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Avoiding Pyrrhic Victories in Orbit: A Need for Kinetic Anti-Satellite Arms Control in the Twenty-First Century

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AVOIDING PYRRHIC VICTORIES IN ORBIT: A NEED FOR KINETIC ANTI-SATELLITE ARMS CONTROL IN THE TWENTY-FIRST CENTURY

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ABSTRACT

On March 27, 2019, India launched a direct ascent anti-satellite (ASAT) weapon, aimed at the Indian Ministry of Defense satellite *Microsat-R*. The kinetic-energy ASAT weapon collided with *Microsat-R* at an altitude of nearly 300 kilometers, creating an estimated 250 pieces of trackable debris from the 740-kilogram satellite. With this effective demonstration of ASAT capability, India became only the fourth nation to successfully intercept an orbiting satellite in the sixty-one years since the U.S.S.R. placed into orbit the first artificial satellite, *Sputnik*. While India's demonstration purported to take deliberate steps to mitigate some of the risk associated with a kinetic-energy ASAT attack, it nonetheless carries significant implications for the international community. Aside from balance of power and regional stability questions, the demonstration is another reminder that space itself is a global commons, and the activities of one state affect the use by every other participant. States must reengage discussions of constraining kinetic-energy ASAT weapons to ensure that unfettered pollution of debris does not prevent future space exploration and commerce.

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This Article argues that the suggested international regimes that might regulate the testing and use of kinetic-energy ASAT weapons are both fragmented and ineffective. It begins with a brief examination of outer space as a global commons, the different types of orbits employed by artificial satellites, and a history of the weapons used to intercept or counter them. This Article then discusses applicable treaties and state practices relevant to activities in outer space that form the foundation of the relevant legal regimes. It analyzes the application and effectiveness of proposed legal regimes for constraining ASAT weapon usage including state liability for space debris, the acceptable means and methods of warfare, and environmental modification regimes. Finding that those regimes have not adequately constrained state use of kinetic-energy ASAT weapons, this Article proposes that states should reengage in reciprocal arms control regimes that would prohibit the testing and use of kinetic-energy ASAT weapons while preserving cyber, directed-energy, and electromagnetic spectrum attacks against space-based assets.

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I. INTRODUCTION

ON MARCH 27, 2019, India launched a direct-ascent anti-satellite (ASAT) weapon from Dr. Abdul Kalam Island, targeting the Indian Ministry of Defense satellite *Microsat-R*.[1] The kinetic-energy ASAT weapon collided with *Microsat-R* at an altitude of nearly 300 kilometers, creating an estimated 250 pieces of trackable debris from the 740-kilogram satellite.[2] With

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1 Ashlyn Still et al., *India Shoots Down Own Satellite*, Reuters (Mar. 27, 2019), https://graphics.reuters.com/INDIA-SATELLITE-WEAPON/0100918Q1RV/index.html [https://perma.cc/4ZMM-5R8A].

2 *See* Madhumathi D.S., *ISRO's First Mission of 2019 to Put Military Satellite* Microsat-R *in Space*, Hindu (Jan. 25, 2019), https://www.thehindu.com/sci-tech/science/isros-first-mission-of-2019-to-put-military-satellite-microsat-r-in-space/article26072511.ece [https://perma.cc/59LB-BP4V]; Sanjeev Miglani & Krishna N. Das, *Modi Hails India as Military Space Power After Anti-Satellite Missile Test*, Reuters (Mar. 27, 2019), https://www.reuters.com/article/us-india-satellite/modi-hails-india-as-military-space-power-after-anti-satellite-missile-test-idUSKCN1R80IA [https://perma.cc/55KJ-Q7TU].

