LAW AS AN INSTRUMENT TO SOLVE THE ORBITAL DEBRIS PROBLEM

BY

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In the last half century of space exploration and use, thousands of satellites have been launched to orbit Earth. These satellites perform essential functions to foster global communication, navigation, and security duties. However, the prevalence of satellites and space exploration have increased the amount of debris in space and ultimately, the risk of collisions. If the orbital debris problem remains unchecked, large parts of Earth's orbit could become unusable due to numerous potential debris obstructions. The technology to track and remove debris from orbit is becoming more feasible, and these advances now demand development of a legal solution to match. The legal solution proposed in this Essay uses the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as a model to create a system of financial incentives for satellite owners and operators to cover orbital debris cleanup costs and settle claims for collisions and cleanup through international commercial arbitration. Implementing this legal solution would give satellite owners and operators incentive to minimize the risk of collision and would equitably assign the responsibility to ensure cleanup of orbital debris.

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I. INTRODUCTION

Over the last fifty years, the exploration and use of outer space has presented unprecedented opportunity for international cooperation and connectivity.[1] In addition to its civilian uses, governments rely on space systems to provide global secured communications, positioning, navigation, timing, intelligence, surveillance, and other functions.[2] However, global reliance on continued, uninterrupted access to space comes at a cost. Due to the growing amount of space debris, we are increasingly at risk of space becoming unusable. This is the premise of the Kessler Syndrome, where space debris collides with satellites, creating a cascade of further debris.[3] The cascade results in whole regions of space being littered with too much debris to safely operate a satellite.[4] From an economic perspective, it may become financially impracticable to operate satellites in various regions of space before it actually becomes physically impossible.[5] Entire regions of Earth's orbit could be inaccessible for millennia.[6] This presents a dangerous, disruptive scenario that could severely impair global communication, navigation, financial transactions, government activity, and national security.

While the number of space users has been increasing exponentially, the laws governing the use of space have largely remained static. A new era of environmentally responsible use of space is necessary to ensure the continued availability of space resources. An ideal arrangement would be multilateral treaties to mandate binding international

[1] *See* Christopher D. Johnson, *The Outer Space Treaty at 50*, SPACE REV. (Jan. 23, 2017), https://perma.cc/4K8Z-XAC4 (discussing the evolution of space in the fifty years since the Outer Space Treaty's enactment).

[2] NAT'L ACAD. OF SCIS., NATIONAL SECURITY SPACE DEFENSE AND PROTECTION 3 (2016).

[3] 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).

[4] Nodir Adilov et al., *An Economic "Kessler Syndrome": A Dynamic Model of Earth Orbit Debris*, 166 ECON. LETTERS 79, 79 (2018).

[5] *Id.* at 79–80.

[6] Michael W. Taylor, *Trashing the Solar System One Planet at a Time: Earth's Orbital Debris Problem*, 20 GEO. INT'L ENV'T L. REV. 1, 20 (2007).

arbitration to assess liability for parties creating orbital debris. Liability for orbital debris damages and cleanup should be assessed in a similar manner to the United States' Comprehensive Environmental Response, Compensation, and Liability Act[7] (CERCLA) statute. As a starting point, a major spacefaring nation could enact this as a national law. For example, since the United States is such a large commercial player in space, enacting responsible domestic law would have far-reaching effects on the space industry and would provide momentum and world leadership toward developing an international law solution.

II. BACKGROUND

Space has become exponentially more crowded over the last few years.[8] Currently, there are over 2,000 operational satellites and over 5,000 total space objects in orbit.[9] New technologies such as reusable launch vehicles and miniaturization of satellites allow for more users to launch more satellites into orbit, especially at the low-Earth orbit (LEO) level.[10] The U.S. Space Force operates a program known as the Space Fence radar, which seeks to track over 200,000 objects and debris in orbit.[11] The Space Fence operates as part of an overall Space Surveillance Network of other satellites and telescopes to provide a comprehensive catalogue of space objects so that satellite operators can avoid other space objects.[12] Despite these efforts, several collisions have happened,[13] and the risk from space debris is only growing larger.[14]

Space debris is non-functional "artificial objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere."[15] Space debris can be parts of satellites or launch vehicles,[16] or items left behind or lost by astronauts, such as tools or

[7] Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §§ 9601–9675 (2018).

[8] Tate Ryan-Mosley et al., *The Number of Satellites Orbiting Earth Could Quintuple in the Next Decade*, MIT TECH. REV. (Jun. 26, 2019), https://perma.cc/8EFX-XZ3V.

[9] *See UCS Satellite Database*, UNION OF CONCERNED SCIENTISTS, https://perma.cc/LF6K-587X (last updated Aug. 1, 2020) (stating that there are over 2,000 operational satellites in orbit); *Online Index of Objects Launched into Outer Space*, UNITED NATIONS OFF. FOR OUTER SPACE AFF., https://perma.cc/MM7L-JDHD (last visited Dec. 3, 2020) (identifying over 10,000 objects in orbit when using the "in orbit" filter).

[10] Brooks Hays, *Space Collisions a Growing Concern as Earth Orbit Gets More Crowded*, UNITED PRESS INT'L (Oct. 23, 2019), https://perma.cc/9XD8-5XBW.

[11] Roger Mola, *How Things Work: Space Fence*, AIR & SPACE MAG. (Feb. 2016), https://perma.cc/XH8N-YZD4.

[12] *Id.*

[13] *The Current State of Space Debris*, EUR. SPACE AGENCY (Oct. 12, 2020), https://perma.cc/84AZ-9259.

[14] Michelle Starr, *Earth's Space Debris Problem is Getting Worse, and There's an Explosive Component*, SCI. ALERT (Oct. 13, 2020), https://perma.cc/FZ5Q-3UF7.

