Journal of Air Law and Commerce

Volume 83 | Issue 3 Article 2

2018

Solving the Space Debris Crisis

Paul B. Larsen
Georgetown University Law Center, pblspace@aol.com

SOLVING THE SPACE DEBRIS CRISIS

PAUL B. LARSEN*

ABSTRACT

Space debris is a growing public safety problem. As described by the Kessler Syndrome,[1] the increasing accumulation of debris will soon hinder and eventually preclude access to outer space unless the trend is swiftly reversed. The Inter-Agency Space Debris Coordination Committee's (IADC) Space Debris Mitigation Guidelines, as adopted by the United Nations (UN) Committee for the Peaceful Uses of Outer Space (COPUOS), are voluntary but are enforced as mandatory regulations by major space powers; however, the guidelines only apply to new debris. The European Space Agency's (ESA) 2017 Space Debris Conference concluded that existing space debris guidelines are inadequate and must be further strengthened in order to successfully control space debris.[2]

---

* The author taught air and space law for more than forty years respectively at Southern Methodist University and at Georgetown University. He is co-author of FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE (2d ed. 2018), widely used for teaching space law, and of PAUL B. LARSEN ET AL., AVIATION LAW, CASES AND RELATED SOURCES (2d ed. 2012).

[1] The Kessler Syndrome holds that space debris of critical mass will fragment in further collisions leading to a cascading chain activity. *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); *see also* STUFF IN SPACE, http://stuffin.space/?intldes=1993-016CH&search=1993-016CH [https://perma.cc/V9TJ-ARBQ] (STUFF IN SPACE is a real-time 3D map of objects in Earth orbit that updates daily).

[2] *See 7th European Conference on Space Debris: Proceedings Database*, EURO. SPACE AGENCY (Apr. 18, 2017), https://conference.sdo.esoc.esa.int/proceedings/list (last visited Sept. 4, 2018); *see also Space Operations Space Debris: The ESA Approach*, EURO. SPACE AGENCY (Mar. 2017), http://www.esa.int/About_Us/ESA_Publications/ESA_Publications_Brochures/ESA_BR-336_Space_Debris_The_ESA_Approach [https://perma.cc/EF7P-JRQ5]; *Solutions to Space Debris Problems Addressed at European Conference*, INSIDE GNSS, para. 5 (Apr. 24, 2017), http://insidegnss.com/solutions-to-space-debris-problems-addressed-at-european-conference/ [https://perma.cc/G2J5-LAW2].

An institutional problem is that the IADC, the committee that originated the current space debris guidelines, is not a UN body. It is an independent organization of the thirteen most active national space agencies. It lacks geographical representation. The IADC has no legal authority to monitor, change, or strengthen the international guidelines as debris accumulation increases. Moreover, the IADC lacks legal enforcement authority. This article will examine several possible alternatives for stronger space debris control. These options are: (1) strengthened COPUOS debris regulations; (2) international space debris regulation by an international organization on the International Civil Aviation Organization (ICAO) model; (3) international space debris regulation by an international organization on the International Telecommunication Union (ITU) model; (4) space debris regulation by a non-governmental organization; (5) bringing the IADC space debris activity into COPUOS in the form of a third subcommittee; and (6) separate international treaty regulation by and for the thirteen IADC states in the absence of UN action.

Ultimately it is the responsibility of the individual states under Article VI of the Outer Space Treaty (OST) to authorize, supervise, and police their generation of space debris and to hold operators responsible for debris.[3] This article makes final recommendations.

I. INTRODUCTION: THE SPACE DEBRIS PROBLEM

SPACE DEBRIS is an unresolved problem. The amount of debris from past activities in space has accumulated to the extent that there are several hundred thousand pieces of debris in orbit,[4] and the prospects for the old debris to be removed

---

[3] *See* Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies art. VI, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

[4] The total number of debris is unknown because only large pieces of debris can be tracked. *See, e.g.*, Kessler, *supra* note 1. The Kessler Syndrome states that large debris pieces constantly collide and fragment into yet smaller pieces, thus increasing the total number. *See id.* Even small debris is dangerous. *See, e.g.*, Johannes Van Zijl, *Space Debris Hit the International Space Station Causing Small Crack in Window*, THE SCI. EXPLORER (May 13, 2016), http://thescienceexplorer.com/technology/space-debris-hit-international-space-station-causing-small-crack-window [https://perma.cc/9D7Q-S2K5]. The International Space Station has been hit by small debris. *Id.* The tenfold increase in small satellites in outer space causes concerns about chaos. *See* Yousaf Butt, *Avoiding Collisions in Outer Space*,

from orbit are slim. Existing space law[5] is of little deterrence because it was established before space debris became generally recognized as a major problem. In fact, existing space law is in some ways a hindrance to the solution of the problem. Thus, the debris of past space activities continues to multiply as it fragments in accordance with the Kessler Syndrome.[6] Kessler predicts[7] that, unless a drastic remedy is introduced, the accumulation of debris will eventually preclude access to outer space. Most debris are too small to be tracked and are therefore unavoidable. The International Space Station, which is navigable, has been required to change orbit to avoid collision with debris twenty-five times.[8]

Space debris moves at a speed of 56,000 kilometers per hour.[9] It can cause great damage to other objects in outer space. Space debris also presents a risk of damage to activities on the surface of the Earth. This deterioration is growing rapidly. The Iridium

---

N.Y. TIMES (Mar. 19, 2018), https://www.nytimes.com/2018/03/19/opinion/space-race-regulation.html (last visited Sept. 4, 2018).

[5] The relevant space law treaties include:

(1) Outer Space Treaty, *supra* note 3;

(2) Convention on Registration of Objects Launched into Outer Space, Nov. 12, 1947, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention];

(3) Convention on the 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, 18 I.L.M. 1434, 1363 U.N.T.S. 3 [hereinafter Moon Agreement]; and

(6) Constitution of the International Telecommunication Union, *reprinted in* COLLECTION OF THE BASIC TEXTS OF THE INTERNATIONAL TELECOMMUNICATION UNION ADOPTED BY THE PLENIPOTENTIARY CONFERENCE 3–54 (2015) http://search.itu.int/history/HistoryDigitalCollectionDocLibrary/5.21.61.en.100.pdf [https://perma.cc/WC8J-JMAX] [hereinafter ITU Constitution].

[6] *See* Kessler, *supra* note 1.

[7] *See id.* at 2642.

[8] *See* Humaid Alshamsi et al., *As the Grapefruit Turns Sixty, It's Time to Get Serious About Clean Up in Outer Space*, 83 J. AIR L. & COM. 45, 51 (2018); *see also* Göktuğ Karacalioğlu, *Impact of New Satellite Launch Trends on Orbit Debris*, SPACE SAFETY MAG. (June 2, 2016), http://www.spacesafetymagazine.com/space-debris/impact-new-satellite-launch-trends-orbital-debris/ [https://perma.cc/24DY-SFEB].

[9] Matt Williams, *Eye-Opening Numbers on Space Debris*, UNIVERSE TODAY (Mar. 21, 2017), https://phys.org/news/2017-03-eye-opening-space-debris.html [https://perma.cc/G7GB-ANLM].

33 collision with a defunct Cosmos satellite in 2009 added more than 2,000 large pieces of debris.[10] An even larger amount of debris was caused in 2007 by China's deliberate destruction of a defunct weather satellite.[11] That resulted in about 3,000 pieces of debris, most of which are still in orbit.[12] One expert predicts that collisions with functioning satellites will begin to happen regularly beginning about the year 2036 and that the rate of collisions can then be expected to increase gradually, ending eventually with foreclosure to outer space.[13] ESA's 2017 Overview of Space Debris states that there may be as many as 750,000 space debris objects larger than one centimeter in outer space, and the ESA Overview observes:

> At typical collision speeds of 10km/s in low orbits, impacts by millimetre-sized objects could cause local damage or disable a subsystem of an operating satellite. Collisions with debris larger than 1 cm could disable an operational satellite or could cause the break-up of a satellite or rocket body. And impact by debris larger than about 10 cm can lead to a catastrophic break-up: the complete destruction of a spacecraft and generation of a debris cloud.[14]

The IADC Space Debris Mitigation Guidelines[15] are the only remedial scheme yet produced with a significant positive effect on space debris accumulation. The guidelines aim to mitigate the adverse consequence of space debris by identifying and publishing known ways to mitigate space debris.[16] However, the guidelines only reduce the amount of new debris. They do not resolve the existing debris problem, which continues to increase. Only actual removal of debris would resolve the space

---

[10] *Space Debris Mitigation*, SPACE SAFETY MAG., http://www.spacesafetymagazine.com/space-debris/mitigation/ [https://perma.cc/XZ2W-7Z7X].

[11] *Id.*

[12] *Id.*

[13] *See* Karacalioğlu, *supra* note 8; *see also Space Smash: Simulating When Satellites Collide*, EURO. SPACE AGENCY, http://www.esa.int/Our_Activities/Space_Engineering_Technology/Space_smash_simulating_when_satellites_collide [https://perma.cc/8AMP-9F5T].

[14] *See Space Operations Space Debris: The ESA Approach*, *supra* note 2, at Overview of Space Debris.

[15] Inter-Agency Space Debris Coordination Comm., *IADC Space Debris Mitigation Guidelines*, IADC-02-01 1, 1 (Sept. 2007), http://www.unoosa.org/documents/pdf/spacelaw/sd/IADC-2002-01-IADC-Space_Debris-Guidelines-Revision1.pdf [https://perma.cc/8MH5-6JWX] [hereinafter *IADC Space Debris Mitigation Guidelines*].

[16] *Id.* at 3.

debris problem.[17] Furthermore the guidelines are voluntary and depend on the individual states for adoption, monitoring, and enforcement.[18]

The Space Debris Mitigation Guidelines were authored by the IADC in 2002. The committee was formed by the national space agencies of Italy, France, China, Germany, India, Japan, the United States, Russia, Ukraine, and the ESA.[19] IADC is not an agency of the COPUOS, but the individual IADC countries are active COPUOS members. The IADC submitted its guidelines to COPUOS at which time they were modified by the COPUOS Scientific and Technical Subcommittee (STSC);[20] they were later adopted by the full COPUOS and, in 2008, approved by United Nations General Assembly (UNGA) Resolution 62/217, which recommended adoption of the guidelines by the individual UN member states.[21] The guidelines are not revolutionary. They reflect state practice in 2007. They are now twelve years old. When drafted, they were intended to be updated and revised.[22] That has not yet happened despite recognized need to be strengthened.[23]

Two kinds of space debris are treated differently in the IADC guidelines. One kind is short-term debris in low Earth orbit (LEO), which must be deorbited within twenty-five years.[24] Another kind is the long-term debris in geostationary Earth orbit (GEO), which cannot be deorbited within twenty-five years but must be sent out into a grave yard orbit before it becomes defunct.[25]

---

[17] *Space Debris Mitigation*, *supra* note 10.

[18] *See* U.N. Office For Outer Space Affairs, *Compendium of Space Debris Mitigation Standards Adopted by States and International Organizations*, http://www.unoosa.org/oosa/en/ourwork/topics/space-debris/compendium.html [https://perma.cc/H3E3-XLHX] [hereinafter *Compendium of Space Debris Mitigation*].

[19] *IADC Space Debris Mitigation Guidelines*, *supra* note 15, at 3.

