 4, 2018, at 18.

ing, can be set by non-governmental entities themselves,¹⁴¹ but standards for space traffic, space debris, and NEOs require government regulation.

Space launch companies have been able to launch many small satellites together, thereby drastically lowering the launch price.¹⁴² Some launch companies, like SpaceX and Airbus, are both satellite operators and launch companies.¹⁴³ Other new launch companies are starting up, attracted by the new small satellite launch opportunities.

The customers of space operators are often governments contracting with private launch companies and satellite operators to save the cost of building satellites and launch rockets. For example, NASA contracts with private launch operators to provide transportation to the International Space Station.¹⁴⁴ That has saved NASA great expense but has also made it dependent on the availability of commercial operators. The recent SpaceX launch of a large satellite toward Mars shows that the non-governmental entities also become independent entrepreneurs in outer space.¹⁴⁵ Another feature of current space business is that people in countries that are not space powers become dependent on space operators from states that do have space capabilities. For example, a small satellite communications company, OneWeb, plans to establish a global net of about 800 small satel-

¹⁴¹ The best-known organization for standardization is the International Organization for Standardization (ISO). See *About ISO*, INT'L ORG. FOR STANDARDIZATION, <https://www.iso.org/about-us.html> [<https://perma.cc/RHR8-9UHN>]. It is a non-governmental entity that consists of the standardization societies of 162 countries. See *ISO Members*, INT'L ORG. FOR STANDARDIZATION, <https://www.iso.org/members.html> [<https://perma.cc/A5YE-YU7Z>]. ISO standards help increase productivity and marketing of products.

¹⁴² See, e.g., Loren Grush, *Later This Year, a SpaceX Falcon 9 Rocket Will Launch Its Biggest Batch of Satellites Yet*, THE VERGE (Aug. 6, 2018, 8:00 AM), <https://www.theverge.com/2018/8/6/17654372/spacex-falcon-9-spaceflight-industries-small-satellite-rideshare> [<https://perma.cc/8B9R-UP54>].

¹⁴³ See *About SpaceX*, SPACE X, <https://www.spacex.com/about> [<https://perma.cc/45MR-QV9A>]; *We Are Airbus*, AIRBUS, <https://www.airbus.com/company/we-are-airbus.html> [<https://perma.cc/C3AY-A6WB>].

¹⁴⁴ See Steven Sicheloff, *NASA Chooses American Companies to Transport U.S. Astronauts to International Space Station*, NAT'L AERONAUTICS & SPACE ADMIN., <https://www.nasa.gov/content/nasa-chooses-american-companies-to-transport-us-astronauts-to-international-space-station> [<https://perma.cc/3BX8-XF93>] (last updated Aug. 7, 2017).

¹⁴⁵ See Mike Wall, *SpaceX Launches Communications Satellite on 2nd-Ever Flight of New Rocket*, SPACE.COM (July 22, 2018, 2:25 AM), <https://www.space.com/41244-spacex-launches-communications-satellite-telesat.html> [<https://perma.cc/CR6G-MR4C>].

lites to provide internet access to developing countries through the use of small satellites.¹⁴⁶ These countries will then become dependent on OneWeb for internet access.

V. EXISTING SPACE LAW AFFECTING NORMS FOR SPACE TRAFFIC, SPACE DEBRIS, AND NEOS

A new international organization charged with establishing norms for civil actors in outer space would be subject to existing international laws and would have to ensure existing laws are reflected in the establishment of these new norms.

A. UN CHARTER

In the absence of a special UN sub-agency for outer space, the responsibility for international problems related to outer space traffic and debris will remain with the UN. Its legal authority is the UN Charter, which mandates the UN “to maintain international peace and security.”¹⁴⁷ The UNGA established the permanent COPUOS as a forum for discussion of outer space issues.¹⁴⁸ COPUOS has been the forum for negotiation of the five basic space law treaties and for several UNGA resolutions that have become guidelines for the UN member states.

B. OUTER SPACE TREATY¹⁴⁹

New international civil norms on space debris, traffic conjunctions, and defending Earth from NEOs must comply with the Outer Space Treaty, the foundational space law treaty. It states that (1) outer space must be used for the benefit of all countries without discrimination;¹⁵⁰ (2) outer space cannot be appropriated by any state by any means;¹⁵¹ (3) weapons of mass destruction in outer space are prohibited;¹⁵² (4) states are responsible for their non-governmental activities in outer space, which must be authorized and supervised by the appropriate national

¹⁴⁶ *Space: A Sudden Light*, THE ECONOMIST (Aug. 25, 2016), <http://www.economist.com/technology-quarterly/2016-25-08/space-2016> [https://perma.cc/SVT5-55AS].

¹⁴⁷ U.N. Charter art. 1, ¶ 1.

¹⁴⁸ See G.A. Res. 1348 (13 Dec. 1958); G.A. Res. 1472 (12 Dec. 1959).

¹⁴⁹ Outer Space Treaty, *supra* note 10; see LYALL & LARSEN, *supra* note 11, at 49; HOBE ET AL., COLOGNE COMMENTARY VOL. I, *supra* note 12.