[15] EUR. SPACE AGENCY SPACE DEBRIS OFF., ESA'S ANNUAL SPACE ENVIRONMENT REPORT 5 (2020).

[16] *Id.*

personal items.[17] There are an estimated 1 million pieces of debris larger than 1 centimeter in diameter and approximately 130 million total pieces of debris.[18] These objects can travel at speeds around 18,000 miles per hour.[19] The vast majority of space debris is in LEO, defined as between 500 to 2,000 kilometers from the Earth's surface.[20]

Debris fields are created by orbital collisions or disintegration of space objects.[21] In 1996, a rocket stage exploded, creating 700 pieces of debris.[22] In 2007, China destroyed one of its satellites with an anti-satellite missile, creating thousands of pieces of debris in a busy area of LEO.[23] In 2009, an Iridium constellation satellite accidentally collided with a defunct Russian satellite, creating over 2,000 pieces of debris.[24] This debris can remain in orbit for longer than a century. [25] Between 2015 and 2016, four satellites disintegrated, creating over 100 pieces of debris.[26] Debris fields can make parts of space unusable. Collisions in space create debris that exponentially causes further collisions and resulting debris.[27] At a certain point, it is no longer viable to operate satellites in these regions of space because of the density of orbital debris and risk of collision.[28]

Satellites and the International Space Station (ISS) use thin-wall designs, which are susceptible to puncture from space debris.[29] The ISS orbits the Earth at 17,150 miles per hour.[30] In 2016, a tiny piece of debris less than a micrometer in size—the size of "a paint flake or small metal fragment"—collided with the ISS and took a chip out of the eighty

[17] *Danger: Orbital Debris*, AEROSPACE CORP. (May 4, 2018), https://perma.cc/8DK4-3CDS.

[18] *Space Debris by the Numbers*, EUR. SPACE AGENCY (Feb. 2020), https://perma.cc/GX4X-DE9X.

[19] *Space Debris*, NASA, https://perma.cc/JJ2R-XPP8 (last visited Dec. 3, 2020).

[20] Fatima Ahmed Mohamed & Noor Azian Mohamad Ali, *Space Debris Low Earth Orbit (LEO)*, 4 INT'L J. SCI. & RES. 1591, 1592 (2015).

[21] *See Star Child Question of the Month for June 2000*, NASA, https://perma.cc/S7FA-6JC6 (last visited Dec. 3, 2020).

[22] Marc G. Carns, *Consent Not Required: Making the Case that Consent is Not Required Under Customary International Law for Removal of Outer Space Debris Smaller than 10CM²*, 77 A.F. L. REV. 173, 181 (2017).

[23] *Id.* at 181–82.

[24] *Id.* at 182.

[25] *Id.* at 182–83.

[26] *Id.* at 183.

[27] Kessler & Cour-Palais, *supra* note 3, at 2637. *See also* Jennifer Leman, *Two Dead Satellites Could've Collided Last Night. Thankfully, They Didn't*, POPULAR MECHANICS (Oct. 15, 2020), https://perma.cc/EJ9P-686Z (noting that a satellite collision could cause debris to spread throughout low-Earth orbit); Dan Falk, *2 Large Pieces of Space Junk Nearly Collided in 'High Risk' Situation*, NAT'L GEOGRAPHIC (Oct. 15, 2020), https://perma.cc/ER7P-UDAS (noting that a large-scale collision would pose a danger to satellites passing through).

[28] Adilov et al., *supra* note 4, at 80.

[29] *Home, Space Home*, NASA SCI. (Mar. 14, 2001), https://perma.cc/CVE2-4PYV.

[30] Lizzie Plaugic, *This is What Happens When a Tiny Piece of Flying Space Debris Hits the ISS*, VERGE (May 12, 2016), https://perma.cc/88JK-5S6K.

centimeter–thick reinforced window.[31] While this particular piece was too small to pose danger, "debris up to 1 cm could cause critical damage while anything larger than 10 cm could 'shatter a satellite or spacecraft . . . .'"[32] Compounding the problem, debris smaller than five centimeters in diameter is impossible to track and avoid.[33]

Since orbital debris is a developing problem, there are several approaches being taken to clean up space debris and remove navigational hazards from the space environment. Private companies and governmental organizations are developing and testing means of capturing and rendering space debris harmless. The European Space Agency (ESA), in conjunction with private developers, is commissioning a satellite that uses robotic arms to capture orbital debris and bring it down to burn up in the Earth's atmosphere.[34] The mission, known as ClearSpace-1, is set for execution in 2025.[35] Another project, known as Obsolete Spacecraft Capture and Removal (OSCaR) is under development by a team at Rensselaer Polytechnic Institute in New York. The concept is a fleet of small satellites (known as CubeSats) steered by artificial intelligence that would seek out space debris, capture it with nets and tethers, and fly the debris into Earth's atmosphere to burn up.[36] In 2018, the University of Surrey's RemoveDEBRIS satellite was launched from the ISS and successfully demonstrated that space debris could be captured by a net.[37] The technology to remove orbital debris is advancing at a rapid pace, surpassing what was considered feasible several years ago.[38] Now that technology is advancing to develop a solution to orbital debris, the legal framework must catch up.

III. DISCUSSION

The Outer Space Treaty[39] and Liability Convention[40] are the primary sources of space law with provisions useful in resolving orbital

[31] *Id.*; *Impact Chip*, EUR. SPACE AGENCY (Dec. 5, 2016), https://perma.cc/CY76-SDQ9.

[32] Plaugic, *supra* note 30.