[20] *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, http://www.unoosa.org/documents/pdf/spacelaw/sd/COPUOS-GuidelinesE.pdf [https://perma.cc/SDG9-9M46] [hereinafter *Space Debris Guidelines of COPOUS*].

[21] G.A. Res. 62/217, ¶¶ 26–27 (Feb. 1, 2008).

[22] *Id.* at ¶ 43.

[23] *See 7th European Conference on Space Debris*, *supra* note 2.

[24] *IADC Space Debris Guidelines*, *supra* note 15, at 9–10.

[25] *See id.* at 9.

The 2007 Space Debris Mitigation Guidelines approved by the UNGA are the following[26]:

(1) To limit the amount of debris released during normal operations;
(2) To minimize the potential for break-ups and to cause minimum space debris when break-up happens;
(3) To limit the probability of accidental break-up in outer space;
(4) To avoid intentional destruction of space objects and other harmful activities;
(5) To minimize the potential for post-mission break-up resulting from stored energy by designing spacecraft so as not to break up and spread debris pieces including fuel;
(6) To limit the long term presence of space craft and launch vehicle orbital stages in the LEO region after the end of their mission;
(7) To limit the long term interference of spacecraft and launch vehicle in the geosynchronous Earth region at the end of their mission.

Each of these guidelines covers a range of activities and capabilities. The guidelines must be applied in accordance with existing space law.[27] However, the guidelines themselves are not a treaty obligation.[28] They may be implemented in accordance with their interpretation by each nation-state.[29] Thus, implementation is not uniform.[30] By comparison, one can look at aviation standards and procedures under the ICAO and at the maritime standards and procedures under the International Maritime Organization (IMO).[31] The ICAO and IMO standards are drafted by experts within the two international organizations and adopted by the organization; then they become mandatory

---

[26] *Id.* at 8–9. For more discussion, see FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE 276 (2d ed. 2018); *see also* STEPHEN HOBE ET AL., COLOGNE COMMENTARY ON SPACE LAW, VOL. III 618–21 (2015).

[27] *Space Debris Guidelines of COPUOS*, *supra* note 20.

[28] *Id.*

[29] *Id.*

[30] *See Compendium of Space Debris Mitigation*, *supra* note 18 (listing standards adopted by states and international organizations containing the space debris regulations of twenty-four states and international organizations, except for Russia and China).

[31] Convention on the Intergovernmental Maritime Consultative Organization arts. 15, 21, 28, Mar. 6, 1948, T.S. No 22, 289 U.N.T.S. 48 [hereinafter IMO Convention].

for the member states, unless individual states file differences needed by that state.[32]

Since 2007, the discussion in COPUOS has mainly concentrated on application and enforcement of the original guidelines. However, there have been several new developments since 2007. There is an increasing sense that the guidelines need to be significantly strengthened. Contributing to greater pressure for stricter international space debris regulation is the tenfold increase in launches—caused by the launches of thousands of small satellites in LEO—expected in the immediate future,[33] the planned tourism of people in outer space, the greater dependence of some states like the United States on outer space activities, the developing military activities in outer space, the greater freedom of commercial space activities, and the looming Kessler Syndrome effects. Can IADC, as currently organized, meet the space debris crisis? Or is this the time for a new international body to examine the existing space debris situation, determine the new need for space debris rules, draft new rules as necessary, approve them, and submit them for eventual approval? To answer those questions, this paper will examine the IADC agency and its history, capabilities, and limits. This article will describe and evaluate alternatives to the IADC to generate new and stronger space debris rules.

II. TRACKING SPACE DEBRIS

When the location of space debris is known, it is possible for a maneuverable satellite to avoid collisions. Furthermore, satellite operators will avoid placing their satellites into orbits of known debris. The large debris are most dangerous; thus, the ability to

---

[32] Convention on International Civil Aviation art. 38, Dec. 7, 1944, 61 Stat. 1180, 15 U.N.T.S. 295 [hereinafter Chicago Convention]. *See* Paul B. Larsen, *Space Traffic Management Standards*, 83 J. AIR. L. & COM. 359, 368–69, 370–71 (2018) [hereinafter Larsen, *Space Traffic*].

[33] *See* Butt, *supra* note 4. The recent increase in start-up small satellite launch operators seeking space insurance is causing space insurers to fear costly accidents. *See* Debra Werner, *Space Insurance Prices Could Rise if New Rocket and Small Satellites Lead to Costly Accidents*, SPACE NEWS para. 2 (Apr. 9, 2018), http://bt.e-editionsbyfry.com/publication/?i=488138&article_id=3056568&view=articleBrowser&ver=html5#{%22issue_id%22:488138,%22view%22:%22articleBrowser%22,%22article_id%22:%223056568%22} (last visited Sept. 4, 2018) (reporting on the current volatility of the space insurance market). Added risk of accidents and collisions result in the higher space insurance prices. *Id.* Availability of affordable space insurance is an important incentive to do business in outer space. *See id.* Increasing danger of collisions with space debris will undermine this incentive.

track them is very important. Nevertheless, all the hundreds of thousands of smaller debris are also threatening.

Tracking is an important tool for avoiding collisions in outer space, but it does not solve the space debris problem. The U.S. Air Force Space Surveillance Network (SSN) tracks 23,000 debris larger than ten centimeters in LEO and larger than thirty centimeters in GEO.[34] The new Air Force Space Fence system will have ten times better tracking capability beginning in 2018.[35] Only a small percentage of objects tracked are operational and navigable. Almost all the debris are unable to navigate and thus not able to change course to avoid collision.

The most extensive tracking occurs through the SSN. However, the SSN is not intended for civilian tracking. Tracking military space objects is essentially what the SSN was tasked to do by the Air Force. It exists for national security. Fortunately, the SSN has so far been willing to share its tracking information with civilian users. However, the SNN is now seeking to be relieved of the civilian users' dependence on it.[36] Some satellites are very small and may cause collisions because they are not trackable by the SSN.[37]

III. EXISTING SPACE LAW[38]

Space debris is subject to existing international space law. Because space law was negotiated and established before debris was recognized as a problem, it does not address debris directly, and it can even be an obstacle to debris removal and liability.

Use of the state authorizing (licensing) process to regulate generations of space debris is fundamental to resolution of the space debris problem. Satellites operating in outer space are required to comply with existing international space law—regard-

---

[34] *See* Mike Gruss, *Good (Space) Fences Make for Good (Orbital) Neighbors*, SPACE NEWS para. 7 (Sept. 19, 2016), https://spacenews.com/good-space-fences-make-for-good-orbital-neighbors/ [https://perma.cc/5H7K-LFJP].

[35] *Id.* In higher orbits, the Air Force can track space debris as small as one meter. *See* DAVID WRIGHT, THE CURRENT SPACE DEBRIS SITUATION 5 (2010), https://swfound.org/media/99971/wright-space-debris_situation.pdf [https://perma.cc/T7GQ-TJPD].

[36] *See also* Jeff Foust, *FAA Pins Price on Taking on Space-Traffic Job*, SPACE NEWS para. 2, 7–8 (Nov. 7, 2016), http://www.spacenewsmag.com/feature/faa-pins-price-on-taking-on-space-traffic-job/ [https://perma.cc/YZ83-G2XV].

[37] *See* Butt, *supra* note 4.

[38] *See* Outer Space Treaty, *supra* note 3; *see* Registration Convention, *supra* note 5; *see* Liability Convention, *supra* note 5; *see* Rescue and Return Agreement, *supra* note 5; *see* Moon Agreement; *see* ITU Constitution, *supra* note 5.

less of whether the satellites are operated by states or by non-governmental entities.[39] Only authorized satellites may be launched and operated in outer space.[40] States are responsible for compliance with space treaties by their authorized satellite operators. The governmental authorization process is the major tool for states to ensure that their authorized operators are able and willing to comply with existing space debris regulations, whether imposed by treaty or by domestic regulations, such as the IADC space guidelines if they are enforced by national regulation. Launches should only be authorized if they are operated in compliance with space debris regulations and guidelines. Unauthorized operators cannot launch legally. Delinquent operators should be required by the authorizing country to deorbit.

A. What is Debris?

Space law does not define space debris. The OST applies to "space objects," but it does not define space objects.[41] The basic question arises whether a piece of space debris is a "space object" and thus governed by existing space law.[42] Both the Liability Convention and the Registration Convention provide that the definition of space object includes their component parts as well as the launching rocket and its component parts.[43] Space debris is therefore considered by space law experts to be space objects.[44]

The owner of a defunct satellite may not wish to define a defunct satellite as space debris for several reasons, one of them being that the owner wishes to retain the orbital slot and will replace the defunct satellite with a working satellite. However, Article II of the OST clearly states that outer space cannot be

---

[39] *See* Outer Space Treaty, *supra* note 3, art. VI.

[40] *See id.*

[41] *Id.* art. X.

[42] *See id.* If space debris is a space object then it is included under the Outer Space Treaty which applies to manmade space objects. If space debris is left out of the definition of "space object," could it then become subject to the Outer Space Treaty Article II, which prohibits appropriation of celestial bodies? *See id.* art. II.

[43] *See* Registration Convention, *supra* note 5, art. 1(b); *see also* Liability Convention, *supra* note 5, art. 1(d).

[44] *See* Hobe et al., *supra* note 26, at 445–46; *see* Lyall & Larsen, *supra* note 26, at 270–75; *see also* Ram S. Jakhu & Md Tanveer Ahmad, *The Outer Space Treaty and States' Obligation to Remove Space Debris: A US Perspective*, Space Rev. para. 9 (Nov. 13, 2017), http://www.thespacereview.com/article/3370/1 [https://perma.cc/C2N6-UQCA].

appropriated "by means of use or occupation, or by any other means."[45] Thus, there is no property right in an orbital slot.

The IADC Space Debris Mitigation Guidelines as adopted by COPUOS define debris as follows: "[s]pace debris are all man made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non functional."[46] The IADC guidelines were not considered by the COPUOS Legal Subcommittee, which is the reason why the guidelines have only this practical definition of space debris.[47] However, since the guidelines were adopted in 2007, the definition has achieved some legal significance as accepted state practice.[48]

B. Harmful Interference with Other States' Activities in Outer Space

In principle, states may not preclude access to outer space by other states. Thus, continued deposits of space debris that may preclude access to outer space would be contrary to Article I of the OST.[49] Specifically, states are prohibited from harmful interference with the space activities of other states under Article IX of the OST.[50] States must respect and pay "due regard" to the interests of other states in outer space.[51] Article 7 of the Moon Agreement also prohibits harmful changes to the Earth's environment.[52] These restrictions govern non-governmental operators operating in outer space under the legal umbrella of their authorizing states.[53]

C. Removal of Debris in Outer Space

The need for removal of debris from outer space motivates much research activity on removal satellites that can repair, renew, and remove defunct satellites and debris.

---

[45] Outer Space Treaty, *supra* note 3, art. II.

[46] *IADC Space Debris Mitigation Guidelines*, *supra* note 15, at 5.

[47] *See* Hobe et al., *supra* note 26, at 612–16.

[48] Accepted state practice is proving the establishment of customary international law. *See* North Sea Continental Shelf (Fed. Repub. Ger. v. Den. & Neth.), 1969 I.C.J. ¶ 1, ¶ 71 (Feb. 28). The other requirement would be *opinio juris*, i.e., support of experts. *Id.*; *see also* Part III.I, *infra.*

[49] Outer Space Treaty, *supra* note 3, art. I.