¹⁵⁰ Outer Space Treaty, *supra* note 10, art. I.

¹⁵¹ *Id.* art. II.

¹⁵² *Id.* art. IV.

state;¹⁵³ (5) in outer space, states retain jurisdiction over space objects on their registry;¹⁵⁴ and (6) states must avoid harmful contamination of Earth and pay due regard to the corresponding interests of other states.¹⁵⁵ Any norms that would be established regarding space debris, outer space traffic, and NEOs would be subject to the law as laid out in the Outer Space Treaty.

C. RETURN OF SPACE OBJECTS

The Agreement on Aid to Astronauts and Return of Space Objects requires states and their non-governmental operators to give assistance to astronauts.¹⁵⁶ Under the Agreement, states shall return, or place at the disposal of the launching state, any lost space objects and their component parts.¹⁵⁷ However, objects of hazardous nature need only be placed at the disposal of the launching state.¹⁵⁸ The launching states must pay any costs incurred by the receiving state.¹⁵⁹ This treaty is significant because it specifically includes component parts of satellites in the same category as space objects. Thus, space debris, being component parts, may legally be characterized as space objects. Return of space debris assumes that the receiving state can identify the owner, which may be difficult, if not impossible. Any norms regarding space debris are also likely to conform with this treaty.

D. LIABILITY CONVENTION

States and their non-governmental operators that launch objects into outer space are broadly liable for damages caused to other states party to the Outer Space Treaty.¹⁶⁰ However, most states are now parties to the later and superseding Liability Convention, which provides for absolute state liability for damages caused in the air and on the surface of the Earth.¹⁶¹ Under the Liability Convention, liability is based on proof of fault for dam-

¹⁵³ *Id.* art. VI.

¹⁵⁴ *Id.* art. VIII.

¹⁵⁵ *Id.* art. IX.

¹⁵⁶ Rescue and Return Agreement, *supra* note 10, art. 2; LYALL & LARSEN, *supra* note 11, at 89; HOBE ET AL., COLOGNE COMMENTARY VOL. II, *supra* note 13, at 1.

¹⁵⁷ Outer Space Treaty, *supra* note 10, art. V.

¹⁵⁸ *Id.*

¹⁵⁹ *Id.*

¹⁶⁰ *Id.* art. VII.

¹⁶¹ Liability Convention, *supra* note 10, art. II.

ages caused in outer space.¹⁶² The Liability Convention also defines the term “space objects” as including component parts of a space object as well as its launch vehicle and its parts.¹⁶³ Launching states are liable for damages caused by their non-governmental entities. Although launching states are liable for debris damage, it could be difficult to establish ownership and fault under the Liability Convention unless the debris included large identifiable pieces. Lastly launching states are only liable for damages caused by direct impacts. Most states, including the United States, do not recognize liability for indirect damages under the Liability Convention.

E. REGISTRATION CONVENTION¹⁶⁴

The Registration Convention requires launching states to register space objects in the UN registry, which is an important, publicly accessible database.¹⁶⁵ Launching states are also required to register space objects in their national registries.¹⁶⁶ The purpose of registration is to clarify which countries exercise jurisdiction and control of space objects and, consequently, can be held responsible for them.¹⁶⁷ Importantly, the Registration Convention defines space object to include component parts of the space objects and their launch vehicles.¹⁶⁸ NEOs fall outside of the definition of space objects and are thus not subject to the Registration Convention. It would be an important safety improvement if known NEOs were registered in the UN registry database as soon as discovered. Alternatively, a separate UN database registry could be established for orbital locations of NEOs to be publicly filed.¹⁶⁹

¹⁶² *Id.* art. III.

¹⁶³ *Id.* art. I. However, NEOs are not considered space objects under the Liability Convention.

¹⁶⁴ UN Registration Convention, *supra* note 10; *see* LYALL & LARSEN, *supra* note 11, at 89; HOBE ET AL., COLOGNE COMMENTARY VOL. II, *supra* note 13, at 1.

¹⁶⁵ UN Registration Convention, *supra* note 10, art. III.

¹⁶⁶ *Id.* art. II.

¹⁶⁷ *Id.*; *see* LYALL & LARSEN, *supra* note 11, at 89; HOBE ET AL., COLOGNE COMMENTARY VOL. II, *supra* note 13, at 1.

¹⁶⁸ UN Registration Convention, *supra* note 10, art. I.

¹⁶⁹ Larsen, *NEOs*, *supra* note 1, at 377–78.