[33] *Space Debris and Human Spacecraft*, NASA, https://perma.cc/299S-UWUX (last updated Aug. 7, 2017).

[34] *ESA Commissions World's First Space Debris Removal*, EUR. SPACE AGENCY (Dec. 9, 2019), https://perma.cc/TSA4-RS6M.

[35] *Id.*

[36] Torie Wells, *Rensselaer Team Developing Tool to Battle Space Debris*, RENSSELAER NEWS (Apr. 23, 2019), https://perma.cc/79V4-QFYZ.

[37] Loren Grush, *Satellite Uses Giant Net to Practice Capturing Space Junk*, VERGE (Sept. 19, 2018), https://perma.cc/LE29-GMTW.

[38] *See* Taylor, *supra* note 6, at 19 (citing J. C. Liou & N. L. Johnson, *Risks in Space from Orbiting Debris*, 311 SCIENCE 340, 340–41 (2006) (discussing how the state of available technology in 2006 meant that orbital debris remediation and removal was not technically and economically viable)).

[39] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, *opened for signature* Jan. 27,

debris issues.[41] However, these treaties do not provide a solution for the current problem because they were developed in a much different context: When the treaties were developed, space was a new domain, and there were only two major governmental players.[42] The last few decades have witnessed the rise of commercial space enterprise, and there are now thousands of satellites in orbit from many nations and private corporations.[43] Space law must adapt to the changed—and changing—circumstances to provide a solution to the threat posed by orbital debris.

A. Current Laws and Treaties

The current body of law that touches orbital debris includes the Outer Space Treaty, Liability Convention, and customary international law. However, these legal tools do not provide an adequate solution to solve the debris problem because the current body of law fails to fully address the problem and does not provide enforceable remedies.

1. Outer Space Treaty

The Outer Space Treaty forms the bedrock of space law.[44] One of the core principles of the treaty is that parties "shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space . . . with due regard to the corresponding interests" of the other parties.[45] Additionally, parties "shall pursue studies of outer space . . . and conduct exploration of them so as to avoid their harmful contamination . . . ."[46] In terms of liability, the Outer Space Treaty provides that,

> Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies,

1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 (entered into force Oct. 10, 1967) [hereinafter Outer Space Treaty].

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

[41] Ram S. Jakhu & Md Tanveer Ahmad, *The Outer Space Treaty and States' Obligation to Remove Space Debris: A U.S. Perspective*, SPACE REV. (Nov. 13, 2017), https://perma.cc/D5NK-SJJ4.

[42] *See* Johnson, *supra* note 1 (discussing the negotiations on whether to allow a commercial space sector when establishing the Outer Space Treaty).

[43] *Commercial Space Data*, FED. AVIATION ADMIN., https://perma.cc/7QFF-58D7 (last visited Dec. 3, 2020) (showing that 363 licensed launches have occurred since 1989, and there are currently 23 active launch and/or reentry licenses.).

[44] Andrew T. Park, *Incremental Steps for Achieving Space Security: The Need for a New Way of Thinking to Enhance the Legal Regime for Space*, 28 HOUS. J. INTL. L. 871, 874 (2006).

[45] Outer Space Treaty, *supra* note 39, art. IX.

[46] *Id.*

> and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the moon and other celestial bodies.[47]

The Treaty also provides that nations may seek to consult if there is reason to believe that a party's activities in space would "cause potentially harmful interference . . . in the peaceful exploration and use of outer space," but the Treaty fails to outline an adjudication mechanism.[48] While the Outer Space Treaty provides aspirational language for parties to avoid creating orbital debris,[49] it does not have an enforcement mechanism.

2. Liability Convention

Under the Liability Convention, fault liability goes back to the launching state for a "space object." [50] The Liability Convention provides that,

> [i]n the event of damage being caused elsewhere than on the surface of the earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible.[51]

The Liability Convention defines "space object" to include "component parts of a space object as well as its launch vehicle or parts thereof."[52] Component parts are, at a minimum, "those parts that are identifiable with a part number and country of origin," and can extend to "anything manmade."[53] There is a consensus that orbital debris from a satellite or its launch vehicle would constitute a space object under the Liability Convention.[54] However, the Liability Convention's provisions pose several difficulties for parties attempting to recover damages from collisions with orbital debris.

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47 *Id.* art. VII.

48 *Id.* art. IX; Taylor, *supra* note 6, at 25.

49 *See* Outer Space Treaty, *supra* note 39, art. IX (urging parties to conduct studies of outer space and celestial bodies in a manner that avoids their "harmful contamination").

50 Liability Convention, *supra* note 40, art. III.

51 *Id.*

52 *Id.* art. I.

53 Henry R. Hertzfeld & Ben Baseley-Walker, *A Legal Note on Space Accidents*, 2 GERMAN J. AIR & SPACE L. 230, 234 (2010) (citing Convention on Registration of Objects Launched into Outer Space, art. V, *opened for signature* Jan. 14, 1975, 128 U.S.T. 695, 1023 U.N.T.S. 15 (entered into force Sep. 15, 1976)).