[50] *Id.* art. IX.

[51] *Id.*

[52] *See* Moon Agreement, *supra* note 5, art. 7, sec. 1.

[53] Outer Space Treaty, *supra* note 3, arts. VI, VIII.

1. Removal of Debris by Its Launching State

A launching state may remove the debris caused by satellites that it authorized in accordance with its own laws, pursuant to Articles VI and VIII of the OST.[54] Pursuant to Article VIII of the OST, objects launched into outer space, including by non-governmental entities, remain subject to the property laws of the launching party.[55] Furthermore, any component part of launched space objects, including its space debris, remains the property and responsibility of the original owner.[56] Thus, early in the space age, launching states like the United States would register large debris pieces as space objects under the Registration Convention.[57] However, the proliferation of space debris, the identity of which was often uncertain, caused states to stop registering debris.

The space debris identity problem is significant. When China caused the demolition of its defunct satellite in LEO,[58] it caused a large cloud of space debris. Space debris interferes with the safety of the space objects of other states, including the safety of orbiting space stations in LEO as well as transit of launch vehicles through LEO to deep space. Eventually this debris will deorbit and may harm the surface of the Earth.[59]

One possible remedy for the space debris problem would be to require the owners of satellites and launch vehicles to post bonds to insure against possible pollution. Such bonds would be

---

[54] *Id.*

[55] *Id.* The Outer Space Treaty Article VIII provides that "[o]wnership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to Earth." *Id.* art. VIII.

[56] *Id.* Issues of jurisdiction, control, and ownership of space objects (including their components such as space debris) are made subject to the law of the state of their registration by the launching state. *Id.*

[57] *See, e.g.*, Letter from Permanent Representative of the United States of America to the Secretary General of the United Nations (Mar. 29, 1976), http://www.unoosa.org/documents/pdf/inf339E.pdf.

[58] *See 2007 Chinese Anti-Satellite Missile Test*, WIKIPEDIA para. 1, https://en.wikipedia.org/wiki/2007_Chinese_anti-satellite_missile_test [https://perma.cc/3EVX-JDV5].

[59] *See* Leanna Garfield, *China's Out-of-Control Space Station May Release a Toxic Chemical When It Crashes*, BUS. INSIDER para. 3 (Mar. 30, 2018) http://www.businessinsider.com/tiangong-1-chinese-space-station-crash-hydrazine-2018-3 [https://perma.cc/685E-HLR9] (reporting on non-navigable defunct Chinese space station deorbited in the Pacific Ocean on April 2, 2018). The IADC is examining the reentry. *See* LYALL & LARSEN, *supra* note 26, at 107–14 (discussion of reentry); *see also Spotted in Space*, SPACE IN IMAGES (Mar. 8, 2018), http://www.esa.int/spaceinimages/Images/2018/03/Spotted_in_space [https://perma.cc/45YQ-GSJS].

available to compensate victims of collisions and for the removal of debris caused by the collision.[60] Consequently, a Global Fund for Space Debris Removal, available for removal expenses, has been proposed.[61] A need exists for an insurance fund to compensate for damages caused by space debris in outer space.[62]

2. Removal of Debris by Third Party States

Uncertainty about ownership of unidentifiable space debris represents a difficulty in appropriation and removal of space debris by states other than by the original launching state of registry.[63] The problem is that some debris cannot be identified, and thus, a claimant cannot prove that it belongs to an identifiable launching party. That may present uncertainty for a launching state about its legal right to valuable space debris. But, in addition, it presents particular legal difficulty as to the right of third party states to remove such debris. The uncertainty of property rights to debris causes third party states to hesitate to remove unregistered and unclaimed space debris. A general international agreement to waive sovereign claims to unidentified space debris to facilitate removal of debris by third parties is recommended.[64]

Related to the removal issue is the 1992 UN Conference on Environment and Development, which adopted the principle that where there is danger of irreversible damages to the environment the threatened states may exercise preventive measures. This principle is also expressed in Article 17(2) of the European Community Treaty. The EU Treaty requires that the preventive measures must be proportional to the danger.[65]

---

[60] *See Polluter Pays*, SUSTAINABLE ENVIRONMENT, http://www.sustainable-environment.org.uk/Principles/Polluter_Pays.php [https://perma.cc/4CL8-HSKZ].

[61] Alshamsi et al., *supra* note 8, at 61–64 (describing the McGill Declaration on Active Space Debris and On-Orbit Satellite Servicing).

[62] *See* LYALL & LARSEN, *supra* note 26, at 270–75; *see also* Mark J. Sundahl, Note, *Unidentified Orbital Debris: The Case for a Market-Share Liability Regime*, 24 HASTINGS INT'L & COMP. L. REV. 125 (2000).

[63] *See* LYALL & LARSEN, *supra* note 26, at 270–75.

[64] *See* Alshamsi et al., *supra* note 8, at 58–60. The authors suggest that such a waiver could be accomplished through the consultations required under Article IX Outer Space Treaty in order to resolve possibilities of harmful interferences with other states. *Id.*

[65] *See* European Commission Press Release IP/00/96, Commission Adopts Communication on Precautionary Principle (Feb. 2, 2000); *see also* Paul B. Larsen, *International Regulation of Near Earth Objects (NEOs)*, 67 ZLW 104, 116 (2018) [hereinafter Larsen, *International Regulation*].

D. Liability for Damages in Outer Space and on Earth

States are internationally liable for damages caused by their satellite operators, including non-governmental entities, whether in outer space or on the surface of the Earth pursuant to the OST.[66] Launching states are liable not only for damages caused by space objects and their component parts, including space debris, but also for debris of the launch vehicle and its parts. Subsequent to the OST, most states have adopted the Liability Convention, which establishes absolute state liability for all damages caused by space objects and space debris of their state and non-governmental entities on the surface of and in the atmosphere of the Earth.[67] Liability for damage by their space debris in outer space is subject to proof of fault.[68] Thus, space objects entering Earth's atmosphere and causing damage are subject to absolute liability for damages caused. However, most damages are caused in outer space, which is governed by a liability regime based on proof of fault by the operator.[69] Much space debris will be difficult to trace to any state and it may thus be impossible to hold states liable under the Liability Convention. Absolute state liability for damages caused by space debris would be a significant deterrent. States would thus be cautioned not to authorize outer space activities that may result in space debris and, consequently, state liability.

Space objects may be launched by international organizations, in which case the international organization is primarily liable, and the individual member states are secondarily responsible for liability.[70]

E. Registration

The Registration Convention requires registration of all space objects, including their components.[71] The purpose of this Convention is to indicate space objects' location in orbit so that they can be avoided and to identify responsible states.[72] Thus, the Convention appears to be intended for registration of known dangerous space debris. Indeed, the reference to components

---

[66] *See* Outer Space Treaty, *supra* note 3, art. VII.

[67] Liability Convention, *supra* note 5, art. II.

[68] *Id.* art. III.

[69] *Id.*

[70] *Id.* art. XXII.

[71] Registration Convention, *supra* note 5, art. I(b), II (defining space objects to include their component parts as well as the "launch vehicle and parts thereof").

[72] *Id.* at Introduction.

appears to require states to register space debris. States such as the United States registered large space debris during the early period of the space age.[73] However, the registration of small pieces of debris presents a practical problem, because most debris is of miniscule size and nearly impossible to register. Even the launching state may not know and recognize all the debris caused by launches or collisions. UNGA Resolution 62/101[74] made recommendations for states to adopt uniform practices in registering space objects. The resolution recommends that the physical condition of space objects, changes in orbit, rate of decay, and possible reentry of objects should be reported to the UN registry.[75]

It is apparent that any ambiguity as to whether identifiable debris should be considered a space object as opposed to being treated separately should be resolved in favor of registering identifiable debris in orbit. One interesting idea is to consider registration as indication of ownership[76] and to treat all unregistered debris as free of ownership claims and thus freely removable by third parties.[77]

F. Duty to Warn of Impending Danger of Collisions with Space Debris.

Related to the discussion of registration is the duty of states to inform other states and the UN Secretary General about observed dangers to astronauts.[78] States that believe their outer space activities may harm other states must first engage in consultations with other states in order to alert them of threatening dangers.[79] The duty to warn is also expressed in the UNGA Remote Sensing Resolution 41/65 of 1985.[80]

---

[73] *See, e.g.*, Letter from Permanent Representative of the United States of America to the Secretary General of the United Nations (Mar. 29, 1976), http://www.unoosa.org/documents/pdf/inf339E.pdf.

[74] G.A. Res. 62/101, ¶ 2 (Dec. 17, 2007).

[75] *Id.*

[76] *See* Outer Space Treaty, *supra* note 3, art. VIII (linking ownership to registration).

[77] *See* Alhamsi et. al., *supra* note 8, at 62. Alhamsi, Balleste, and Hanlon suggest that registration should determine ownership. *Id.* Thus, unregistered debris could be freely removed by third parties. *Id.*

[78] *See* Outer Space Treaty, *supra* note 3, art. V. The UN Secretary General in turn should notify the States.

[79] *Id.* arts. IX, XI; *see also* Moon Agreement, *supra* note 5, arts. 5, 6, 7.

[80] *See* G.A. Res. 41/65 (Dec. 3, 1986).

G. Radioactive Debris in Outer Space

Space debris from nuclear explosions in outer space is specifically prohibited by the Limited Nuclear Test Ban Treaty of 1963.[81] However, states are permitted to use nuclear power sources (NPS) to generate electric energy for the operation of satellites. NPS debris is of particular interest because of its dangerous nature. NPS debris became an actual problem with the disintegration of the Russian satellite COSMOS 954 over Northern Canada, which spread nuclear debris over a large area of the Canadian tundra in 1978.[82] Russia (then the USSR) acknowledged its responsibility by agreeing to compensate Canada for the damages caused.[83]

NPS debris, in addition to being regulated by existing regulations on space debris, is also subject to the 1992 UN Principles Relevant to the Use of Nuclear Power Sources in Outer Space.[84] The UN Principles seek to minimize the use and danger of radioactive space debris. Only U235-enriched uranium may be used to generate electricity.[85] NPS reactors may be used if sent into high graveyard orbits at the end of their use.[86] Reactors may not be made critical until they reach operating orbit or in interplanetary travel.[87] Radioisotope generators (RTG) must also be stored in high graveyard orbit at the end of use.[88] NPS energy sources must be safely enclosed so that they will not fracture and cause contamination if they reenter the Earth's atmosphere and land on the surface of the Earth.[89]

H. Return of Debris

Article VIII of the OST provides that space objects, including their components, found outside their state of registration must be returned to the state of registry upon proof of ownership.[90] Thus space debris, being included within the definition of the

---

[81] *See* Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water art. I, Aug. 5, 1963, 480 U.N.T.S. 43.

[82] Canada: Claim against the Union of Soviet Socialist Republics for Damage Caused by Cosmos 954, 18 I.L.M 899 (1979).

[83] *Id.*

[84] *See* G.A. Res 47/68 (Dec. 14, 1992).

[85] *Id.* at Principle 3(2)(c).

[86] *Id.* at Principle 3(2)(a)(iii).

[87] *Id.* at Principle 3(2)(d).

[88] *Id.* at Principle 3(3)(a).