F. MOON AGREEMENT¹⁷⁰

The Moon Agreement applies to all celestial bodies within the Solar System (except for Earth); therefore, it applies to NEOs. However, it only applies among the eighteen parties to the Agreement. Much of the Moon Agreement is a repetition of the Outer Space Treaty. For example, Article IX of the Outer Space Treaty requires states to pay “due regard” to the corresponding interests of other states; a similar provision exists in the Moon Agreement’s Article 2. However, the principle that the Moon and celestial bodies are the common heritage of mankind is new.¹⁷¹ This would be an economic exploitation issue to be regulated separately, as provided in Moon Agreement Article 11(5). Economic exploitation should not be included in the new international regime establishing safety norms regarding space debris, space traffic, and NEOs.¹⁷²

G. ITU LEGAL REGIME

The ITU is a sub-agency of the UN. It regulates civil uses of radiofrequencies in outer space, including orbital slots of those satellites being navigated by use of radiofrequencies.¹⁷³ The ITU is charged with removing radio interferences with users’ access to those frequencies. Collisions in outer space may interfere with ITU management of assigned frequencies and orbital slots, so it would benefit from the establishment of international norms. The ITU would need to know about possible interferences by existing space debris that could endanger their satellites and orbital slots. Thus, the ITU is vitally involved in all

¹⁷⁰ Moon Agreement, *supra* note 10. Eighteen states are now parties to the Moon Agreement. Several states have joined recently. These states are treaty-bound to observe the Moon Agreement in their relations with each other.

¹⁷¹ *Id.* art. XI.

¹⁷² See discussion *supra* Section I. Note that the details of the economic regime for economic exploitation of outer space is further detailed in Moon Agreement Article 11. Specifically, Section (7)(a) discusses orderly and safe development of the natural resources; Section (7)(b) governs natural management of those resources; Section (7)(c) controls expansion of opportunities in use of those resource; and Section (7)(d) mandates equitable sharing in the benefits with special consideration given to the developing countries and to those countries which have contributed to exploration of those resources. Moon Agreement, *supra* note 10, art. 11(7).

¹⁷³ ITU Constitution, *supra* note 34, art. 1. The Federal Communications Commission coordinates with the ITU regarding use of radiofrequencies. See Christensen & Wolny, *supra* note 87; see also LYALL & LARSEN, *supra* note 11, at ch. 8 (entitled Radio and the International Telecommunication Union).

issues involving space collisions and space debris. The ITU is also involved with assisting in communication relief after disasters happen.¹⁷⁴

H. CUSTOMARY INTERNATIONAL LAWS¹⁷⁵

New civil international space debris, space traffic, and NEO norms would be subject to customary international law. Customary international law is defined by Article 38 of the Statute of the International Court of Justice as “general practice accepted as law” by the states.¹⁷⁶ Thus, polluters, whether they be states or non-governmental entities, may be held responsible for damages caused by their space debris pollution. They may also be held responsible for failure to observe the Precautionary Principle requiring states and non-governmental entities to exercise extraordinary caution in deciding whether to launch space objects that may cause space debris or that are likely to collide with outer space objects.¹⁷⁷

I. UN GENERAL ASSEMBLY RESOLUTIONS

The series of UNGA resolutions relating to space debris, space traffic, and NEOs is important for establishing norms for civil users.¹⁷⁸ While UNGA resolutions are not binding like treaties, they tend to establish norms for the states to adopt as binding regulations. The following rules are particularly important to consider.

1. *The IADC Space Debris Guidelines as Approved by COPUOS and Enacted as UNGA Resolution 62/101 on January 11, 2008*¹⁷⁹

The IADC guidelines have been adopted by major space powers as mandatory domestic regulations, but there is not uniform application because the states have accepted the guidelines dif-

¹⁷⁴ ITU Constitution, *supra* note 34, art. 46 (requiring ITU members to render assistance in disasters); *see* Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations art. 4, June 18, 1998, 2296 U.N.T.S. 5.

¹⁷⁵ LYALL & LARSEN, *supra* note 11, at 63–73.

¹⁷⁶ Statute of the International Court of Justice, art. 38, ¶ 1.

¹⁷⁷ *See* Larsen, *Application of Precautionary Principle*, *supra* note 112.

¹⁷⁸ *See, e.g.*, G.A. Res. 41/65 (Dec. 3, 1986); G.A. Res. 61/110 (Dec. 14, 2006).

¹⁷⁹ *See* G.A. Res. 62/101 (Jan. 10, 2008); *see also* Johnson, *supra* note 73; STEPHEN HOBE ET AL., COLOGNE COMMENTARY ON SPACE LAW (VOL. III), 605 (2015).

ferently. Agreement exists among the space debris experts that the IADC space debris guidelines should be further strengthened in order to limit additional generation of space debris.¹⁸⁰ These guidelines would be an excellent starting point for new binding, uniform space debris norms to be implemented by the states.

2. *The UNGA Resolution on the Use of Nuclear Power Sources in Outer Space: UNGA Resolution 47/68 of December 14, 1992*¹⁸¹

UN Resolution 47/68 is relevant to the establishment of norms for use of nuclear power sources (NPS), including the creation guidelines for reducing the generation of dangerous NPS debris.¹⁸² The UN Resolution concerns the prevention of NPS accidents happening in outer space. NPS contamination may also occur if an NPS-powered satellite disintegrates on impact with Earth. A precedent for such an event was established in 1978 when Kosmos 954, a Russian NPS satellite, crashed and scattered NPS debris over the tundra in Northern Canada.¹⁸³ Russia accepted responsibility for the debris damage, most of which remains where it landed in 1978.