54 Taylor, *supra* note 6, at 27–28.

First, the Liability Convention's remedies only apply to nations who are parties to the treaty.[55] In a collision involving satellites owned and operated by private entities, a company seeking compensation would have to request for its national government to assert the claim.[56] When the Outer Space Treaty and Liability Convention were developed, virtually all of the actors in space were governmental.[57] As the number of commercial entities using space rises, it potentially becomes more difficult for negligent actors to be held responsible. For instance, a company in one country may have used another country's launch facilities to launch its satellite and registered the satellite in the launching country. That country is then responsible for the satellite under the Outer Space Treaty and Liability Convention but may have had nothing to do with the cause of a collision.[58] The satellite may be owned by yet another company in a third country and operated by a different company in a fourth country. However, if the company that owns the satellite has no assets located in the registry country, then it would be difficult to enforce compensation against the company whose satellite caused the damage.[59]

Second, even if a nation asserts a claim under the Liability Convention, it may find fault and damages difficult to prove.[60] Absolute liability does not apply to claims for damage in space. Thus, the International Court of Justice (ICJ) or Claims Commission would follow customary international tort law to determine "fault."[61] From a common law perspective, fault under the Liability Convention would follow along the lines of the elements of negligence.[62] From a civil law perspective, fault would mean the failure to act as a reasonable person would under the circumstances, which does not have the same requirement for a duty of care as in common law negligence.[63] Proving negligent conduct

[55] Liability Convention, *supra* note 40, art. XXII.

[56] *Id.* art. VIII; Kendra Webb, *To Infinity and Beyond: The Adequacy of Current Space Law to Cover Torts Committed in Outer Space*, 16 TUL. J. INT'L & COMP. L. 295, 307 (2007).

[57] *See Timeline: 50 Years of Spaceflight*, SPACE.COM (Sept 28, 2012), https://perma.cc/HF4E-8LGP (discussing how various governmental organizations conducted all major space launches through the present and through 1972).

[58] Outer Space Treaty, *supra* note 39, art. VIII; Liability Convention, *supra* note 40, art. III.

[59] *See* Henry R. Hertzfeld & Timothy G. Nelson, *Binding Arbitration as an Effective Means of Dispute Settlement for Accidents in Outer Space*, 2013 PROC. INT'L INST. SPACE L. 129, 133 (2013) (discussing the possibility of suing a private party in either the plaintiff's home state of the defendant's launch jurisdiction and the difficulties of securing a judgement).

[60] *See* Hertzfeld & Baseley-Walker, *supra* note 53, at 236–37 (analyzing the fault for the Cosmos-Iridium collision under the Liability Convention).

[61] James P. Lampertius, *The Need for an Effective Liability Regime for Damage Caused by Debris in Outer Space*, 13 MICH. J. INT'L L. 447, 453, 455–56 (1992).

[62] *Id.* at 456.

[63] Colmernares Vivas v. Sun All. Ins. Co., 807 F.2d 1102, 1109 (1st Cir. 1986) (Torruella, J., dissenting); PHILIP CHRYSTAL ET AL., SPACE DEBRIS: ON COLLISION COURSE FOR

requires sufficient evidence to show a duty of care, breach of the duty of care, causation, and damages.[64] Defining the duty of care may be difficult, since there is no international negligence treaty.[65] The best evidence that could establish duty of care is that there are orbital debris mitigation guidelines promulgated by the U.N. as well as several of the spacefaring nations.[66] While these guidelines are not binding as a matter of international law,[67] they could be used to establish a standard of practice within the space industry.[68] The custom of standard practice within the space industry then provides evidence of the duty of care. While a party may be able to recover damages for destroyed property in a collision, there would not likely be a way to recover environmental damages for costs to remediate the orbital debris created by the collision.

Finally, there is no mandatory adjudicatory mechanism within the Liability Convention.[69] If parties are unable to resolve liability under the convention through diplomatic channels within one year from notification of a claim, then one of the party nations may request that a Claims Commission be convened.[70] However, the decision of the Claims Commission is a "recommendatory award, which parties shall consider in good faith" unless all parties have agreed that the award is binding.[71] Additionally, the decision of the Claims Commission is a reasoned award, which the parties may not want.[72] Thus, the Claims Commission

INSURERS? 23 (2011) (discussing difficulties of using the Liability Convention to assess liability).

64 RESTATEMENT (SECOND) OF TORTS § 281 (AM. LAW INST. 1965).

65 Luke Punnakanta, *Space Torts: Applying Nuisance and Negligence to Orbital Debris*, 86 S. CAL. L. REV. 163, 177 (2012).

66 *See, e.g.*, United Nations Office for Outer Space Affairs, Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, at 2–4 (2010) [hereinafter Space Debris Mitigation Guidelines]; U.S. GOVERNMENT ORBITAL DEBRIS MITIGATION STANDARD PRACTICES (2019); Council Conclusions on the Draft Code of Conduct for Outer Space Activities (EU), 2008, §§ I.2, II.4, II.5 2008 [hereinafter EU Code of Conduct for Outer Space Activities]. *See also* United Nations Office for Outer Space Affairs, Space Debris Mitigation Standards: Russian Federation, https://perma.cc/7BHR-VW9N (last visited Feb. 25, 2021).

67 Space Debris Mitigation Guidelines, *supra* note 66, at 2 (stating that the guidelines "are not legally binding under international law"); EU Code of Conduct for Outer Space Activities, *supra* note 66, § 1.4.

68 RESTATEMENT (SECOND) OF TORTS § 295A (AM. LAW INST. 1965); Taylor, *supra* note 6, at 46. *See* TIMOTHY M. BIDDLE ET AL., INDUSTRY STANDARDS AS A SOURCE OF LIABILITY FOR TRADE ASSOCIATIONS AND ASSOCIATION MEMBERS (2002), https://perma.cc/EFT9-QNX9 ("Violation of industry standard (or failure to follow one) may be offered as evidence in establishing whether a party has met a standard of care.").

69 Ka Fei Wong, *Collaboration in the Exploration of Outer Space: Using ADR to Resolve Conflicts in Space*, 7 CARDOZO J. CONFLICT RESOL. 445, 460–61 (2006).