this effective demonstration of ASAT capability, India became only the fourth nation to successfully intercept an orbiting satellite in the sixty-one years since the U.S.S.R. placed into orbit the first artificial satellite, *Sputnik*.[3] While Prime Minister Modi lauded the success of *Operation Shakti* in a nationally televised address,[4] India's Ministry of External Affairs specifically stated that India has no intention of entering into a space arms race, and it repeated the proclamation of the 1967 Outer Space Treaty that "[o]uter space is the common heritage of humankind."[5] The Ministry also stated that, while the test was not directed at any specific country, India's ASAT capability is a credible deterrent against threats to India's space-based assets.[6] While India suggests the demonstration took deliberate actions during the engagement to mitigate some of the risk associated with a kinetic-energy ASAT attack, the strike nonetheless carries significant implications for the international community.[7]

Aside from balance-of-power and regional stability questions, the demonstration is another reminder that space itself is a global commons, and the activities of one state affect its use by every other participant.[8] States must reengage discussions over constraining kinetic energy ASAT weapons to ensure that unfettered pollution of debris does not prevent space exploration and commerce. Intentional breakups, such as kinetic-energy ASAT testing, are responsible for thousands of pieces of debris in low-Earth orbit (LEO).[9] Depending on the altitude, it can

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[3] *See* Steve Garber, *Sputnik and the Dawn of the Space Age*, NASA, https://history.nasa.gov/sputnik/ [https://perma.cc/MXH8-E8JV] (last updated Oct. 10, 2007); Still et al., *supra* note 1.

[4] *See* Miglani & Das, *supra* note 2; Still et al., *supra* note 1.

[5] Press Release, Ministry of External Affairs, Gov't of India, Frequently Asked Questions on Mission Shakti, India's Anti-Satellite Missile Test Conducted on 27 March, 2019 (Mar. 27, 2019) [hereinafter Frequently Asked Questions on Mission Shakti].

[6] *Id.*

[7] *See infra* section III.B.

[8] *See* Eligar Sadeh, *International Space Governance: Challenges for the Global Space Community*, *in* RECENT DEVELOPMENTS IN SPACE LAW 43, 45 (R. Venkata Rao et al. eds., 2017).

[9] Low-Earth orbit (LEO) is typically defined as an orbit with an altitude between 160 and 2,000 kilometers from the Earth's surface. *See Satellites 101: LEO vs. GEO*, IRIDIUM (Sept. 11, 2018), https://www.iridium.com/blog/2018/09/11/satellites-101-leo-vs-geo/ [https://perma.cc/E6Y3-9NF8]. Satellites in this orbit travel at approximately 7.8 kilometers per second and circle the Earth every 90 minutes. *See Types of Orbits*, EUROPEAN SPACE AGENCY, https://www.esa.int/Our_Activities/Space_Transportation/Types_of_orbits [https://perma.cc/W4LL-8GN5] (last visited Mar. 17, 2020). This altitude is particularly suited for remote

take anywhere from a few months to several decades before the debris eventually degrades into the Earth's atmosphere.[10] Until then, even pieces as small as several centimeters can pose significant dangers to operational spacecraft in orbit.[11] This problem is exacerbated in mid-Earth orbit (MEO),[12] where debris can persist for centuries, and geostationary orbit, where debris remains indefinitely.[13]

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sensing operations, military intelligence gathering, and human spaceflight because the short orbital period allows for rapid, repeated overflight. *See id.* Additionally, the majority of commercial communications satellites are in LEO, operating in a constellation to provide near-instantaneous global communications. *See Satellites 101: LEO vs. GEO*, *supra*. Polar orbits are a specific type of LEO where satellites make continuous vertical passes over the Earth that, due to the Earth's natural rotation, allow the satellite to effectively map the entirety of the planet twice in a 24-hour period. *See Popular Orbits 101*, AEROSPACE SECURITY, https://aerospace.csis.org/aerospace101/popular-orbits-101/ [https://perma.cc/E3YA-FH82] (last updated Oct. 4, 2019).