3. *UNGA Resolution 62/101 of December 17, 2007: Recommendation on Enhancing the Practice of States and International Intergovernmental Organizations in Registering Space Objects*¹⁸⁴

Registration of space debris, particularly large identifiable space debris, remains a serious problem. The Registration Convention (as well as the Liability Convention) governs space objects, which is explicitly defined as including component parts. Registration requirements were construed to include space deb-

¹⁸⁰ See Larsen, *Solving the Space Debris Crisis*, *supra* note 1.

¹⁸¹ LYALL & LARSEN, *supra* note 11, at 255; HOBE ET AL., COLOGNE COMMENTARY VOL. III, *supra* note 179, at 401; *see also* Claim for Damage Caused by Cosmos 954, Can.-U.S.S.R., Feb. 8, 1978, 18 I.L.M. 899; Protocol on Settlement of Canada's Claim for Damages Caused by Cosmos 954, Can.-U.S.S.R., Apr. 2, 1981, 20 I.L.M. 689; LYALL & LARSEN, *supra* note 11, at 255 (section entitled Nuclear Power).

¹⁸² See G.A. Res. 47/68 (Dec. 14, 1992).

¹⁸³ See Marc Montgomery, *Canada History: Jan 24, 1978, Soviet Radiation Across the Arctic*, RADIO CAN. INT'L (Jan. 24, 2017), <http://www.rcinet.ca/en/2017/01/24/canada-history-jan-24-1978-soviet-radiation-across-the-arctic/> [https://perma.cc/USQ7-P8LR].

¹⁸⁴ See UN Registration Convention, *supra* note 10; LYALL & LARSEN, *supra* note 11, at 95(i); HOBE ET AL., COLOGNE COMMENTARY VOL. III, *supra* note 179, at 401.

ris in the early history of the Registration Convention. In the beginning of the space age, states, like the United States, registered space debris with the UN Registry, thereby acknowledging ownership and responsibility for their space debris. States discontinued registering space debris as it multiplied and identifying the smallest parts was impossible. This has created a problem in locating the small debris and identifying ownership of and responsibility for them. New international guidance on space debris registration is needed to establish norms for identification and assignment of responsibility for limiting and removing space debris.

4. *UNGA Resolution 59/115 of December 10, 2004: Application of the Concept of the "Launching State"*

The Registration Convention and the Liability Convention place responsibilities on the launching states to register satellites and component parts in the UN registry as well as for launching states to assume liability under the Liability Convention.¹⁸⁵ In both Conventions, the meaning of the term "launching state" is very broad.¹⁸⁶ It is defined to include four categories of states: (1) the states that launch space objects; (2) the states that procure the launching of space objects; (3) the states from whose territory space objects are launched; and (4) the states from whose facilities space objects are launched.¹⁸⁷ All four categories are "launching states." UNGA Resolution 59/115 encourages states to arrange and regulate the states' identification of the one state that authorizes the launch and supervises the satellite after launch so that it is clear which state is required to authorize and continuously supervise an individual space object.¹⁸⁸ An international norm on this issue should clarify and establish international uniformity. UNGA resolutions relating to space debris, space traffic, and NEOs are important for a new international organization that is establishing norms for civil users.

¹⁸⁵ See UN Registration Convention, *supra* note 10; Liability Convention, *supra* note 10, art. II.

¹⁸⁶ Compare UN Registration Convention, *supra* note 10, art. I(a), with Liability Convention, *supra* note 10, art. I(c).

¹⁸⁷ UN Registration Convention, *supra* note 10, art. I(a); Liability Convention, *supra* note 10, art. I(c); see HOBE ET AL., COLOGNE COMMENTARY VOL. II, *supra* note 13, at 363. Note that space objects are considered to include component parts under both treaties.

¹⁸⁸ See G.A. Res. 59/115 (Jan. 25, 2005).

VI. COMPARING INTERNATIONAL FRAMEWORK OPTIONS FOR MINIMUM CIVIL TECHNICAL SPACE NORMS

This section will examine and compare the strengths and weaknesses of a number of existing organizations as potential models for a new international organization to establish international norms for resolving space debris, STM, and NEO problems.

A. THE ICAO MODEL FOR ESTABLISHING NEW INTERNATIONAL NORMS

The ICAO is a sub-agency of the UN, but it is authorized by a separate treaty, the Chicago Convention.¹⁸⁹ ICAO's main task is to establish international norms (called standards and procedures) for international civil aviation.¹⁹⁰ If the ICAO model for establishing international norms for space activities prevails, such norms would be applicable as minimum standards in outer space.¹⁹¹ Since there is no sovereignty in outer space, these international norms adopted for outer space would become fully applicable as drafted and adopted by the international space organization. In this way, all civil traffic in outer space would navigate by the same norms and would be subject to the same uniform space debris regulations.