70 Liability Convention, *supra* note 40, art. XIV.

71 *Compare* Liability Convention, *supra* note 40, art. XIX, *with* Permanent Court of Arbitration, Optional Rules for Arbitration of Disputes Relating to Outer Space Activities, art. 34 (2011) (providing that awards are reasoned by default, but the parties may agree to an award where the arbitrators do not state their reasons for the award).

72 Liability Convention, *supra* note 40, art. XXVI.

procedures in the Liability Convention do not provide a solution to resolving liability and cleanup for on-orbit collisions.

3. Customary International Law

Customary international law is binding on a nation, even if that nation has not ascribed to the particular treaty or state practice.[73] Customary international law has two elements: state practice and *opinio juris*, which is a body of law to confirm the practice.[74] The ICJ looks to "induction, deduction, and assertion" to determine when there is state practice or *opinio juris* that constitutes customary international law.[75] Currently, there is no customary international law that squarely addresses the issues of creation of orbital debris and liability.[76] There are international debris mitigation standards to reduce orbital debris.[77] While compliance with debris mitigation measures is increasing,[78] those debris mitigation standards are non-binding and thus cannot be used to establish customary international law.[79]

The closest contribution that customary international law provides to resolving the orbital debris problem is the precautionary principle. The precautionary principle provides that nations should avoid taking actions resulting in environmental harm without balancing the risks of harm against the benefits of the action and adopting mitigation measures.[80]

4. International Court of Justice

Since the Outer Space Treaty and Liability Convention are United Nations treaties, the ICJ is the judicial body that will render decisions on breaches of the treaties or liability.[81] However, the decisions of the

[73] Vienna Convention on the Law of Treaties art. 38, May 23, 1969, 1155 U.N.T.S. 331; North Sea Continental Shelf Cases (Ger. v. Den.; Ger. v. Neth.), Judgement, 1969 I.C.J. 3, ¶ 37 (Feb. 20).

[74] *See* Taylor, *supra* note 6, at 28.

[75] Cedric M. J. Ryngaert & Duco W. Hora Siccama, *Ascertaining Customary International Law: An Inquiry into the Methods Used by Domestic Courts*, 65 NETH. INT'L L. REV. 1, 2 (2018) (citing Stefan Talmon, *Determining Customary International Law: The ICJ's Methodology Between Induction, Deduction and Assertion*, 26 EUR. J. INT'L L. 417, 441 (2015)).

[76] Taylor, *supra* note 6, at 29.

[77] Space Debris Mitigation Guidelines, *supra* note 66, §§ 3–4; INT'L STANDARDS ORG., ISO/CD TR 18146 (2015).

[78] *See* EUROPEAN SPACE AGENCY SPACE DEBRIS OFFICE, *supra* note 15, at 4.

[79] Space Debris Mitigation Guidelines, *supra* note 66, at 2 ("These guidelines are applicable to mission planning and the operation of newly designed spacecraft and orbital stages and, if possible, to existing ones. They are not legally binding under international law.").

[80] Taylor, *supra* note 6, at 31.

[81] U.N. Charter art. 36, ¶ 1.

ICJ are not easily enforceable.[82] Per the U.N. Charter, the ability to enforce decisions of the ICJ rests with the U.N. Security Council.[83] However, the Security Council has only chosen to enforce an ICJ decision one time in its history.[84] Enforcement of a decision rendered against a permanent member of the Security Council with veto power, such as the United States, United Kingdom, France, China, or Russia is unlikely to succeed.[85] Coincidentally, these permanent members of the Security Council are major spacefaring nations.[86] The result is that the ICJ has the authority to render a decision to determine liability under the treaties, but if the decision is directed against one of the major spacefaring nations, they can veto the decision, rendering it unenforceable.

B. Proposed Legal Solutions

Since the current legal tools are inadequate to regulate orbital debris and enforce remediation, a new legal scheme is needed. This Essay's proposed approach would provide both promptness and enforceability to ensure that responsible parties clean up orbital debris. CERCLA provides a model for a new remediation liability scheme, and international arbitration provides enforceability and promptness to resolve cases that is lacking under the current treaty system.

1. Using CERCLA as a Model for Cleanup Liability

CERCLA provides a template for handling liability and remediation of orbital debris[87] and a system for cleaning up hazardous waste contamination at former industrial sites to prevent groundwater pollution.[88] It also provides authority for the government to orchestrate cleanup response actions up front and sort out liability later.[89] To fund cleanup response actions, CERCLA created a trust fund, known as the Superfund, from taxes on petroleum and chemical companies.[90] The expenditures from the Superfund for response actions are reimbursed by

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[82] Gary Born, *A New Generation of International Adjudication*, 61 DUKE L.J. 775, 787–88 (2012).

[83] U.N. Charter art. 94, ¶ 2.

[84] Jose E. Alvarez, *The New Dispute Settlers: (Half) Truths and Consequences*, 38 TEX. INT'L L.J. 405, 416 (2003).

[85] *Id.*

[86] Johnny Wood, *The Countries with the Most Satellites in Space*, WORLD ECON. F. (Mar. 4, 2019), https://perma.cc/2Z8N-L46Z.

[87] CERCLA, 42 U.S.C. §§ 9601–9628 (2018).

[88] *This is Superfund: A Community Guide to EPA's Superfund Program*, U.S. ENV'T PROTECTION AGENCY, https://perma.cc/27NN-SKV4 (last updated Apr. 30, 2020).

[89] 42 U.S.C. §§ 9604, 9607.