[89] *Id.* at Principle 3(3)(b).

[90] *See* Outer Space Treaty, *supra* note 3, art. VIII; *see also* Search and Rescue Convention, *supra* note 5, arts. 4, 5.

"component parts" of space objects, must be returned.[91] It is impossible to prove ownership of most space debris. That would relieve states of their duty to return. There is uncertainty about the legal right to dispose of found debris. However, much debris is of no value, so the states of registry may not wish to claim ownership.

Article 5 of the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space[92] specifically requires states to notify launching authorities of recovery of their debris and to place it at the disposal of the launching authority. However, the Agreement provides that cost of recovery and return shall be paid by the launching authority.[93]

I. Customary International Law

A question remains whether a state must remove space debris that originates from objects it authorized to be placed in outer space. Article 38 of the Statute of the International Law of Justice states that the International Court of Justice shall apply customary international law in deciding disputes brought before the court.[94] Customary international law is evidenced by "general practice accepted as law" by the states.[95] For guidance the court looks at precedents set by prior international law decisions. A court of arbitration in the Trail Smelter Case[96] issued a seminal decision on pollution. It held that a state (Canada) was liable for pollution damage caused to another state (the United States).[97] Several other international court cases concluded likewise.[98] Thus, it is customary international law that states can be held responsible for pollution damage caused to other states.

Space debris may be viewed as pollution of outer space. That may trigger the customary international law principle that the

---

[91] Outer Space Treaty, *supra* note 3, art. VIII.

[92] *See* Rescue and Return Agreement, *supra* note 5, art. 5.

[93] *Id.*

[94] *See* The Statute of the International Court of Justice art. 38, 1977 U.N.Y.B. 31, U.N. Sales No. E.79.1.1; *see also* Vienna Convention on the Law of Treaties, May 23, 1969, 1158 U.N.T.S. 331; Lyall & Larsen, *supra* note 26, at 63–73.

[95] *See* The Statute of the International Court of Justice art. 38, 1977 U.N.Y.B. 31, U.N. Sales No. E.79.1.1.

[96] *Trail Smelter Arbitral Tribunal*, 33 Am. J. Int'l. L. 182, 182 (1939).

[97] *Id.* at 182.

[98] *See* Corfu Channel Case (U.K. v. Alb.), Judgment, 1948 I.C.J. Rep. 1 (Dec. 17); *see also* Factory at Chorzow (Ger. v. Pol.), Judgment, 1928 P.C.I.J. (ser. A) No. 13 (Sept. 13).

polluter must pay for pollution damage caused by the polluter. The principle may apply not only to prevent the polluter from engaging in pollution of outer space but also to cause the polluter to compensate for the damage.[99] The principle that the polluter pays for pollution it caused is adopted in Article 191(2) of the Treaty of the Functioning of the European Union and it is increasingly adopted into national legislation, including U.S. environmental laws.[100]

Also, relevant as customary international law is the Precautionary Principle, which requires launching states to exercise extraordinary caution in deciding whether to launch objects into outer space when there is a significant element of uncertainty about the outcome.[101] Thus, if a launch includes the danger of space debris causing irreversible damage, then the Precautionary Principle would require a launching state as well as a nongovernmental operator to take extra precaution in launching a space object that may result in space debris. Such a precaution would, at a minimum, require a state and an operator to observe the Space Debris Mitigation Guidelines, which are founded on normal operating procedures. The liability that a state and an operator incur for violating the Precautionary Principle will be an incentive to avoid and minimize causing space debris. Being a legal principle that is protective of the Earth's environment, it can be read into Article IX of the OST, the purpose of which is also to protect the Earth's environment.[102]

J. State of Convenience Problem

Many small states do not have the resources to fully carry out their responsibilities under existing space law, but they may still encourage operators of space objects to register and be authorized in their states. These are so-called "flag of convenience"

---

[99] *See Principles of EU Environmental Law: The Polluter Pays Principle*, Euro. Comm'n 1, 6 (2012), http://ec.europa.eu/environment/legal/law/pdf/principles/2%20Polluter%20Pays%20Principle_revised.pdf [https://perma.cc/RC2M-X3YK] [hereinafter *Principles of EU Environmental Law*]; *see also Polluter Pays Principle*, Wikipedia, https://en.wikipedia.org/wiki/Polluter_pays_principle [https://perma.cc/Q5FC-8E8G].

[100] *See Principles of EU Environmental Law*, *supra* note 99, at 14.

[101] Paul B. Larsen, *Application of the Precautionary Principle to the Moon*, 71 J. Air L. & Com. 295, 296 (2006).

[102] *See* Larsen, *International Regulation*, *supra* note 65, at 117.

states, a familiar phenomenon of maritime law.[103] At issue are states' responsibilities and liabilities under the OST, the Liability Convention, the Registration Convention, the ITU Constitution, and the ITU Convention (including its radio regulations).[104] Some small states encourage commercial operators to operate out of their states by "offering incentives and accommodating regulatory frameworks as the proliferation of new technologies and companies continues apace."[105] Thus, the flag of convenience states present a possible weakness in the legal framework for regulation of space debris and for minimizing its effects. Flag of convenience is a developing trend in current space commerce and needs to be considered.[106]

IV. URGENCY OF THE SPACE DEBRIS PROBLEM

A. New Debris Restrictions are Needed

The IADC guidelines are not universally adopted and, where adopted, they are implemented differently by the nation-states. The ESA Overview of Space Debris[107] reports that the IADC guidelines, being voluntary, lack enforcement. LEO is the most critical space environment that needs to be more strictly regulated. "Only 25% of the rocket upper stages and 10% of the satellites in LEO perform an active manoeuvre in order to comply with the IADC recommendations."[108]

A drastic increase in new launches is expected in the near future. In 2017, there were 3,200 intact objects in LEO.[109] One expert estimates launches of 6,200 small satellites are actually scheduled for the 2017–2026 time period.[110] Another recent

---

[103] Frans G. von der Dunk, Towards "Flags of Convenience" in Space? 2 (2012), http://www.unoosa.org/pdf/pres/lsc2012/symp-05E.pdf [https://perma.cc/9A7Q-HDKR].

[104] *See generally* Lyall & Larsen, *supra* note 26; *see also* Alshamsi et al., *supra* note 8, at 55.

[105] *See* Butt, *supra* note 4. This author points to Luxemburg and United Arab Emirates as examples. *Id.* Neither country has a member agency in the IADC. *See* Inter-Agency Space Debris Coordination Committee, https://www.iadc-online.org/ [https://perma.cc/5KG2-WC83].

[106] *See* Butt, *supra* note 4 (noting the problems posed by the use of flags of convenience in space with respect to debris).

[107] *See Space Operations Space Debris: The ESA Approach*, *supra* note 2.

[108] *Id.*

[109] *Active Debris Removal*, Euro. Space Agency (Apr. 14, 2017), https://m.esa.int/Our_Activities/Operations/Space_Debris/Active_debris_removal [https://perma.cc/V6Z6-NM2L].

[110] *See* Jaroslaw Adamowski, *Smallsat Market Forecast to Exceed $30 Billion in Coming Decade*, Space News (Aug. 9, 2017), https://spacenews.com/smallsat-market-

source reports that at least 8,000 satellites are currently planned to be orbited by LEO and MEO broad band constellations from a number of countries, including the United States, China, Canada, South Korea, Russia, India, and England[111] (the space agencies of these countries are members of the IADC).

Such a large, unprecedented proliferation of new launches presents a new situation, causing IADC to review whether the current IADC guidelines are adequate. This increase in launches raises the issue of whether the twenty-five year deorbit rule should be strengthened by requiring quicker deorbits. The 2017 IADC report states: "It is clear that significant improvements in the reliability of the disposal function at end of life will be needed for the new constellations compared with that currently demonstrated by space systems on orbit."[112] IADC favors stricter rules and enforcement thereof.

Several studies and models of the growing danger have been made. The NASA orbital debris evolutionary model (LEGEND), developed in 2012, focused on accumulation in LEO of debris greater than ten centimeters[113] because it is most likely to damage functioning satellites and because it is so large that it can be tracked and studied. The study showed "that even with no future explosion and global 95-percent compliance with the 25-year rule, the LEO debris population is expected to increase slowly during the next 200 years."[114] Modeling shows that there would be an average of twenty-six catastrophic and nineteen non-catastrophic collisions in the next 200 years under this model.[115] In view of expected quadrupling of the number of new launches with regular replacements of defunct satellites, these numbers may be expected to be significantly higher. J.-C. Liou, one of the NASA space debris experts, states that even if space launches

---

forecast-to-exceed-30-billion-in-coming-decade/ [https://perma.cc/GG5L-DKQX].

111 *See* Caleb Henry, *LEO and MEO Broadband Constellations Mega Source of Consternation*, SPACE NEWS (Mar. 13, 2018); *see also* Butt, *supra* note 4 (predicting a ten-fold increase in small satellites in orbit).

112 *See* Holger Krag, *An Overview of the IADC Annual Activities*, IADC 1, 17 (Feb. 1, 2017), http://www.unoosa.org/documents/pdf/copuos/stsc/2017/tech-16E.pdf [https://perma.cc/3WXE-LTKN].

113 *See* J.-C. Liou, *Effectiveness of Satellite Postmission Disposal to Limit Orbital Debris Population Growth in Low Earth Orbit*, NAT'L AERONAUTICS & SPACE AGENCY 1, 72 https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20150003819.pdf [https://perma.cc/2FE8-9A36].

114 *Id.* at 73.

115 *Id.* at 72.

were to cease that would not stop the increase of debris in space.[116] New procedures will have to be established.[117]

Examples of international regulation of new debris could involve:

(1) Mandatory international standards imposed on states by UN-affiliated Organizations;[118]
   (a) Operational standards in outer space (Rules of the Road)
   (b) Construction standards
   (c) Launch standards
(2) Legal obligation on the operator and the authorizing country to remove debris caused by new launches;
(3) Removal of new debris by non-owners;
(4) Registration of space debris;
(5) Lower than twenty-five years deorbits in LEO;
(6) More efficient transfer of satellites in GEO into graveyard orbits at the end of their useful existence;
(7) Greater restrictions on the number of launches;
(8) Greater restrictions on launches into certain orbits;
(9) Duty to catalogue and register as much debris as possible;
(10) Design of satellites and launch vehicles so they cannot break up;
(11) Passive protection techniques (presently used to protect the ISS).

B. Old Debris Removal

The total amount of space debris will continue to grow even with 100% implementation of the IADC guidelines. Providing for the removal of old debris may be a most difficult task. Nevertheless, the 2017 ESA Space Debris Conference concluded that space debris removal is necessary for resolution of the space debris problem.[119] Several removal schemes are being investigated.[120] ESA has reportedly dedicated $445 million to the in-

---

[116] *Id.* at 73.

[117] *Id.*

[118] *See generally* Larsen, *Space Traffic*, *supra* note 32 (describing several models for international standards in space traffic management).

[119] *See Solutions to Space Debris Problems Addressed at European Conference*, *supra* note 2.

[120] *See Space Debris*, Wikipedia, https://en.wikipedia.org/wiki/Space_debris [https://perma.cc/7ET4-R2NS].

vention and construction of removal satellites.[121] However, no widely successful approach has yet been found.