International norms could require all new launches to reduce or even cease adding more debris. Norms could be adopted to reduce the existing amount of space debris, in particular large debris. The goal would be to prevent the Kessler space debris syndrome from closing access to outer space. In addition, states would adopt joint procedures for coordinating and defending against NEOs threatening collision with Earth and for dealing with disasters caused by NEOs that cannot be deflected. States with special needs would be able to file special deviations to meet their needs.¹⁹²

¹⁸⁹ Chicago Convention, *supra* note 15, art. 37 (“Each contracting State undertakes to collaborate in securing the highest practicable degree of uniformity in regulations, standards, procedures, and organization in relation to aircraft, personnel, airways[,] and auxiliary services in all matters in which such uniformity will facilitate and improve air navigation.”).

¹⁹⁰ *About ICAO*, INT’L CIVIL AVIATION ORG., <http://www.icao.int/about-icao/pages/default.aspx> [<https://perma.cc/9KRM-RG4P>].

¹⁹¹ Chicago Convention, *supra* note 15, arts. 37, 38.

¹⁹² *Id.* art. 38.

In using the ICAO model to establish a new international civil space organization that would create international minimum norms for civil space activities, it would be necessary to appoint standing expert commissions on the subjects for which norms were to be established.¹⁹³ The expert commissions would recommend mandatory international norms to be adopted by a decision-making council, similar to the ICAO Council. Following the ICAO model,¹⁹⁴ membership on the Space Council should provide adequate representation of the major space powers, such as the United States, Russia, China, India, and the ESA, and ensure that all major geographic areas of the world are represented on the council. The size of the council would depend on the amount of activity prescribed by the enabling treaty, but in principle, the council should be small. Assemblies of all the member states would meet to set fundamental policy.¹⁹⁵

The ICAO model has proven effective and successful in establishing norms for aviation. ICAO has managed to preserve its technical nature and not be contaminated by international politics. The standing expert ICAO International Air Navigation Commission has formulated and updated norms as necessary. The urgent and continuing need for studying existing norms and updating them as the technology and environment change is particularly important for space debris. The world is in need of better rules for new debris, and much research is needed to remove existing debris and prevent it from multiplying as predicted by the Kessler Syndrome.

In comparison with the weak decision-making machinery of COPUOS, the ICAO decision-making authority shines. Expert drafting commissions would be able to focus expeditiously on new problems and to produce recommendations for a decision-making council. The council would operate by majority but tend to act in unison.

The space industry should be given an adequate role in shaping norms for its own activities. Incorporating industry input

¹⁹³ For example, space traffic, space debris, and NEO issues would each require a separate standing commission.

¹⁹⁴ Chicago Convention, *supra* note 15, art. 50. Extending ICAO jurisdiction and standards to outer space has been considered. See generally *The Need for an Integrated Regulatory Regime for Aviation and Space*, in *STUDIES IN SPACE POLICY* (Ram S. Jakhu et al. eds., 2011). That idea has not been accepted. See Ruwantissa Abeyratne, *Bringing Commercial Space Transport Regulatory Regime Under ICAO: Is it Feasible?*, 62 *ZLW* 387 (2013); LYALL & LARSEN, *supra* note 11, at 152.

¹⁹⁵ Chicago Convention, *supra* note 15, art. 43.

into decision-making would happen in several ways: (1) industry leaders should be invited by their own government to contribute to position papers for upcoming meetings of any of the decision-making bodies; (2) industry representatives should be invited to serve on national delegations to international meetings; and (3) knowledgeable international industry observers should be invited to participate in international meetings.¹⁹⁶

The ICAO-modeled decision-making organization would be costly. However, that cost would have to be measured against the cost of major collisions in outer space and their disastrous consequences. Space debris is accumulating fast, and outer space collisions with space debris will happen more and more frequently unless action is taken.¹⁹⁷ The ultimate result of inaction would be foreclosure of access to outer space.¹⁹⁸ Failure to act is not an option because the debris problem will be so much more difficult to resolve later than it is now.¹⁹⁹ The same argument applies to avoidance of space traffic conjunctions. Even NEOs require expedited action. Asteroid orbits must be identified and recorded. Their orbits must be studied to observe whether they threaten Earth. International protocols for planetary defense must be prepared. It is increasingly apparent that neither industry nor government can wait any longer to adopt uniform norms for their outer space activities. It is now not only a business requirement but also a public safety requirement.

B. PRESENT COPUOS AS THE MODEL FOR ESTABLISHING NEW INTERNATIONAL NORMS

The major function of COPUOS is to advise the UNGA on all outer space issues.²⁰⁰ In the absence of a specific UN sub-agency on outer space issues, like ICAO on aviation, IMO on maritime, and ITU on telecommunication issues, COPUOS is the international forum for discussion of all international space issues. Those issues are plentiful because outer space, being non-sover-

¹⁹⁶ Industry participation is common for ICAO working group meetings (the author is a former U.S. delegate to ICAO-related meetings and speaks from personal experience).

¹⁹⁷ See U.S. Space Policy Directive 3, *supra* note 1.

¹⁹⁸ See Kessler et al., *supra* note 53.

¹⁹⁹ ESA studies show that delay of remedial action until 2060 would be less effective than action now. *ESA BR-336 Space Debris: The ESA Approach*, EURO. SPACE AGENCY (Apr. 11, 2017), http://www.esa.int/About_Us/ESA_Publications/ESA_Publications_Brochures/ESA_BR-336_Space_Debris_The_ESA_Approach [<https://perma.cc/ECD9-399R>].