[90] *Superfund: CERCLA Overview*, U.S. ENV'T PROTECTION AGENCY, https://perma.cc/6X3C-HPAS (last updated Jan. 4, 2021).

liable parties.[91] In general, the responsible parties are jointly and severally liable.[92] The Act broadly construes who is a potentially liable party.[93] Additionally, CERCLA provides for retroactive liability, so parties could be liable for cleanup of hazardous waste contamination that occurred before the law was enacted.[94] CERCLA holds responsible parties strictly liable for response costs.[95]

CERCLA's structure provides multiple benefits to ensure hazardous waste site cleanup occurs efficiently. One benefit of CERCLA is that it prioritizes cleanup response actions to mitigate environmental harm to the community.[96] Another benefit is that the Act allows for recovery against multiple liable parties, jointly and severally, to ensure a better chance of fully reimbursing the Superfund for incurred cleanup costs.[97] From there, the onus is on the potentially responsible parties to sort out liability amongst themselves in contribution actions.[98] Retroactive applicability is a third benefit because the Act is able to provide a response to earlier environmental harm.[99]

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[91] *Superfund Cost Recovery*, U.S. ENV'T PROTECTION AGENCY, https://perma.cc/72YG-T7JD (last updated May 29, 2019).

[92] 42 U.S.C. § 9607(a)(4); United States v. Monsanto Co., 858 F.2d 160, 171 (4th Cir. 1988).

[93] 42 U.S.C. § 9607 (Superfund may seek reimbursement from (1) "the owner and operator of a vessel or a facility," (2) "any person who at the time of disposal . . . owned or operated any facility at which such hazardous substances were disposed of," (3) any person who arranged for or contracted for disposal, treatment, or transportation of the hazardous substances, or (4) any person who accepted the hazardous substance for transport to the site where the release occurred.); *id.* § 9601 (defining "owner or operator" as (1) "any person owning, operating, or chartering" the vessel, (2) "any person owning or operating" an industrial facility or (3) any person who owned the facility immediately prior to "bankruptcy, foreclosure, tax delinquency" or "abandonment").

[94] James A. Resila, *The Retroactive Application of CERCLA: Pre-Enactment Response Costs*, 1 FORDHAM ENV'T L. REP. 69, 70 (1989).

[95] *See* 42 U.S.C. § 9607 (discussing how a person is liable for response costs when there is a release of hazardous waste at the site, the same type of waste that such person transported and disposed of); Andrew W. Marrero, *Innocent in the Land of the Guilty: Promoting Efficiency and Fairness in CERCLA Defenses*, 30 GEO. ENV'T L. REV. 521, 526 (2018) (discussing how CERCLA imposes strict liability on potentially responsible parties); Owen T. Smith, *The Expansive Scope of Liabilities Under CERCLA*, 63 ST. JOHN'S L. REV. 821, 824–25 (1989) (discussing that although the statute does not explicitly mention strict liability, it holds parties strictly liable based on application of the provisions of 42 U.S.C. § 9607).

[96] *See Superfund: CERCLA Overview*, *supra* note 90 (stating that CERCLA provides broad federal authority to respond to releases of hazardous substances that endanger public health).

[97] *See* 42 U.S.C. § 9607 (referring to covered persons in regard to liability implying multiple parties); *Monsanto Co.*, 858 F.2d at 171.

[98] 42 U.S.C. § 9613. *But see* Cooper Indus., Inc. v. Aviall Servs., Inc., 543 U.S. 157, 167 (2004) (limiting contribution actions only to parties ordered to pay cleanup response costs and not parties who voluntarily clean up a site); Ronald G. Aronovsky, *Federalism and CERCLA: Rethinking the Role of Federal Law in Private Cleanup Cost Disputes*, 33 ECOLOGY L.Q. 1, 4 (2006).

[99] *See* Resila, *supra* note 94, at 69 (discussing how courts have generally concluded that parties are subject to liability for acts committed prior to the passage of the statute

There are a few drawbacks to CERCLA. One major lack of clarity in the Act has been that, while there is retroactive liability for cleanup response costs incurred after the enactment of the statute, there is disagreement about whether retroactive liability extends to response costs incurred before the enactment of the statute.[100] A second criticism is that the bureaucratic element required to administer the program is inefficient.[101] A third criticism has been that CERCLA's strict liability standard, with defenses applied very narrowly, results in cases of innocent parties expending large sums on legal fees to escape harsh joint and several liability provisions.[102] Some commentators argue that CERCLA's strict liability provisions provide no economic advantage over fault-based negligence theories of recovery.[103] While CERCLA's liability provisions may enable quicker cleanup responses, parties to CERCLA litigation could be "snared in a litigation web for years simply because they happened to be found on the spot of land ownership or control."[104] While these drawbacks present difficulties with CERCLA as applied to cleanup of industrial sites, there would be fewer issues presented in space as the technology to perform debris tracking improves, and the hazard presented by collisions is readily apparent and traceable to a specific event. CERCLA involves cleanup of hazardous waste pollution that may not have been apparent for decades prior to the cleanup.

Translating CERCLA into a space environmental liability scheme provides an important model for several reasons. First, it would hold satellite owners and operators liable for environmental harms and cleanup, not just for property damage.[105] As technological capability is advancing to the point of orbital debris remediation, a CERCLA-like scheme for orbital debris would better ensure that the costs of removal and remediation would be reimbursed by the parties who owned or operated the satellites that generated the debris. Of course, this is not a solution for every case because some pieces of debris are too small to be tracked, so it is not possible to ascertain the origin of every piece of orbital debris.[106] However, this would resolve debris remediation from

under CERCLA); Smith, *supra* note 95, at 837 (stating that CERCLA is retroactive given that one of its purposes is to clean up existing waste disposal sites).

100 Resila, *supra* note 94, at 75–77.

101 Kathleen Chandler Schmid, *The Depletion of the Superfund and Natural Resource Damages*, 16 N.Y.U. ENV'T L.J. 483, 508 (2008).