Examples of better international regulation of old debris could involve:

(1) General authority to remove old debris regardless of previous ownership;[122]
   (a) Removal of large objects
   (b) Removal of debris most likely to collide because of orbiting in orbits densely populated by functioning satellites
   (c) Removal of debris likely to remain the longest in outer space
(2) Registration of large debris;
(3) More effective transfer of old satellites in GEO into graveyard orbits;
(4) Resolution of ownership of debris issue;
(5) Regulation of graveyard orbits;
(6) Obligation to catalogue and register all known past debris caused;
(7) Absolute liability for debris in outer space as provided in the Outer Space Treaty Article VII.

C. Conclusion

Because of the increasing growth of debris, the collision dangers are escalating. Thus, the sooner new and improved regulation of outer space debris is established and implemented, the more effective the new regulations will be. ESA studies show that delay of remedial action until 2050 would be less effective than remedial regulation taking effect now.[123] The ESA report expresses the view that change of international law on ownership of space objects and of liability for space objects are most urgently needed.[124]

Outer space does not belong to any state. It is non-sovereign. Therefore, regulation requires international agreement to regulate all nations. States must agree not only to adopt necessary regulations, but also to enforce those regulations. The drasti-

---

[121] *See* Alshamsi et al., *supra* note 8, at 60.

[122] *See, e.g.*, *Space Operations Space Debris: The ESA Approach*, *supra* note 2 (discussing potential mitigation initiatives by the ESA).

[123] *Space Operations Space Debris: The ESA Approach*, *supra* note 2, at 6.

[124] *See id.* at 11 ("Legal constraints associated with the ownership of space debris and related liability issues cannot be neglected . . . .").

cally increased outer space activities and the seemingly unstoppable increase in space debris will require new international laws and regulations. Otherwise, long term outer space use will not be sustainable.[125]

V. INSTITUTIONAL OPTIONS FOR THE SPACE DEBRIS PROBLEM

A. Introduction: History of Space Debris Restrictions

COPUOS[126] is the major forum for discussion, coordination, and resolution of international regulation of space debris problems. The major treaties, such as the OST, are negotiated first in COPUOS. The IADC Space Debris Mitigation Guidelines were drafted in IADC, proposed and adopted in COPUOS, and submitted to the UNGA for approval in UNGA Resolution 62/217 in 2007. All the space-interested states participate in COPUOS negotiations reflecting their individual and common interests. Initiatives adopted by COPUOS, such as the voluntary Space Debris Mitigation Guidelines, achieve their effectiveness through mandatory regulation and enforcement by the individual states because the guidelines have no legal compulsion in and of themselves. The guidelines are the only recognized regulatory restriction on space debris generation. Their preparation by the IADC and submission to COPUOS were absolutely essential for their adoption. This IADC initiative was very important and valued by all countries. The problem is that the guidelines are not a sufficient restriction on space debris generation.

B. The IADC Space Debris Regulatory Option

Early concerns with the proliferation of space debris led NASA and ESA to consider the need for space debris mitigation.[127] The United States, being most heavily invested in outer space affairs, has the most to lose from space debris collisions with space objects. The United States invests heavily in tracking large debris in order to avoid collisions, but tracking is not the

---

[125] *See* Butt, *supra* note 4.

[126] *See* G.A. Res. 1472 (XIV) (Dec. 12, 1959); *see* Lyall & Larsen, *supra* note 26, at 15.

[127] *See* Nicholas Johnson, *Origin of the Inter-Agency Space Debris Coordination Committee*, Nat'l Aeronautics & Space Agency 70, 70, https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20150003818.pdf [https://perma.cc/X3JG-7BCQ].

solution to the problems.[128] To counter the ultimate problem of debris' foreclosure of access to outer space, NASA initiated conversation with other major space powers to limit debris generation.[129] Beginning in 1987, NASA and ESA discussed ways to limit and mitigate new generation of space debris.[130] Because the debris problem is international in scope, other major space agencies became involved in these efforts. There are now thirteen IADC members.[131] Notably, the IADC is not a member of COPUOS.[132] However, it briefs COPUOS on its activities, and individual country delegations can and do introduce IADC ideas unto COPUOS.[133] In these ways, IADC is able to influence COPUOS decision-making and has, by default, become the major source of technical knowledge about space debris and its regulation. As a result, the IADC Space Debris Mitigation Guidelines were adopted by COPUOS with minor modifications in 2007. Other IADC activities include discussing exchanges of information among members about deorbiting space objects, untracked debris objects in orbit, and ways to protect space objects from space debris.[134] IADC has formed the following working groups: (1) Measurements; (2) Environment and Databases; (3) Protection of Satellites in Orbit; and (4) Debris Mitigation.[135] IADC members use these working groups to exchange information about space debris research, cooperate on space debris research, review progress made on cooperative activities, and identify alternative ways to mitigate debris.[136]

IADC considers itself to be the world's technical and scientific authority on space debris. It aims to continue to develop space debris mitigation strategies and to influence COPUOS space debris mitigation activities.[137]

---

[128] *See supra* Section IV.

[129] *See supra* Section IV.

[130] *See* Johnson, *supra* note 127, at 70.

[131] *See* INTER-AGENCY SPACE DEBRIS COORDINATION COMMITTEE, *supra* note 105.

[132] *See* Johnson, *supra* note 127, at 71.

[133] *Id.*

[134] *Id.*

[135] INTER-AGENCY SPACE DEBRIS COORDINATION COMMITTEE, *supra* note 105.

[136] *See* Krag, *supra* note 112, at 4.

[137] *Id.* at 18; *see also* INTER-AGENCY SPACE DEBRIS COORDINATION COMMITTEE, https://www.iadc-online.org/index.cgi?item=docs_pub [https://perma.cc/WFU4-B7FJ] (list of documents published by the IADC showing the continuing work by the IADC).

1. IADC Strengths

IADC is a unique organization, having been able to galvanize the major national space agencies into recognition that the debris in outer space is rapidly accumulating and of the dangers thereto.[138] Furthermore, these thirteen state agencies have the resolve to act jointly when member states of COPUOS prove either unable or too slow to agree on remedies for the space debris problem in COPUOS. Key to the success of the IADC initiative has been IADC's ability to characterize the guidelines as technical, thus distancing the debris issue from the realm of national security politics. The success of the technical IADC guidelines may be contrasted with the failure of the European Union to persuade the world to adopt a code of conduct for reasonable traffic rules in outer space. The EU's valiant effort to establish a code of behavior for outer space activities failed because the draft Code of Conduct touched on national security issues, which is difficult in today's political world. By contrast, IADC avoids politics by addressing the dangers of space debris from a non-political stance. Characterizing space debris as being a technical problem establishes an important precedent for other outer space regulation because many aspects or functions in outer space can be characterized and treated as technical.[139]

The general acceptance of the IADC guidelines by the wider geographical distribution of COPUOS member states is indeed remarkable.[140] Considering the slow process of decision-making in COPUOS, it was unusual that the guidelines, authored by an outside committee, were so quickly accepted. Their acceptance illustrates the urgency of the space debris issue.[141] It helped progress on the guidelines in that the states began to make them mandatory standards even before they were approved by the UNGA Resolution 62/217.[142] The IADC must be praised for its

---

[138] *See* STUFF IN SPACE, *supra* note 1 (database tracking objects in Earth's orbit).

[139] Aviation and maritime transportation as well as satellite telecommunication are characterized as technical by the Chicago Convention, IMO, and ITU treaties. *See* Chicago Convention, *supra* note 32; IMO Convention, *supra* note 31; ITU Constitution, *supra* note 5. Several other outer space issues may also be characterized as similarly technical in nature. For example, standards and procedures for regulation of traffic in outer space may be characterized as technical. *See* Larsen, *Space Traffic*, *supra* note 32, 23–24. Regulation of collision with asteroids may also be characterized as technical. *See* Larsen, *International Regulation*, *supra* note 65, at 104.

[140] *See* HOBE ET AL., *supra* note 26, at 624–25.

[141] *Id.*

[142] *Id.* at 614–15.

leadership and organization where and when COPUOS was unable to perform. Consequently, the world now benefits from action on the space debris problem, although the remedy is insufficient to resolve the problem. Much more needs to be done. Despite its limited mandate to resolve one of the world's problems, the IADC continues to exercise its initiative, because no other international organization has stepped up to the task. Great credit goes to the individuals who took this initiative as well as to the agencies that facilitated and joined.

2. IADC Weaknesses

The focus of the following discussion is on IADC's legal shortcomings, including its lack of UN status, the inadequate geographical distribution of its membership, its inability to enforce international space debris regulations, its inability to adopt mandatory international regulations, its inability to constantly supervise and update space debris regulations, and its inability to adopt international regulations on responsibility for removal of old space debris.

a. IADC Lack of Official UN Status and Geographic Representation

The IADC is without official UN status. The universality of the space debris problem illustrates the difficulty of a small group of thirteen national space agencies establishing space debris guidelines for the large majority of countries. It raises the issue of the need for greater universality of decision-making regarding control of space debris. Decision-making gets skewed when a group of specialized state agencies, with no official status in the United Nations, formulates rules of behavior for adoption by all the countries in the world instead of national governments. There is a need for universal, international decision-making by all states rather than just a few. It raises the issue of whether an international treaty on space debris would be a better solution.[143]

b. Problems of Enforcement

ESA and NASA surveys[144] show lack of enforcement of the Space Debris Mitigation Guidelines. They can also be interpreted to show that 100% compliance is necessary. As of 2015, IADC reports a large number of fragments in LEO; only 40% of

[143] LYALL & LARSEN, *supra* note 26, at 274.
[144] *See supra* Section IV.

space objects in GEO orbits are properly re-orbited, and only 65% of space objects in LEO comply with the twenty-five year deorbit rule, which means that significant new debris still continues to be left in outer space.[145] Thus, the 2017 ESA Space Debris Conference concluded that the IADC guidelines need to be strengthened considerably.[146] However, IADC does not have legal authority to enforce its guidelines. Only the states can do so. The lack of state enforcement indicates that stronger and broader state commitment to the guidelines are needed for resolution of the space debris problem.

c. Constant Need for Updating Guidelines

Increasing evidence shows that much stricter regulation is needed and that the guidelines should be updated.[147] The twenty-five year deorbit rule for space objects placed in LEO should be tightened; states should be required to deorbit small satellites more quickly. This is particularly important because of the avalanche of small satellites planned to be orbited in the near future. The IADC guidelines were last approved by COPUOS in 2007. However, neither the IADC nor COPUOS have managed, in the eleven subsequent years, to update the guidelines. Furthermore, IADC experts agree that removal of *old* debris is necessary, but the IADC has not been able to agree on guidelines on old debris removal. Nor has the IADC been able to persuade COPUOS to agree on debris *removal* guidelines. It is apparent that an international permanent space debris commission, somewhat like the ICAO Air Navigation Commission, is needed to continuously analyze the space debris developments and use its expertise to write and adopt new guidelines. A stronger international decision-making framework is needed.[148]

The IADC has no prospect of being able to produce mandatory space debris standards because is not an organization of member *countries*. It only represents space *agencies* participating in the IADC. The IADC representatives do not even have authority to adopt mandatory regulations applicable to branches of government in their own countries. NASA does not issue licenses to U.S. non-government operators.[149] Nor does it

---

[145] *See* Krag, *supra* note 112, at 13.

[146] *Solutions to Space Debris Problems Addressed at European Conference*, *supra* note 2.