²⁰⁰ See G.A. Res. 1348 (XIII) (Dec. 13, 1958).

eign, is inherently international. Originally established in 1958,²⁰¹ COPUOS became the forum for negotiation of the space law treaties and several important UNGA resolutions on outer space. The IADC space debris guidelines²⁰² were processed by COPUOS, submitted to the UNGA for recommended adoption, and then adopted by UNGA in 2007.²⁰³ COPUOS is also the forum for discussion of STM issues. Further, COPUOS actively discusses NEO dangers and has recently created two advisory groups on NEO issues, International Asteroid Warning Network and Space Mission Planning Advisory Group.²⁰⁴

COPUOS's strength is that it has an actual mandate from the UNGA to examine outer space issues. On that basis, COPUOS recommends UNGA resolutions. UN member states are able to contribute to these recommendations and have benefitted from adopting them as their domestic laws and regulations. COPUOS activities on space debris guidelines, STM, and examination of NEOs are evidence of the benefits of COPUOS to outer space activities.

The question is whether the COPUOS activities sufficiently meet the needs for international outer space management and regulation. COPUOS, aided by UNOOSA, has only recommendatory authority; it does not have authority to adopt mandatory uniform norms by which operators can safely accomplish their business activities in outer space. Most importantly, COPUOS does not have decision-making authority. The recent drastic increase in outer space activities requires active management and operating norms. The COPUOS organization is much too slow and cumbersome to establish and administer operating norms for space debris and space traffic and to prevent NEO conjunctions. COPUOS also lacks expert standing committees like the Air Navigation Committee²⁰⁵ or the ITU Regulation Board.²⁰⁶ The new space problems are in fast motion and need consistent

²⁰¹ *Id.*; see also LYALL & LARSEN, *supra* note 11, at 13–18.

²⁰² See *IADC Space Debris Mitigation Guidelines*, *supra* note 83.

²⁰³ G.A. Res. 62/217 (Dec. 22, 2007).

²⁰⁴ NEAR-EARTH OBJECTS AND PLANETARY DEFENCE, *supra* note 98, at 12–14.

²⁰⁵ Chicago Convention, *supra* note 15, arts. 56, 57; see discussion of ICAO, *supra* Section VI.A.

²⁰⁶ ITU Constitution, *supra* note 34, art. 14.

monitoring and action. They cannot wait for the annual COPUOS meetings.²⁰⁷

C. ITU AS MODEL FOR INTERNATIONAL SPACE NORMS²⁰⁸

The ITU is also a sub-agency of the UN and, like ICAO, was established by its own constitution and treaty.²⁰⁹ It is virtually independent. ITU originated in 1865,²¹⁰ and its treaty provisions have been modified as new technology has developed.²¹¹

The ITU regulations are treaty obligations and thus differ from the ICAO standards, which are binding regulations without being treaty obligations. The ITU regulations are adopted by ITU World Assemblies²¹² and, as compared to ICAO standards, are less flexible and harder to amend and update because changes in regulations require adoption by a new assembly. Thus, the ITU process of establishing norms tends to be slower than the ICAO mode.

Applying existing radio regulations, the ITU Radio Regulations Board decides whether individual applications for use of frequencies conflict with existing users and would cause radio interference.²¹³ The Board meets four times a year.²¹⁴ With only twelve members, it is a small group, but each member must have expertise in the subject matter before the Board.²¹⁵ All their expenses are paid by the ITU, but they are not ITU employees.²¹⁶

²⁰⁷ COPUOS meets once every year. Meanwhile, new ICAO traffic norms were expeditiously developed after the disappearance of the Malaysian Airlines plane over the Indian Ocean. ICAO quickly adopted new standard requiring aircraft to report position every fifteen minutes. See *Malaysia Airlines Flight 370*, WIKIPEDIA, https://en.wikipedia.org/wiki/Malaysia_Airlines_Flight_370#Aircraft_tracking [<https://perma.cc/ZUM3-CE43>] (citing Joan Lowy, *Airlines Slow to Adopt Safety Technologies after MH370*, PHYS.ORG (Mar. 4, 2016), <https://phys.org/news/2016-03-airlines-safety-technologies-mh370.html>).

²⁰⁸ ITU Constitution, *supra* note 34.

²⁰⁹ See *id.*

²¹⁰ *Constitution and Convention*, INT'L TELECOMM. UNION, <https://www.itu.int/en/history/Pages/ConstitutionAndConvention.aspx> [<https://perma.cc/7X77-CQD4>].

²¹¹ LYALL & LARSEN, *supra* note 11, ch. 8 (entitled Radio and the International Telecommunication Union).

²¹² *Id.*

²¹³ See *Radio Regulations Board (RRB)*, INT'L TELECOMM. UNION, <https://www.itu.int/en/ITU-R/conferences/RRB/Pages/default.aspx> [<https://perma.cc/W22C-WX69>].