10 *See Frequently Asked Questions*, NASA ORBITAL DEBRIS PROGRAM OFFICE, https://www.orbitaldebris.jsc.nasa.gov/faq/ [https://perma.cc/42A5-7H7X] (last visited Mar. 17, 2020).

11 *See id.*

12 Mid-Earth orbits (MEO) are typically defined as having an altitude greater than 2,000 and less than 36,000 kilometers, with orbital periods that range from 2 to 24 hours. *See Popular Orbits 101*, *supra* note 9; *Satellite Orbits*, EMEA SATELLITE OPERATORS ASS'N, https://esoa.net/technology/satellite-orbits.asp [https://perma.cc/9YRV-4AQB] (last visited Mar. 17, 2020). The primary occupants of MEO orbits are navigation satellite constellations, such as the Global Positioning System, GLONASS, and Galileo systems. *See Satellite Orbits*, *supra*. Because of the orbital periods, communications satellites that provide coverage of the Earth's poles are placed in MEO as well. *See id.* One of the difficulties of placing satellites into MEO is the presence of the Van Allen radiation belts, which are caused by the Earth's natural magnetic fields trapping charged particles from solar winds and cosmic rays. *See Popular Orbits 101*, *supra* note 9. The two belts extend roughly from 500 to 5,500 kilometers and 12,000 to 22,000 kilometers in altitude. *Id.* The costly additional shielding required to protect solar arrays and electronic components, combined with the increased transmission power requirements, preclude smaller satellites from occupying these orbits. *Cf. id.* Highly elliptical orbits (HEO) are a special form of MEO orbit that extends the elliptical orbit of the satellite in an oblong manner, allowing for maximum coverage time of a particular hemisphere. *See id.* HEO orbits were of particular importance in the Cold War, where the United States and the U.S.S.R. placed numerous reconnaissance satellites in HEO Molniya orbits (an inclination of 63.4 degrees from the equator, with an average apogee of 40,000 kilometers) to provide constant observation of each other.

13 Geostationary orbits (GEO) have an altitude of 35,786 kilometers, giving them an orbital period of exactly 24 hours. *Popular Orbits 101*, *supra* note 9. GEO satellites appear to be in a fixed position to an observer on Earth, making them ideal for communications purposes, since ground-based antennas can consistently be aimed directly at the satellite. *See* T.S. Kelso, *Basics of the Geostationary Orbit*, SATELLITE TIMES, May 1998, at 76, 76–77, https://www.celestrak.com/col-

In an effort to constrain the creation of artificial debris, the international community has tried with limited success to prohibit the intentional destruction of satellites in orbit. Both the Outer Space Treaty of 1967[14] and the Liability Convention of 1972[15] address responsibility and liability for damage caused by debris from human spaceflight. While both treaties remain in force, current systems are capable of tracking only a small fraction of the debris population, thus making it difficult or impossible to identify the party at fault. Another suggestion has been that the use of kinetic-energy ASAT weapons is a means of warfare that violates the principles of the law of armed conflict. Specifically, it is impossible to contain the debris produced, and the debris can indiscriminately harm otherwise-protected state property. This approach is also unsuccessful at constraining ASAT use, since the proportionality balancing assessment prescribed by the law of armed conflict would likely justify an attack that crippled adversarial space assets when weighed against any potential future harm resulting from an unintentional collision with debris. A final approach contemplated is that the use of kinetic-energy strikes in space causes widespread, long-term, and severe damage to the natural environment in violation of several environmental protection regimes. This argument also fails to prohibit kinetic strikes directed against a satellite, as the environmental regimes either require use of the environment as a weapon against an enemy or intent to damage the environment.