[147] *See supra* Section IV.

[148] *See supra* Section IV.

[149] *See* Paul B. Larsen, *Small Satellite Legal Issues*, 82. J. AIR. L. & COM. 275, 281–82 (2017). NASA authorizes only its own governmental launches. The Fed-

have the authority to order U.S. non-governmental operators to obey the guidelines. In the United States, each federal agency is free to adopt and enforce their own space debris guidelines. Thus, there are many opportunities for different interpretations of the guidelines. A standing international body with decision-making authority for uniform interpretations of the guidelines is needed.

3. Evaluation: IADC is Admirable, but is Not the Ultimate Solution to the Space Debris Problem

The IADC cannot resolve the overall problem presented by the Kessler Syndrome of steadily increasing accumulation of space debris and thus escalating dangers of collisions in outer space.[150] The IADC succeeded in gaining COPUOS' adoption of its proposed space debris mitigation guidelines for future outer space launches. Those guidelines need to be further strengthened; they need to be mandatory and be enforced strictly. Furthermore, new regulations are needed for the escalating amount of old debris which keeps multiplying as it collides and fragments further. Thus, it is necessary to consider whether other options may function better than the IADC approach to space debris regulation.

C. Option of a Strengthened COPUOS Committee on Debris Regulation

COPUOS is a committee of the UNGA responsible for specialized outer space issues. It is not a decision-making body. Its purpose is to study and to recommend to the UNGA the adoption of measures to promote peace and security in the world. Thus, it is the obvious forum for discussion of space issues. It has been the forum for the drafting of the five major treaties on the law of outer space, of which the OST has become something in the nature of a "constitution" for outer space. While COPUOS has been instrumental in drafting rules for outer space, the final decision-maker on these legal instruments are the separate diplomatic conferences of states. COPUOS accepted the IADC

---

eral Communications Commission (FCC) licenses radiofrequencies and related orbital slots for commercial space activities, the FAA licenses commercial launches, and the National Oceanic and Atmospheric Administration administers remote sensing satellite. *Id.* Oversight over activities in outer space has not been delegated by implementing U.S. legislation. *Id.* at 282. Administration of space treaty responsibilities remains the task of the Department of State. *Id.*

[150] *See* discussion *supra* Section V.B.2.

recommendation for guidelines, approved them with minor modifications, and submitted the guidelines to the UNGA for final approval, after which it became the task of individual states to adopt and implement the guidelines.

1. Strengths

COPUOS is the generally accepted forum for states to meet to discuss and coordinate all space issues. By contrast there is no specialized international sub-agency for outer space. ICAO is the UN sub-agency for aviation. IMO is a UN sub-agency for maritime issues, and ITU is a UN sub-agency for telecommunication. COPUOS is serviced by the UN Office for Outer Space Affairs (UNOOSA). Besides servicing COPUOS, UNOOSA administers the registration of space objects pursuant to the Registration Convention. It maintains UN-SPRINGER to service the UN Disaster Charter, and it services the special International Advisory Committee for Global Navigation Satellite Systems (ICG), which provides a special forum for international coordination and cooperation of Global Navigation Satellite Systems (GNSS).[151] The UN could establish a similar international advisory committee for space debris which could serve as a forum for states to coordinate all issues relating to space debris. Such a committee could draft and update space debris guidelines for approval by the COPUOS for submission to the UNGA for approval and distribution to the states.

2. Weaknesses

Work in COPUOS proceeds very slowly mainly because it operates by consensus decision-making. Another difficulty is that COPUOS discussions include national security considerations. Space debris issues are technical issues. Space debris can have military consequences but is basically a civil issue. The military space issues are now focused in the UN Conference of Disarmament in Geneva.[152]

As shown in its formulation of and approval of the Space Debris Mitigation Guidelines, COPUOS usually works very slowly. By contrast, the Kessler Syndrome makes the space debris issue ur-

---

[151] *See* Paul B. Larsen, *International Regulation of Global Navigation Satellite Systems*, 80 J. AIR. L. & COM. 365, 365 (2015).

[152] *See* discussion in Paul B. Larsen, *Outer Space Arms Control: Can the USA, Russia and China Make this Happen*, J. CONFLICT & SECURITY L. 1, 1–23 (2016) [hereinafter Larsen, *Outer Space Arms Control*].

gent and not suitable to the slow proceedings of COPUOS. Space debris will foreclose access to outer space and debris will collide with functioning satellites if the problem is not resolved quickly. COPUOS was able to process the IADC guidelines because they were basically negotiated by IADC, an outside, non-UN organization. The prospects are slim that COPUOS can speedily produce international standards for removal of old debris and produce strengthened standards for new debris production. Production of new guidelines might require new legal authority, in particular if the guidelines were to become more like mandatory international standards in the nature of the ICAO international air navigation standards.

3. Evaluation: COPUOS Is Too Slow, Unwieldy, and Not Suited for Decision-Making and Administration of International Regulations that Will Resolve the Space Debris Problem

The difficulty of leaving the basic space debris problem with COPUOS is best illustrated by COPUOS's present reliance on the IADC to spearhead COPUOS activity on space debris. COPUOS is charged with responsibility for a large number of outer space issues. COPUOS meets only once a year and is not able to assume responsibility for resolving all the problems of the urgent Kessler Syndrome. It cannot produce mandatory space debris regulations, cannot supervise enforcement, and cannot administer space debris regulations.

D. Option of an International Space Debris Organization

1. ICAO Analogy Option

An international space debris organization capable of establishing international mandatory standards for old as well as for new space debris would require new decision-making authority. One model for such an organization could be the ICAO, which is a sub-agency of the United Nations. ICAO's main purpose is to establish international standards and procedures for air traffic that are mandatory and uniform.[153] The authorizing treaty is the 1944 Chicago Convention.[154] Its Article 37 establishes

---

[153] Chicago Convention, *supra* note 32.

[154] *Id.* ICAO declined to participate in the regulation of outer space at the beginning of the space age, thus leaving outer space issues for the United Nations and the states. *See* Paul B. Larsen, *Space Activities and Their Effect on International Civil Aviation*, 9 Proc. on L. Outer Space 159, 163 (1966).

ICAO's standard-setting functions for civil aviation.[155] Article 56 provides for the creation of the ICAO Air Navigation Commission, which is a standing commission of nineteen experts.[156] Its function is to draft standards and to continuously update existing standards as needed by new developments.[157] The technical experts do not represent states and are therefore not beholden to specific states. The Commission has subcommittees on specific subjects. In their examinations, the experts solicit contributions from private operators, users, and air services, as well as from states. The standards are agreed to by the Air Navigation Commission and submitted to the ICAO Council for approval, after which the standards are submitted to the ICAO member states. At that point in time the individual states have the option of filing deviations from the international standards.[158] The standards apply only to civil users.[159] Military operators tend to observe the civil standards for the sake of uniformity and safety.

a. Strengths

Focusing decision-making on international standards and procedures for all kinds of space debris would remove the decision-making from all the other many issues that are now discussed in COPUOS. If the ICAO model were adopted, then an expert technical commission would be charged with examination of the technical and physical ways of best limiting and removing debris. The commission would not be distracted by political issues as COPUOS is now. The decision-making would take place in a UN forum. It would not be dependent on an outside group like the IADC. The standards and procedures developed by a space debris commission would become mandatory upon approval by a small space debris council and only subject to deviations by individual states for good cause. States would appreciate the safety and navigation advantages of uniform international space debris rules. Decision-making would be expedited because the space debris commission would only be motivated by the urgency of the need for space debris regulation. As in ICAO, the space debris standards and procedures would establish the minimum requirements with states free to create more comprehen-

---

[155] Chicago Convention, *supra* note 32, art. 37.
[156] *Id.* art. 56.
[157] *Id.*
[158] *Id.* art. 38.
[159] *Id.* art. 3.

sive rules. The individual states would implement and enforce the space debris standards and procedures, subject to oversight by a new international space debris organization. It would be a small UN sub-agency with universal participation and decision-making powers, similar to ICAO. The ICAO model has certainly worked for commercial aviation. Applied to space traffic, the aim would be an ICAO-like transparency, certainty, and reliability.

b. Weaknesses

The weakness of adopting the ICAO model would be that it is very difficult for states to adopt a new framework. However, major devastating collisions, like a destructive collision with the International Space Station or cascades of collisions caused by cascades of debris would convince the world of the need for drastic action.[160] Such collisions in outer space *will* happen. The wise choice would be to adopt new regulation before the big collisions happen. Another weakness is that there would be additional costs because the ICAO model would require more technology and operations. Finally, the major problem with this option would be the difficulty of organizing and adopting new international law on space debris regulation. Unfortunately, that may happen after major outer space collisions and the consequent urgency to remedy the debris problem that would follow a disaster.

c. Evaluation: Option of Using the ICAO Model for Space Debris Regulation[161]

It is generally agreed that the space debris problem is universal. It requires action and decisiveness for its resolution. ICAO is constantly faced with resolving aviation safety issues and regulating air space. ICAO, as a UN sub-agency, is within the UN umbrella of specialized agencies. Space has similarities to air space. Most of air space is not sovereign. Outer space is also not sovereign. ICAO has proven successful in organizing and resolving joint use of air space by all the states. Using the ICAO model to

---

[160] Catastrophes can be strong motivators. In 1956, the Grand Canyon mid-air collision of two large passenger airplanes convinced the United States to adopt new laws to exercise air traffic control. *See* Jennifer Oldham, *Crash Set a New Course*, LA TIMES (June 3, 2006), http://articles.latimes.com/2006/jun/03/local/me-aircrash3? [https://perma.cc/PAR8-45MY].

[161] Compare use of ICAO model option for establishment of outer space traffic standards and procedures in Larsen, *Space Traffic*, *supra* note 32.

form a similar world safety organization for outer space debris should be considered. ICAO regulations are mandatory and uniform. International space debris regulations also need to be mandatory and uniform. ICAO regulation is accepted and even appreciated by military users as being of a technical nature. A similar arrangement should work for space debris regulation. A commission of space debris experts would be charged with drafting international space debris regulations. The space commission would be able to constantly evaluate the success of existing regulations and be able to make adjustments and improvements as needed. The space debris commission would prepare regulations for generation of new debris. It should also establish acceptable regulations for significant removal of existing debris sufficient to stabilize, if not reduce, the existing debris accumulation.

A small representative space debris council would be formed to approve the draft regulations. The mandatory space debris regulations would be sent to states, who would be able to file necessary individual deviations as occurs with aviation standards and procedures. The council would be guided by long term policies established by an assembly of states. Such an assembly of ICAO member states meets every three years. A similar assembly would establish long term policy for the space debris organization.

For its work on new regulations, a new space navigation commission would need substantial input of information from the users of outer space about their needs, evaluations of regulations that are successful and beneficial, and their negative reaction to regulations that do not work and are too restrictive. Users of outer space should be able to contribute technology, both for mitigation of new debris and for effective ways of removing old debris.

The actual implementation of the new regulations would occur through the states themselves. They and their authorized non-governmental users would have to comply with the international regulations. The burden of actual removal of old debris would fall on the states, unless states in the debris organization agree to contract out debris removal to commercial companies.

New international law would be established by a diplomatic conference to authorize the space organization and to detail its duties. The organization would be funded by the member states the same way ICAO is presently funded.