²¹⁴ *Id.*

²¹⁵ *Id.*

²¹⁶ LYALL & LARSEN, *supra* note 11, ch. 8 (entitled Radio and the International Telecommunication Union).

The ITU model could establish norms for space debris, traffic conjunctions, and planetary defense against NEOs. However, the ITU model would be less flexible than the ICAO model because norms would be developed at world assemblies of parties to the organizational treaty.²¹⁷ The proposed norms would not necessarily be of interest, nor fully appreciated or understood by delegates to the world assemblies called to adopt the regulations. These urgent issues would be better understood by the standing expert committees established under the ICAO model.

The ITU model would be less expensive to organize and operate than the ICAO model, but its deficiency in resolving the urgent space debris, space traffic, and NEO problems would probably not result in successful resolution of the problems.

D. NON-GOVERNMENTAL ORGANIZATIONS AS MODELS FOR MINIMUM SPACE NORMS

Space industry operators are concerned that national and international government-established operating norms may be too restrictive and may kill off the inventive start-up space business initiatives now appearing in the marketplace.

No one state or non-governmental entity can appropriate or assert sovereignty over outer space. The Outer Space Treaty Article IX requires states to pay due regard to the corresponding activities of other states.²¹⁸ But that requirement does not give one state regulatory authority over the business authorities of other states. Article IX merely requires appropriate international consultations.²¹⁹

Individual space businesses need room to experiment.²²⁰ At the same time, they are concerned about the intense competition and the need for some basic safety and traffic rules. Another complication is that the competing space businesses are of different nationalities, and the space businesses authorized by one state may receive inadequate protection from their authorizing state against competing businesses authorized by another state. The nations have to coordinate in order to establish order and basic operating rules for non-sovereign outer space by voluntary agreement.

²¹⁷ *Id.*

²¹⁸ Outer Space Treaty, *supra* note 10, art. IX.

²¹⁹ *Id.* arts. II, IX.

²²⁰ U.S. Space Policy Directive 3, *supra* note 1.

Several operators have sought to join together in associations for their own protection and coordination. A good example is the Space Data Association, in which large space operators like Intelsat, SES, and Euelsat have joined with large manufacturers such as Airbus, and even some space agencies like NASA and the German DLR, to pool information about traffic in outer space.²²¹ They have formed subcommittees on urgent issues such as safety, procedural developments, and interference with radio frequencies.²²² However, the large number of small satellite operators have tended to form their own association representing New Space. It is recognized that industry standard-setting organizations, such as the International Standardization Organization (ISO),²²³ and the new space standardization organization, CONFERS,²²⁴ have important roles for setting product standards for the space industry. However, the norms needed for management of space traffic, space debris, and NEOs require minimum government coordination among the states to establish international uniformity. Several industry observers call for some kind of international policing of outer space.²²⁵

The private associations can only depend on the goodwill of their competitors in obeying and complying with association rules. Private associations have no inherent police powers for enforcement other than legal action for breach of contract.²²⁶ Enforcement of contracts may depend on national laws and on national courts that may favor domestic business over foreign business. Furthermore, associations may be restricted by national antitrust and anti-monopoly laws.

Conflicting with the idea of operators working in unison for their common good is the proposition that space operators are basically in business for individual profit. Thus, an individual business may not be willing to sacrifice its profit motives for the sake of public safety. That becomes the nub of the question of whether to leave safety in outer space to be resolved by the non-

²²¹ SPACE DATA ASS'N, <http://www.space-data.org/sda> [<https://perma.cc/3F3N-MLDS>].

²²² *Committees and Working Groups*, SPACE DATA ASS'N, <http://www.space-data.org/sda/committees-and-working-groups/> [<https://perma.cc/3S3P-MU7D>].

²²³ *See About ISO*, INT'L ORG. FOR STANDARDIZATION, <https://www.iso.org/about-us.html> [<https://perma.cc/RZ9G-KDFN>].

²²⁴ *See* CONFERS Press Release, *supra* note 139.

²²⁵ Klotz, *Space Cop*, *supra* note 38, at 19.

²²⁶ *Id.*

governmental entities: each of the operators will always be motivated by self-interest. A neutral policing authority would therefore be more acceptable to direct traffic than competing business operators.

Importantly, the individual national governmental authorities do not have exclusive policing authority in outer space. The only effective solution is to establish international minimum operating norms for space debris generation, space traffic, and planetary defense. It appears that, for space business to succeed, international norms with adequate input from business operators will be the best solution for these urgent public safety problems for space business to succeed.

Standards and norms are commercial necessities. They enable businesses to satisfy a larger market demand for their products and services. Some technical standards and norms can be established by the commercial interests without government involvement, but others require minimum governmental regulation and oversight. Space traffic norms will benefit business enterprises, but they require international coordination and policing to assure uniformity. Reduction and elimination of space debris is another activity that requires international coordination combined with national enforcement. Planetary defense against threatening NEOs is yet another area beyond the ability of commercial enterprises to control. These three space activities requiring minimum government safety norms will help businesses prosper and allow space exploration to continue.