This Article argues that the applicable international regimes are both fragmented and ineffective, and a better approach to prohibit future kinetic-energy ASAT strikes is to reengage in multilateral, reciprocal arms control agreements. These agreements have previously been successful in ending the means and methods of warfare identified by the international community as

umns/v04n07/ [https://perma.cc/54KJ-PKQ2] (last updated Dec. 28, 2019). Geostationary orbits with no inclination travel directly over the top of the Earth's equator and maintain a ground track directly over the same point. *Id.* Geosynchronous orbits have a minute variation in altitude and a slight inclination above or below the equator, which cause them to appear to travel in a figure-eight pattern over a fixed point to a ground-based observer. *Id.*; *Popular Orbits 101*, *supra* note 9.

14 *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. VII, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

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

excessively injurious, damaging, or inhumane. China and Russia have made progress in establishing a comprehensive ASAT arms control regime; the United States should now take the lead in negotiating such an agreement in order to protect its dependence on space-based assets and retain its military and economic supremacy. The United States' failure to establish these agreements will likely be taken as an acquiescence to recent state action, which may cement a customary international law norm that tolerates the use of kinetic-energy interceptors.

This Article begins with a brief examination of outer space as a global commons, the different types of orbits employed by artificial satellites, and a history of the weapons used to intercept or counter them. The Article then looks at applicable treaties and state practices that form the foundation of governance in outer space. It then analyzes the application and effectiveness of a control regime based upon state liability for space debris and a regime constrained by the acceptable means and methods of warfare available to states. Finding that those regimes have not adequately constrained state use of kinetic-energy ASAT weapons, this Article proposes that states should pursue reciprocal arms control regimes that would prohibit the testing and use of kinetic-energy ASAT weapons while preserving cyber, directed-energy, and electromagnetic spectrum attacks against space-based assets.

II. THE ASAT THREAT TO THE GLOBAL COMMONS

A. What Are Anti-Satellite Weapons?

ASAT weapons are any intentional physical object or electromagnetic force directed against the normal functioning of a space-based asset.[16] Traditional ASAT weapons are direct-ascent ballistic missiles launched on an intercept trajectory; the kinetic energy from the collision causes damage ranging from fragmentation to outright obliteration, depending on the mass of the objects and their relative speed at the time of impact.[17] Other kinetic-energy weapons include co-orbital ASAT weapons that establish an orbit, transition to the target orbit, and either col-

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16 *See* U.S. Dep't of Def., Joint Chiefs of Staff, JP 3-14, Space Operations I-6 (Apr. 10, 2018) [hereinafter JP 3-14, Space Operations].

17 *Cf. id.*

lide with or detonate in close proximity to the target, destroying it with the resulting fragmentation.[18]

Satellites are equally vulnerable to non-kinetic attacks. Intentional attacks manipulating the electromagnetic (EM) spectrum can interfere with the link between the satellite and the ground control station or can be directed against the satellite itself.[19] These attacks include radiation and reflection jamming of the space or link segment or the direct lasing of a satellite to "blind" or destroy it.[20] Finally, the ground control station is vulnerable to an attack through cyberspace, degrading or destroying the satellite.[21]

B. Why Are Countries Intent on Developing ASAT Technologies?

States' economic and military activities are increasingly reliant on access to space and the use of space-based assets. Satellites map natural resources through remote sensing, provide updated imagery in the wake of natural disasters, and ensure compliance with international regimes through monitoring of weapons production facilities.[22] Satellites also provide global communication capabilities, real-time weather mapping, and navigation guidance for transiting vessels.[23] For example, it is estimated that, in 2011, between 6%–7% of western European gross domestic product was reliant on the use of the Global Posi-

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[18] *See id.* at II-15. Russia chose to pursue a co-orbital ASAT system rather than the nuclear-tipped interceptors employed by the United States. The Russian program, codenamed *Istrebitel Sputnikov* (Satellite Fighter), was operational from 1968–1982 and consisted of at least twenty tests in LEO. *See* Staff of S. Comm. on Aeronautical & Space Sciences, 94th Cong., 1 Soviet Space Programs, 1971–75: Overview, Facilities and Hardware, Manned and Unmanned Flight Programs, Bioastronautics, Civil and Military Applications, Projections of Future Plans 66–67, 424–26 (Comm. Print 1976), *reprinted in* 3 Histories of the Soviet/Russian Space Program: Soviet Space Programs, 1971–1975, at 60–61, 353–54 (Progressive Management 2013); *see also* Todd Harrison et al., *Space Threat Assessment 2018*, at 13–14, Ctr. for Strategic & Int'l Studies (2018), https://aerospace.csis.org/wp-content/uploads/2018/04/Harrison_Space ThreatAssessment_FULL_WEB.pdf [https://perma.cc/6CHB-UNCA].