102 Marrero, *supra* note 95, at 528.

103 Michael B. Gerrard, *Demons and Angels in Hazardous Waste Regulation: Are Justice, Efficiency, and Democracy Reconcilable?*, 92 N.W. U. L. REV. 706, 716 (1998).

104 Marrero, *supra* note 95, at 541.

105 *See* Mary Button, *Cleaning Up Space: The Madrid Protocol to the Antarctic Treaty as a Model for Regulating Orbital Debris*, 37 WM. & MARY ENV'T L. & POL'Y REV. 539, 563–64 (2013) (contrasting liability under the Liability Convention with environmental liability).

106 *See* Taylor, *supra* note 6, at 51–52 (discussing the difficulty of applying market-share liability to orbital debris because of the amount of unknown and untraceable debris).

the trackable debris created by collisions, whether intentional or unintentional.[107]

Under U.S. law, insurance on satellites is only required to cover a satellite for thirty days past the launch date, making it ineffective to cover liability in case of collision during the satellite's lifespan.[108] A CERCLA-like scheme in space could encourage satellite owners and operators to obtain insurance on satellites that covers the entirety of the satellite's life cycle. This would be a similar effect to how owners and operators of industrial properties obtain environmental insurance to limit their potential liability exposure under CERCLA.[109]

2. International Arbitration

It would be ideal to meld an orbital debris liability and cleanup response law with the responsiveness provided by international commercial arbitration. Since the late 1970s, commentators have been calling for using international arbitration as a method of dispute resolution for issues arising in space.[110] Arbitration results in an enforceable award that will be confirmed and enforced by national courts.[111] Because of the New York Convention, arbitral awards "can be effectively enforced in almost every corner of the world."[112] As of the writing of this Essay, 166 nations are parties to the New York Convention.[113] While arbitral awards are binding on the parties when issued, decisions of the ICJ or Claims Commission are not enforceable from a practical standpoint.[114]

Disputes submitted to arbitration are generally resolved much quicker than disputes resolved through the judicial system.[115] Arbitration provides for far greater flexibility than the ICJ or national

107 *See id.* at 10 (discussing the actions of the United States and China to intentionally destroy satellites, creating orbital debris).

108 14 C.F.R. § 440.11 (2020); Taylor, *supra* note 6, at 21.

109 *See* PERKINS COIE LLP, INSURANCE COVERAGE FOR ENVIRONMENTAL LIABILITIES 2 (2015), https://perma.cc/P5CX-RH4T (discussing available options on the marketplace for environmental insurance).

110 *See, e.g.*, Karl-Heinz Böckstiegel, *Arbitration and Adjudication Regarding Activities in Outer Space*, 6 J. SPACE L. 3, 18 (1978).

111 U.N. Comm'n on Int'l Trade Law, *Convention on the Recognition and Enforcement of Foreign Arbitral Awards (New York, 1958)*, at 1 (2015), https://perma.cc/6JPN-KV59.

112 Carolyn B. Lamm et al., *International Arbitration in a Globalized World*, DISP. RESOL. MAG., Winter 2014, at 4, 4 (discussing Convention on the Recognition and Enforcement of Foreign Arbitral Awards, June 10, 1958, 21 U.S.T. 2517, 330 U.N.T.S. 38).

113 *Status: Convention on the Recognition and Enforcement of Foreign Arbitral Awards (New York, 1958)*, UNITED NATIONS COMMISSION ON INT'L TRADE L., https://perma.cc/4A5K-ALUS (last visited Dec. 3, 2020).

114 Born, *supra* note 82, at 787–88; Liability Convention, *supra* note 40, art. XIX ¶ 2.

115 *See, e.g.*, Roy Weinstein et al., *Efficiency and Economic Benefits of Dispute Resolution through Arbitration Compared with U.S. District Court Proceedings*, MICROECONOMICS 10 (2017), https://perma.cc/AWN4-KAPR (discussing that federal court cases in California and New York took an average of 15 months and 18 months longer, respectively, than arbitrated claims).

courts to resolve disputes. While an arbitration agreement provides for a "seat" of the arbitration, such as London, New York, or Singapore, the arbitration can actually be conducted anywhere in the world that is convenient to parties, witnesses, and arbitrators.[116] From a venue standpoint, arbitration is clearly superior to judicial options. Additionally, the rules for arbitration provide more flexibility for the actual hearing than the Claims Commission process promulgated by the Liability Convention.[117] Parties to an arbitration are free to adapt the rules of the proceedings to suit the nature of the arbitration, while the Claims Commission rules are fixed. The Permanent Court of Arbitration has developed a set of optional rules for arbitration of disputes involving outer space.[118] These optional rules modify the U.N. Commission on International Trade Law rules to reflect the unique circumstances presented by these types of disputes.[119] These optional rules have laid the groundwork for successful implementation of arbitration in space law disputes.

There is also precedent for mandatory arbitration of some space law issues. The INTELSAT Treaty,[120] which governs allotment of telecommunications satellite space within Geosynchronous Equatorial Orbit, requires mandatory arbitration for compliance with rules and standards set forth in allotment approvals for space or Earth stations.[121] However, arbitration is optional regarding other legal issues pertaining to the agreement.[122] The ESA Convention also provides for mandatory arbitration of disputes arising under the Convention.[123] These agreements serve as limited models for how to implement mandatory arbitration in the proposal at issue.