VII. APPRAISAL AND CONCLUSION

A. APPRAISAL

The time has been reached when international coordination of safety in outer space is necessary.²²⁷ Norms for outer space are required not only so that commercial non-governmental operators (who have only recently appeared) can safely do business in outer space. The need for norms is greater than that—the entire Earth-space infrastructure needs greater order. Common minimum international rules need to be established at this stage of space development. Fortunately, there are precedents for handling this dilemma. After World War II, basic standards were established to avoid collisions of airplanes.²²⁸ International

²²⁷ LYALL & LARSEN, *supra* note 11, at 270.

²²⁸ *About ICAO*, *supra* note 190.

maritime standards were also established.²²⁹ Basic standards for the use of radiofrequencies were developed by the ITUs which also regulates orbital location of space objects being navigated by use of radiofrequencies.²³⁰ The last of these is the most relevant because it initiated standard-setting for space activities.

Another important, relevant precedent was established by the decision not to include the military. The ITU, ICAO, and IMO standards were made applicable only to civil activities.²³¹ Military activities were not bound by the civil norms; however, in the long run, the military operators found it advantageous to adopt the civil norms to the extent possible in order to avoid possible collisions. The military operators realized that this accommodation was to their advantage as well. That kind of civil accommodation with the military operators is the only way that orderly norms can be adopted for outer space.

A third precedent for civil norms for space traffic, space debris, and NEOs comes from the separation of space exploration from economic exploitation addressed in the Outer Space Treaty and the Moon Agreement.²³² Consequently, the lesson from these precedents is that civil norms for outer space should concern safety and not apply to economic exploitation. That distinction has worked well in aviation, maritime practice, and telecommunication. It would also work well for outer space traffic, space debris reduction, and planetary defense.

Individual states have adequate flexibility under the ICAO model.²³³ States can file individual deviations from the international standards, and the individual states are fully in charge of enforcement of the mandatory standards. There is no enforcement by international authorities.

Establishing new norms for civil activities in outer space would require negotiation of a new treaty regime using the ICAO model. Like the Chicago Convention, it would create standing commissions to prepare and police norms. The drafts of these norms would have to be approved by a representative governing council and include an escape valve for individual states, allowing necessary deviations from the common standards and op-

²²⁹ *Introduction to IMO*, INT'L MARITIME ORG., www.imo.org/en/about/pages/default.aspx [<https://perma.cc/3WBC-AH46>].

²³⁰ See *Overview*, *supra* note 128.

²³¹ ITU Constitution, *supra* note 34, art. 48.

²³² See discussion *supra* notes 9–14. Note that the norms established by ICAO, IMO, and ITU are all essentially safety related.

²³³ Chicago Convention, *supra* note 15, art. 38.

erating procedures.²³⁴ The decision under U.S. Space Policy Directive 3²³⁵ to establish national STM is a step towards uniform management, but the growth of international space activity clearly points to the need for international uniformity. Outer space activities are inherently international, and only international norms and standards can reduce space debris and possible collisions.

Consequently, management of standards for space traffic, space debris reduction, and planetary defense against NEOs would be carved away from COPUOS. COPUOS would continue to deal with all other space issues. Basic common safety norms would apply in non-sovereign outer space. Commercial operators would be able to move safely, the entire Earth-space infrastructure would be secure for use, and outer space would continue to be accessible for exploration by mankind.

B. CONCLUSION

Based on review of four different models for establishing international minimum civil norms for space traffic, space debris, and planetary defense problems, the following conclusions may be drawn:

- (1) ICAO Model: Aviation experience with the ICAO model shows that establishment of standing expert committees making recommendations to a decision-making council is the most effective way to create mandatory norms for technical space issues. These international norms would need to be implemented by individual member states.
- (2) COPUOS: Existing experience with COPUOS shows that it is neither designed nor intended to be a decision-making body capable of establishing mandatory norms.
- (3) The ITU Model: Experience with the ITU model shows that it can produce norms for the relevant problems but that acceptable norms established by world assemblies that are administered by a small geographically representative board are probably not the best solution. The continuing need for and supervision of detailed norms is more than the world assemblies can produce; standing expert committees are better suited for this task. Furthermore, a standing body like the ICAO Council is needed to make final decisions about acceptable norms.

²³⁴ *Id.*

²³⁵ U.S. Space Policy Directive 3, *supra* note 1.

- (4) Effective non-government entities' regulation of space debris, space traffic, and NEO protection is not possible. The multitude of non-governmental entities, each motivated by profit as well as healthy competition among the operators, indicates that a government-directed international model such as the ICAO model would be more effective. However, non-governmental operators must participate in formulation of norms in order to ensure the users' needs for order are fulfilled and that their business incentives are respected and protected.

It is thus concluded that efficient international norms are necessary and that they can best be established by a strong international organization based on the ICAO model.²³⁶

²³⁶ The establishment of mandatory international norms for space debris, space traffic, and planetary defense against NEOs would require a treaty like the Convention on International Civil Aviation that established ICAO. The treaty would create an assembly, a decision-making council, and expert commissions. The council and commissions would be standing bodies. The council would have representation from the major space powers as well appropriate geographical representation. Decisions would be by majority votes.