[19] *See* JP 3-14, Space Operations, *supra* note 16, at I-6.

[20] *See id.*

[21] *See id.* at I-7.

[22] *See What Are Satellites Used For?*, Union of Concerned Scientists, https://www.ucsusa.org/resources/what-are-satellites-used [https://perma.cc/MW7R-D5TC] (last updated Jan. 15, 2015).

[23] *See id.*

tioning System (GPS) constellation of satellites.[24] Military communications satellites, spy satellites, and GPS satellites are indispensable tools of modern conflict; they detect missile launches, guide precision weapons, and facilitate near-instantaneous communications among all levels of military command.[25]

Countries with a robust space presence seek credible deterrents to protect their access to the space domain and their existing assets. The 2006 National Space Policy provided that the United States would view any "purposeful interference with its space systems as an infringement on its rights."[26] Coupled with a threat to deny adversaries the use of capabilities that infringe on U.S. freedom of action in outer space, the international community has approached the declaration as evidence of unilateralist intentions for space.[27] The United States updated the language of its space policy in 2010, though deterrence remains a common theme to ensure freedom of action.[28]

Freedom of action in space, as defined by *Joint Publication 3-14: Space Operations* (United States) and *Joint Doctrine Publication 0-30: UK Air and Space Power* (United Kingdom), is derived from the ability to control access to and movement in space.[29] Both the United States and the United Kingdom state that protection of space assets will rely on credible deterrence where the "cost"

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[24] Dale Stephens, *Increasing Militarization of Space and Normative Responses*, *in* RECENT DEVELOPMENTS IN SPACE LAW, *supra* note 8, at 91, 101.

[25] *See* JP 3-14, SPACE OPERATIONS, *supra* note 16, at II-4 to II-6, II-11.

[26] OFFICE OF SCI. & TECH. POLICY, EXEC. OFFICE OF THE PRESIDENT, U.S. NATIONAL SPACE POLICY 1 (2006). The fifth principle states,

> The United States considers space capabilities—including the ground and space segments and supporting links—vital to its national interests. Consistent with this policy, the United States will: preserve its rights, capabilities, and freedom of action in space; dissuade or deter others from either impeding those rights or developing capabilities intended to do so; take those actions necessary to protect its space capabilities; respond to interference; and deny, if necessary, adversaries the use of space capabilities hostile to U.S. national interests.

Id. at 1–2.

[27] Bao Shixiu, *Deterrence Revisited: Outer Space*, CHINA SECURITY, Winter 2007, at 2, 2–4 (taking the position that space is a limited resource and that the U.S. declaration is an attempt to establish sovereignty over the resource).

[28] EXEC. OFFICE OF THE PRESIDENT, NATIONAL SPACE POLICY OF THE UNITED STATES OF AMERICA 3 (2010) (describing the need to "defend our space systems and . . . if deterrence fails, defeat efforts to attack them.").