2. ITU Model Option[162]

The International Telecommunication Union (ITU) is also a sub-agency of the United Nations.[163] It regulates radio frequencies.[164] Satellites depend on the use of radio frequencies to receive and send data, as well as for their navigation.[165] Only clear frequencies can be relied upon. In accordance with Article 4(3) of the ITU Constitution, ITU adopts uniform international standards so that users may have clear frequencies without radio interference.[166] The standards are prepared by the ITU Telecommunication Sector, which adopts the standards in global assemblies of all the ITU member states. Applying the agreed standards is the function of the small ITU Radio Regulations Board. It assigns radio frequencies for transmission of data to individual satellites in their related orbital slots.[167] The ITU standards apply only to civilian uses of radio frequencies. ITU Constitution Article 48 provides that military users need only comply with the civilian regulations "so far as possible."[168] Nevertheless, military users tend to observe civilian regulations for reasons of safety and international uniformity.

a. Strengths of Using the ITU Model

The ITU model provides extensive international participation in the establishment of regulations. Thus, adoption of standards and regulations using the ITU model would be in the nature of an enlarged COPUOS assembly. The international telecommunication regulations have the status of treaties and are binding and enforceable on individual members in the regular international assemblies. Similarly, the space debris standards would have the force of independent treaties thus making the Radio Regulations Board an executive agency.

b. Weaknesses

Adoption of ITU regulations by states as treaty obligations can be slow. That causes difficulty in decision-making because of the need for majority votes in ITU World Assemblies, which are

---

[162] *See* ITU Constitution, *supra* note 5.
[163] *Id.* art. 2.
[164] *Id.* art. 1.
[165] LYALL & LARSEN, *supra* note 26, at 205.
[166] ITU Constitution, *supra* note 5, art. 4(3).
[167] LYALL & LARSEN, *supra* note 26, at 205.
[168] ITU Constitution, supra note 5, art. 48.

cumbersome. Administration of detailed space debris regulations by the ITU model would be difficult. It has happened that some states have not adopted the latest ITU regulations and thus remain bound by the old regulations adopted by previous assemblies.[169] That creates a lack of uniformity of regulations. The same could be true when using the ITU model for space debris. While the ITU model would be slower than the ICAO model, the ITU model would be better than COPUOS because it would be more comprehensive, decisive, and enforceable. There would be new costs because the ITU model would entail new activities. As with the ICAO model, a major problem with this option would be the difficulty of organizing and adopting new international law on space debris regulation, which may not happen until after major outer space collisions and consequent urgency.

c. Evaluation: Option of Using the ITU Model for Space Debris Regulation

Using the ITU model would establish a separate international space debris organization as a sub-agency of the United Nations. A space debris organization and its functions would have to be authorized by new international treaties which would be funded by its members. Its task would be to establish mandatory space debris regulations to mitigate new debris caused by future launches, as well as to mandate removal of existing debris. The main difference from the ICAO model would be that an assembly of states would meet regularly to direct a commission of space debris experts in the same way that an ITU world assembly meets to make decisions on radio frequencies.

Comparing these two options for an independent space debris organization, the option of the ICAO model would be a stronger organization. The option of the ITU model would be less costly.

E. Regulation of Space Debris by Non-Governmental Operators

The non-governmental (commercial) operators of space traffic do not wish to "choke off the commercial space revolution."[170] These operators have formed the Space Data

---

[169] Lyall & Larsen, *supra* note 26, at 207.

[170] Butt, *supra* note 4. The author mentions that the 2016 total world space economy exceeded $320 billion and is vital to the world's economic wellbeing. *Id.*

Association to share information about traffic conditions in outer space.[171] The Association includes many commercial operators; it also includes major space manufacturers, such as Airbus.[172] It also includes space agencies such as NASA and the German space agency Deutsches Zentrum für Luft- und Raumfahrt (DLR), but military operators are not included.[173] Like IADC, the Space Data Association has formed several subgroups on common issues such as safety, radio frequency interference, product development, and product operations. Furthermore, the Association has access to the civilian tracking information of the SSN.

The International Organization for Standardization (ISO) is another non-governmental, standard-setting international organization.[174] Standards are adopted by consensus of ISO members.[175] ISO currently requires space objects to satisfy their mission performance requirements during the complete life cycle.[176] Thus, the ISO requires space objects to comply with the construction standards contained in the IADC Space Debris Mitigation Guidelines, if so required by the launching state of registry. However, ISO is not involved in debris removal, deorbits, or enforcement.

1. Strengths

The commercial users of outer space favor space debris regulations that will benefit their movements and existence in outer space. They need regulation and reduction of space debris that threatens to damage or destroy their assets in outer space. Thus, they have the incentive and self-interest in space debris regulation because it is good for business. The major advantage of this option is that it would require no new international law. It could be based on existing cooperative activities among non-govern-

---

171 *See* SPACE DATA ASSOCIATION, http://www.space-data.org/sda [https://perma.cc/E2GG-L2FP].

172 *Participants*, SPACE DATA ASSOCIATION, http://www.space-data.org/sda [https://perma.cc/98BA-RJ8S].

173 *Id.*

174 *See International Organization for Standardization*, WIKIPEDIA, https://en.wikipedia.org/wiki/international_organization_for_standardization [https://perma.cc/V8PY-A7EV].

175 *See id.*

176 Int'l Org. for Standardization, *Space Systems—Programme Management; Part 2: Product Assurance*, ISO 14300-2:2002, (July 1, 2002), https://www.sis.se/api/document/preview/899666/ [https://perma.cc/7H2P-N5NA].

mental operators, and it would have the approval and cooperation of the commercial operators.

2. Weaknesses

Non-governmental operators want freedom to do business for profit. They want to remove interferences with doing business. However, they want minimum regulation that would influence their motivation for international space debris regulation. Past experiences with the private sector regulating safety obstacles to their operations have proven problematic. In international maritime commerce, a non-governmental standard-setting organization, the American Bureau of Shipping (ABS), was established in 1862 to establish standards for ship construction and operation, including protection of ships from collisions.[177] Ships are inspected and classified by ABS for their degree of compliance with the ABS safety standards.[178] The standards are linked to the requirements of the Load Line Convention, the Safety of Life at Sea Convention, and the Marine Pollution Convention.[179] Thousands of ABS examiners are employed and widely employed for the classification of ships. The effectiveness and reputation of the ABS is at stake whenever a major ship is lost at sea. An example is the wreck of the oil tanker *Prestige* in 2002.[180] The ABS had determined the ship compliant with regulations and thus safe; however, the ship was not seaworthy.[181] Safety questions have arisen in similar cases. Industry regulation of its own safety brings into question the Latin maxim *quis custodiet ipsos custodes* (can the police be trusted to police its own abuses?). This raises concerns with the non-governmental operators' regulation of space debris. Can they adequately pursue business objectives and exercise control of public and private safety at the same time? Enforcement would also be a problem for non-governmental operators' regulation of space debris. They would not have the police power necessary for mandatory enforcement of non-governmental regulation. Such regulation might also en-

---

[177] *See American Bureau of Shipping*, WIKIPEDIA, https://en.wikipedia.org/wiki/American_Bureau_of_Shipping [https://perma.cc/D86H-34X9].

[178] *Id.*

[179] *See* International Convention on Load Lines, Apr. 5, 1966, 18 U.S.T. 1857, 640 U.N.T.S. 133; International Convention for the Safety of Life at Sea, Nov. 1, 1974, 32 U.S.T. 47, 1184 U.N.T.S. 2; Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Aug. 30, 1975, 1046 U.N.T.S. 120.

[180] *See American Bureau of Shipping*, *supra* note 177.

[181] *Id.*

counter legal problems with anti-competitive and anti-trust governmental regulations.

3. Evaluation: Non-Governmental Operators' Regulation of Space Debris

Non-governmental entities would like to be able to operate without any restriction in outer space. At the same time, they want their investments in outer space to be safe. They can coordinate some outer space activities, but they also compete with each other. Their motivation for competition and profit conflicts with and is sometimes stronger than their motivation for safety.[182] Furthermore, they would not be able to establish mandatory regulations or enforce regulations without the enforcement of government agencies, because they cannot enforce regulations on other private operators. Such joint and coordinated activities could also be anti-competitive and contrary to government business regulation. Thus, non-governmental operators regulating space debris is not a good idea.

Nevertheless, the contribution of non-governmental operators to government regulation of space debris is very important. Their information about whether government regulations work efficiently and conveniently and their suggestions for improvements are valuable. Such flow in regulatory information is most conveniently provided through association of non-government operators, rather than individually.

F. Option of Incorporating the IADC Activities into COPUOS to Form a Third COPUOS Subcommittee

The creation of a special standing COPUOS subcommittee on space debris reporting directly to the full committee would be a way of raising the level of attention paid to space debris by establishing an expert space debris subcommittee within COPUOS. The experts would be provided by the participating states. The subcommittee would research ways and means of reducing

[182] For example, the Swarm Technologies Co. insisted on launching very small satellites without a permit from the FCC, in disregard of public safety. *See* Tim Fernholz, *Swarm May Have to Answer for Launching Satellites Without US Permission*, Quartz (May 1, 2018), https://qz.com/1266602/swarm-technologies-is-in-trouble-with-the-fcc-for-unauthorized-satellite-launches/ [https://perma.cc/23SJ-XKJR]; *see also* Butt, *supra* note 4. FCC authorization is required before launch. However, the FCC has proposed to streamline its rules for the deployment of small satellites. *See* Streamlining Licensing Procedures for Small Satellites, 83 Fed. Reg. 24064 (proposed May 24, 2018).

space debris and would be given the task of preparing space debris regulations. Considering the volume of work needed, the subcommittee might need to become a standing committee (the IADC is in a way already acting as a *de facto* COPUOS working group). Creation of a special COPUOS subcommittee on space debris would be a way of incorporating the valuable IADC space debris activity into the UN organization, resulting in universality.

1. Strengths

There are several strengths created by establishing a specialized COPUOS subcommittee. Space debris would no longer be a tangential problem delegated to an outside organization. It would involve virtually all the states directly in formulating and dealing with space debris regulations. Ideally, it would move the IADC experts directly into the COPUOS organization, and they would become the nucleus of a more extensive organization. The IADC might or might not continue to exist. That would depend on the IADC members themselves, based on their assessment of the effectiveness of the new subcommittee.

Formation of the new subcommittee may not require new international law to expedite the establishment of new guidelines. Being quickly established, a further benefit would be that subsequently a more comprehensive international space debris regulatory agency on the ICAO model could be established by treaty. Such an additional subcommittee could become a short-term expedited remedy until states could manage to negotiate a long-term permanent legal regime.

2. Weaknesses

Recommendations by COPUOS to the UNGA are adopted by consensus of all eighty-seven states that are members of the committee.[183] That means that disapproval of one state can prevent a recommendation from being adopted. A COPUOS subcommittee on space debris would merely have power to recommend guidelines to COPUOS, which in turn could obtain UNGA approval, which would then be sent to the states for their adoption if they so choose. The states would continue to be able to pick those aspects of the guidelines that they favor. Thus, the result

[183] U.N. Office for Outer Space Affairs, *Committee on the Peaceful Uses of Outer Space: Membership Evolution*, http://www.unoosa.org/oosa/en/ourwork/copuos/members/evolution.html [https://perma.cc/X9DL-EGD3].

would not be uniform. It would be difficult to know the applicable regulations in different countries. Furthermore, the states could each determine whether to make the guidelines mandatory. So, it is unlikely that the idea of a COPUOS subcommittee on space debris would resolve the space debris problem. It would merely be an improved remedy.