3. Implementation of the Proposal

A bilateral or multilateral treaty or agreement among the major spacefaring nations would be the most comprehensive way to implement

116 G.A. Res. 65/22, art.18, United Nations Commission on International Trade Law Arbitration Rules (Dec. 6, 2010).

117 Wong, *supra* note 69, at 462.

118 OPTIONAL RULES FOR ARBITRATION OF DISPUTES RELATING TO OUTER SPACE ACTIVITIES, PERMANENT COURT OF ARBITRATION 4 (Dec. 6, 2011), https://perma.cc/8ERV-JVCT.

119 *Id.*

120 Agreement Relating to the International Telecommunications Satellite Organization "INTELSAT" art. XVIII, *opened for signature* Aug. 20, 1971, 23 U.S.T. 3813, 1200 U.N.T.S. 21 [hereinafter INTELSAT Treaty].

121 *Id.*

122 Operating Agreement Relating to the International Telecommunications Satellite Organization art. 14(c), 15(c), 1971, 10 I.L.M. 909, 927–29 (1971).

123 Convention for Establishment of a European Space Agency, art. XVII, May 30, 1975, 1297 U.N.T.S. 186.

this proposal. This could either be a new agreement[124] or modifications to an existing agreement, such as the Liability Convention. Unfortunately, because of the political difficulties in reaching consensus for a treaty, such an approach is not likely to occur in the near term.[125]

Another approach to implementation is through national laws. One viable implementation method would be new launch license requirements for entities involved in the launch or operation of the satellite. Each of these entities could be required to "accept international arbitration of any collision claims involving any . . . actor which is also engaged in space-faring activity," and also publish its consent to arbitration.[126] If a major spacefaring nation or entity, such as the United States, China, Russia, or the ESA were to implement this proposal, it would speed the process toward establishing a global custom. For instance, domestic laws of the United States have far-reaching effects on space enterprise and conduct because the United States is responsible for the plurality of operational satellites.[127] There have been circumstances, such as the proclamation extending territorial seas to encompass the continental shelf, where action taken by the United States established "a virtually 'instant' customary international law."[128]

A major spacefaring nation using its domestic national law to further its interest in this area could lead to international consensus. An agreement or treaty among the major spacefaring nations would be the most comprehensive vehicle to implement this proposal. This could either be a new agreement[129] or modifications to an existing agreement, such as the Liability Convention. However, because of the political difficulties in reaching consensus for a treaty, such an approach is not likely to occur in the near term.[130] Thus, using domestic law as a tool to generate leadership on this issue would be the most profitable approach in the meantime.

4. Limitations of This Approach

A liability response scheme needs to be paired with mandatory preventative measures to be truly effective.[131] Liability response

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124 *See, e.g.*, Space Law Comm. of the Int'l Law Ass'n, *Final Draft of the Revised Convention on the Settlement of Disputes Related to Space Activities*, 68 INT'L L. ASS'N REP. CONF. 239, 240 (1998).

125 Gennady M. Danilenko, *International Law-Making for Outer Space*, 37 SPACE POL'Y 179, 183 (2016).

126 Hertzfeld & Nelson, *supra* note 59, at 137–38.

127 Wood, *supra* note 86.

128 Carns, *supra* note 22, at 214–15 (quoting MICHAEL P. SCHARF, CUSTOMARY INTERNATIONAL LAW IN TIMES OF FUNDAMENTAL CHANGE: RECOGNIZING GROTIAN MOMENTS 118 (2013)).

129 *See, e.g.*, Space Law Comm. of the Int'l Law Ass'n, *supra* note 124, at 249.

130 Danilenko, *supra* note 125, at 183.

131 Raymond T. Swenson, *Pollution of the Extraterrestrial Environment*, 25 A.F. L. REV. 70, 80 (1985) ("After-the-fact liability is also no substitute for prevention of risk.").

measures, such as this Essay proposes, can provide an incentive for actors in space to reduce orbital debris. However, operators may determine that it is more feasible to take on after-the-fact financial risks rather than adjust their conduct to avoid creating debris.[132]

In order for mandatory international arbitration to be a viable option, parties must have an agreement to arbitrate. Responsible parties to a collision who launched items into space prior to effectiveness of this proposed scheme have no obligation to arbitrate and may be reluctant to voluntarily submit to arbitration.[133] However, there is precedence for industries voluntarily creating an arbitration scheme through a "decentralized process."[134] For example, securities and commodities investment in the United States, maritime salvage, and disputes involving international sporting events are areas where industries themselves created an arbitration dispute resolution mechanism that is standard throughout the industry.[135]

Until the last few years, a major limitation on implementing this proposal would have been the lack of feasible technology to remove orbital debris. However, technology has been developing in this area at a rapid pace.[136] At this stage, the biggest limitation to implementing this legal proposal is that there has not yet been a first mover, such as a major spacefaring nation or industry participant. Once that happens, it will create momentum to solve this problem.

IV. CONCLUSION

Orbital debris presents an increasing problem for space users. If left unchecked, orbital debris could render large swaths of Earth's orbit unusable for centuries. Technology that can tackle this problem by removing debris from space is developing. At the same time, the law must advance to ensure parties who create orbital debris are responsible for the ramifications, including debris removal. Current space law does not adequately ensure this will happen because of the lack of enforceability and vagueness present in the current treaties. This Essay poses the solution of using CERCLA as a model for regulating orbital debris cleanup and pairing it with the benefits provided by international commercial arbitration to ensure enforceability and prompt response to the creation of orbital debris. While, ideally, this would happen through multilateral treaties, a major spacefaring nation could also lead the charge through implementation in national law.

132 Taylor, *supra* note 6, at 46.
133 Hertzfeld & Nelson, *supra* note 59, at 137–38; Danilenko, *supra* note 125, at 183.
134 Hertzfeld & Nelson, *supra* note 59, at 138.
135 *Id.* at 138–39.
136 *See supra* notes 34–37 and accompanying text.