[29] *See* UK MINISTRY OF DEF., JDP 0-30, UK AIR AND SPACE POWER 95 (2d ed. Dec. 2017) [hereinafter JDP 0-30, UK AIR AND SPACE POWER]; JP 3-14, SPACE OPERATIONS, *supra* note 16, at II-2.

of adversary action outweighs any perceived "benefits."[30] Control of space is professed as the new high ground for military operations, enabling control over the battlefield below.[31] China is also committed to protection of its space-based assets through a credible ASAT deterrent.[32] Russia, which first conducted ASAT tests in the 1960s, continues to develop various ASAT systems to protect its assets.[33]

C. Why Is Space Debris Resulting from ASAT Attacks a Concern?

Because outer space is a global commons beyond the sovereign jurisdiction of states, a collective action problem exists in the assignment and utilization of viable orbits around the Earth.[34] As long as a state possesses the technological means to achieve orbit (or the capital to pay for enabling launch services), that state can enjoy free use and equal access to orbits. In the absence of international regimes to govern use, a tragedy of the commons results from states acting in self-interest, with no regard for the proliferation of orbiting debris or pollution of celestial bodies, absent the threat that continued creation of debris poses to the state's own interests.[35] If states believe that proposed regulations on use and access will benefit direct competitors also seeking to exploit the space commons, collective action to regulate state behavior is further impeded.[36] This phenomenon is apparent in previous iterations of the National Space Policy and comparative deterrence policies espoused by the current spacefaring nations, placing freedom of action in space and protection of space-based assets as vital to their national interests, arguably at the expense of free use and access to the space commons.

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[30] JDP 0-30, UK Air and Space Power, *supra* note 29, at 112; JP 3-14, Space Operations, *supra* note 16, at I-9.

[31] *See* Stephens, *supra* note 24, at 93. General Lance Lord, Commander of the Air Force Space Command, noted, "Space superiority is the future of warfare. We cannot win a war without controlling the high ground, and the high ground is space." *Id.*

[32] Bao, *supra* note 27, at 9.

[33] *See* Sean O'Connor, *Russia's ASAT Development Takes Aim at LEO Assets*, Jane's (2008), https://www.janes.com/images/assets/591/81591/Russias_ASAT_development_takes_aim_at_LEO_assets.pdf [https://perma.cc/NEA3-FFR3] (last visited Mar. 18, 2020).

[34] *See* Sadeh, *supra* note 8, at 45.

[35] *See id.*

[36] *See id.* at 49.

For the nations currently capable of launching payloads into orbit, freedom of action in space has translated to placing as many spacecraft into orbit as possible in order to secure footholds on limited orbital space.[37] In the past decade alone, the number of states operating satellites in orbit has doubled to over 50, while over 100 nations actively use space systems and services.[38] The annual launch rate of spacecraft more than doubled in previous years, increasing from 129 launches in 2010 to 262 in 2015.[39] A major factor for this increase is the trend in launching into orbit micro- and nanosatellite constellations, which provide regional or global network capability from linked satellites that weigh less than 10 kilograms each.[40] While the vast majority of the small satellite constellations operate in LEO, it is the GEO region that contains the majority of satellite mass, at nearly 40% of the total satellites in orbit.[41]

GEO orbits are arguably a limited natural resource, facing similar allocation and conservation problems as other depleting global resources.[42] Due to the altitude of the orbit, only a limited degree of inclination is available to maintain a geostationary orbit, significantly limiting the number of objects that can be within the GEO band at any given time.[43] Currently, there is no international allocation system for any orbit, which further contributes to the tragedy of the commons problem. The congestion created by the limited inclination is not the only problem with the altitude of GEO orbits—debris trapped in GEO is relatively permanent, since it generally does not degrade into the atmosphere.[44] Destruction of GEO satellites and the resulting debris cloud would have a disproportionate impact compared to a breakup in low-, mid-, or high-Earth orbit because of the lim-

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37 States that currently have the capability to launch a payload into orbit are: the United States, Russia, France (which also launches for the European Space Agency), China, Japan, India, Israel, Ukraine, Iran, North Korea, and South Korea. *See The Global Nature of Space Activities*, SECURE WORLD FOUND., https://swfound.org/space-sustainability-101/the-global-nature-of-space-activities/ [https://perma.cc/HG6N-CEAC] (last updated Feb. 6, 2015).