Space debris guidelines would require continuous administration, and strengthened guidelines would need to be developed as the space debris multitude increases. It is uncertain that a COPUOS subcommittee could manage such a high volume of work. The COPUOS practice of adopting resolutions by consensus might paralyze or slow adoption of amended guidelines. The subcommittee might have to adopt an expedited decision-making process.

3. Evaluation: Forming a Third COPUOS Subcommittee on Space Debris Regulation

The creation of a special COPUOS subcommittee on space debris could be a short-term temporary remedy for the space debris problem because it would not require new international law. Such a subcommittee would probably require approval of the UNGA because it would require additional funding and servicing by UNOOSA. The subcommittee would report directly to the full COPUOS committee. The issue of space debris would receive more direct attention. It would not compete with other urgent problems in the Scientific and Technology Subcommittee. A subcommittee of space debris would have equal status with the Scientific and Technology and the Legal Subcommittees. The assumption would be that the new subcommittee would contain and be propelled by the impetus behind what is now IADC. It would probably not be a standing subcommittee, so it would not have the ability to react immediately to dramatic events such as sudden collisions of active satellites with debris, but the subcommittee could and should meet more frequently than once a year.

However, the subcommittee would only be able to recommend guidelines for adoption by the full committee and approval by the UNGA. It would not be able to adopt mandatory regulation, nor be able to supervise implementation of regulations. Those functions would remain with the individual states. Furthermore, the states would continue to be able to pick and choose which UN recommendations to adopt and enforce.

Thus, there would continue to be lack of international uniformity of regulation.

The major appeal of this idea is that it could be adopted much more quickly than the creation of an international debris organization by diplomatic conference. But it would not resolve the basic problem. It would not be the answer to the threat of the Kessler Syndrome. In fact, it could delay facing up to the danger stated by the Kessler Syndrome.

G. Option of the IADC Countries Implementing and Enforcing Stricter Regulations Among Themselves in the Absence of UN Action

The countries of the national space agencies that are IADC members could possibly agree among themselves to adopt more stringent space debris regulations. These countries are the major space powers in the world. If their national policies are to adopt stringent regulations, then these countries could easily conclude a treaty that would control their debris production, and their regime would set an example for the non-members. Such an agreement, including possible joint international enforcement authority, would not constitute a sub-agency of the UN. There is little probability of conflict since the IADC regulations would be improved space debris regulation. Such regulation would become mandatory and would be enforced by the state parties. Regulation could also be enforced by a joint international enforcement agency.

1. Strengths

The obvious advantage of adopting stringent space debris regulation by the major space powers would be a significant reduction of space debris. The parties could coordinate with each other through a central organization. Stricter regulation is in the pronounced interest of these countries. Such an arrangement would not be subject to the slow UN decision making and could be executed in the short term. The individual national space agencies could probably influence their national governments to participate in and favor the arrangement.

2. Weaknesses

There would be several weaknesses of such an arrangement. One weakness would be duplication. There would be two debris control regimes due to the duality of COPUOS and IADC. The

IADC member space agencies would have to prove that their stringent debris policies indeed represent the policies of their home countries. Some space agencies may have difficulty convincing their military departments. Because the regime would not be universal, it would suffer from the competitive freedom of countries which remain unregulated and become flag of convenience countries. Experience indicates that some non-government operators find it to be in their commercial interest to establish themselves in such flag of convenience countries in order to enjoy a competitive advantage. If major operators chose to move to flag of convenience countries, then the effort of more stringent space debris regulation could be defeated.

3. Evaluation: Option of IADC Countries Implementing and Enforcing Stricter Regulations Among Themselves in the Absence of UN Action

The IADC is currently the best organized and most effective antidote to space debris. The idea of agreement among the thirteen IADC member countries to adopt stringent debris regulations among themselves would require a diplomatic conference and new international law. Based on their common understanding of the issues and their motivation, such a diplomatic action could be taken in rather short time. It would be negotiated and adopted outside of the UN framework by those major space powers that are currently most likely to cause debris. Countries planning outer space activities in the near future might be persuaded to join such an agreement in order to provide safety for their outer space investments. A problem would be that some operators would find it to their competitive advantage to register, launch, and operate out of flag of convenience countries outside the newly-regulated space debris area. The stringent regulations of the group of the participating countries would not be internationally uniform and universally enforced, which would be a defect in the system. It would divide countries into space-adapted countries (which would be a minority) and countries that do not have outer space capability (which would be the majority of states). Such an action by the IADC countries could not ultimately resolve the space debris problem. That would require participation by all countries. Thus, this approach has its detractions.

H. Special Problem of Debris Caused by the Military

Military activities in outer space are growing significantly. The United States is increasing its military capabilities.[184] Other major space powers are following suit.[185] This increase has an effect on outer space. As an example, by using anti-satellite technology to destroy a defunct Chinese satellite in outer space in 2007, the Chinese People's Liberation Army generated thousands of additional debris pieces in outer space.[186] Military actions in outer space will cause more space debris. Military authorities around the world wish to preserve the possibility of causing debris by military action. Causing debris by military action would expedite the Kessler Syndrome effect. Nevertheless, military authorities need operational safety and freedom from interference in order to operate remote sensing, communication satellites, and GNSS satellites safely in outer space, free from possible obstacles.[187] Thus, military experts advocate order in outer space.[188]

It is relevant for this discussion that the Chicago Convention establishing the ICAO regulatory regime applies only to civilian air traffic.[189] Military air traffic is not subject to the Convention.[190] Adoption of international standards and procedures for aviation is considered to be a technical issue. Nevertheless, military aviation tends to observe the civilian traffic rules. The reason is that the civil aviation traffic rules are universally standardized by ICAO. It is safest for military aviation to follow the civilian rules. Likewise, the International Maritime Convention also applies only to civilian maritime traffic.[191] Military maritime traffic is not subject to the Convention and is not regulated by IMO. But military ships also observe the civilian traffic rules in the interest of safety. The reason is that the civilian maritime traffic regulation are considered to be of a technical nature.[192] The ITU legal regime also governs only civilian

---

184 *See* Larsen, *Outer Space Arms Control*, *supra* note 152, at 1.

185 *Id.*

186 *2007 Chinese Anti-Satellite Missile Test*, *supra* note 58.

187 *See* Larsen, *Outer Space Arms Control*, *supra* note 152, at 21.

188 *Id.*; *see also* Butt, *supra* note 4. The author of that article cites the commander of the U.S. Strategic Command calling for establishment of regulation and "norms" for outer space activities, adding that "'[n]orms can serve to highlight . . . abnormal behavior by adversaries and would be militarily useful.'" Butt, *supra* note 4.

189 Chicago Convention, *supra* note 32, art. 3.

190 *Id.*

191 *See* IMO Convention, *supra* note 31, art. 1.

192 *Id.*

traffic. Furthermore, Article 48 of the ITU Convention states that military traffic need only comply with the ITU civilian traffic "so far as possible."[193] Likewise, there is much outer space military communication, and it tends to observe civilian traffic rules as much as possible for the sake of safety and in order to avoid radio interference. Thus, satellite telecommunication is treated basically as a technical issue. To this end, military communication satellites tend to register their locations and radio frequencies with ITU just to avoid radio interference.

It is strongly recommended that regulation of outer space debris be based on the long, successful ICAO, IMO, and ITU experiences in providing technical civilian standards and procedures for air, sea, and outer space communication. This recommendation is based on the assumption that these are technical and not political issues. The existing IADC guidelines are currently established by civilian space agencies in IADC and submitted as such to COPUOS. They are adopted by COPUOS, approved by the UNGA, and adopted by the individual countries as mandatory regulations. The military users follow suit just as they do with the international aviation, maritime, and telecommunication rules. That leaves the military authorities in the position of following the civilian space debris regulation "so far as possible," as ordained by the ITU Constitution.[194]

VI. CONCLUSION AND RECOMMENDATIONS

The escalating space debris problem is a danger that must be faced as soon as possible in order to avoid foreclosure of access to outer space. Because of the continuing growth of debris, remedial action taken now will be more effective than remedial actions in the future.

Growing space debris is both a national and an international issue. Enforcement of international guidelines and regulations is concentrated at the national level. However, outer space, being non-sovereign, requires comprehensive international regulation. It is agreed[195] that the IADC guidelines are insufficient to stop the growth. Extensive coordination is necessary. At the moment the main impetus is with the IADC. It is actively studying the space debris problem and coordinating the response. COPUOS follow-up and implementation is also important, but it

---

[193] *Id.* art. 48.

[194] *Id.*

[195] *See supra* Section IV.

depends on IADC initiatives. The IADC and COPUOS efforts, while admirable, are insufficient. For the present, in the absence of more effective efforts and remedies, they offer some restraint on debris generation.

COPUOS is only able to produce voluntary guidelines. A problem is that these guidelines are not uniformly applied and enforced. Thus, space debris guidelines are not the ultimate solution. It is necessary to establish an international organization that can develop and establish mandatory standards and procedures for both new launches and for debris. ICAO has proven to be the best model for establishing, administering, and supervising international mandatory regulations applied and executed by the individual states. Developing an organization like ICAO would require new international laws to be established by a diplomatic conference. It took three years for the ICAO organization to become fully operational. If the ICAO model is chosen, an interim organization may well be required until full status is achieved. The new organization would become responsible for dealing with the Kessler Syndrome and preventing foreclosure of access to outer space. Space debris escalation demands that the long-term solution of adopting the ICAO model should begin at once.

IADC members, in particular ESA and NASA, have concluded that the IADC guidelines cannot possibly resolve the space debris crisis. The IADC states could reasonably be expected to take the initiative to form a global space debris decision-making organization capable of resolving the approaching crisis in outer space. IADC expertise could reasonably be expected to become an essential part of a new organization. Prospects of the alternative future makes such initiative almost imperative.

In addition, the diplomatic conference establishing new independent regulatory organization for space debris should consider the following two issues: ownership of space debris and liability for space debris damages.

A. Ownership of Space Debris

Space debris can be legally construed to be space objects and thus subject to the ownership laws of the state on whose registry a space object is launched.[196] It is necessary to change current international laws on ownership of debris. That would enable

[196] Outer Space Treaty, *supra* note 3, art. VIII.

any states and possibly a new organization to begin to remove the largest and most dangerous space debris.

Incidental to this change, it is also advisable to clarify the issue of whether and to what extent states are obligated by the Registration Convention to register debris. There should be an obligation on launching operators and states to register known space objects so that they can be identified and thus avoided. Registration would be an acknowledgement recognizing and accepting responsibility for the consequences of space debris.

B. Liability for Space Debris Damages

Finally, Article II of the Liability Convention provides that states are only liable for outer space collisions if the victim is able to prove fault of the launching state. This Article should be changed. Making states absolutely liable for their identifiable space debris would be a useful deterrent to creating debris.[197] That should also be concluded at the diplomatic conference.

---

[197] Operators and launchers of space objects could be required to post a space debris bond prior to launches that would compensate for space debris damages caused by failure of deorbit or graveyard disposal of space objects. *Polluter Pays*, *supra* note 60.