38 *Id.*; *see also* K.R. Sridhara Murthi & V. Gopalakrishnan, *Trends in Outer Space Activities—Legal and Policy Challenges*, *in* RECENT DEVELOPMENTS IN SPACE LAW, *supra* note 8, at 27, 30–31.

39 Murthi & Gopalakrishnan, *supra* note 38, at 31.

40 *Id.*

41 *Id.*

42 *See* Michel Bourbonniere & Louis Haeck, *Jus in Bello Spatiale*, 25 AIR & SPACE L. 2, 10 (2000).

43 *See* Kelso, *Basics of the Geostationary Orbit*, *supra* note 13.

44 *See* Sadeh, *supra* note 8, at 47.

ited number of viable GEO orbits. Since eleven countries control access to the space commons,[45] the allocation and utilization of GEO orbits presents a situation ripe for future conflict, such as the previous attempt by eight equatorial states to assert sovereignty over geostationary orbits through the Bogotá Declaration.[46] Along with the limited inclination available for

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45 The United States, France (European Space Agency), Russia, China, Japan, India, and Ukraine are the only countries with confirmed lift capability to geosynchronous or geostationary transfer orbits, even at small-lift weights (less than 2,000 kilograms). *See The Global Nature of Space Activities*, *supra* note 37. Ukraine manufactures the *Dnepr* rockets for access to geo-transfer orbits, though it has no current indigenous launch facilities aside from the non-operational Sea Launch *Odyssey* floating platform. *See, e.g.*, *DNEPR User's Guide*, KOSMOTRAS (Nov. 2001), https://snebulos.mit.edu/projects/reference/launch_vehicles/DNEPR/Dnepr_User_Guide.pdf [https://perma.cc/JG4K-DACL]; *Sea Launch Celebrates 20th Anniversary*, YUZHNOYE (Mar. 28, 2019), https://www.yuzhnoye.com/en/press-center/news/copy_news_516.html [https://perma.cc/MA97-M897]; *Space Systems Forecast: Dnepr*, FORECAST INT'L (Aug. 2017), https://www.forecastinternational.com/archive/disp_pdf.cfm?DACH_RECNO=1287 [https://perma.cc/9UYJ-N6RA]. For information about each country's capabilities, see generally *About H3 Launch Vehicle*, JAPAN AEROSPACE EXPL. AGENCY, https://global.jaxa.jp/projects/rockets/h3/ [https://perma.cc/33KV-8PWT] (last visited Mar. 19, 2020) (Japan's capabilities); *Angara Launch Vehicles Family*, KHRUNICHEV STATE RESEARCH & PROD. SPACE CTR., http://www.khrunichev.ru/main.php?id=44&lang=EN [https://perma.cc/TVA3-95D3] (last visited Mar. 19, 2020) (Russia's capabilities); Rui C. Barbosa, *China Conducts Long March 5 Maiden Launch*, NASA SPACEFLIGHT (Nov. 2, 2016), https://www.nasaspaceflight.com/2016/11/china-long-march-5-maiden-launch/ [https://perma.cc/Y9QM-6JS8] (China's capabilities); Paul K. McConnaughey et al., *Draft Launch Propulsion Systems Roadmap*, at TA01-2, NASA (2010), https://www.nasa.gov/pdf/500393main_TA01-LaunchPropulsion-DRAFT-Nov 2010-A.pdf [https://perma.cc/FFS5-F8A3] (U.S. capabilities); *Polar Satellite Launch Vehicle*, INDIAN SPACE RESEARCH ORG., https://www.isro.gov.in/launchers/pslv [https://perma.cc/UL6L-YZGK] (last visited Mar. 19, 2020) (India's capabilities).

46 *See* Int'l Telecomm. Union [ITU], Minutes of the First Plenary Meeting, Broadcasting Satellite Conference, annex 4, at 16–17, ITU Doc. No. 81-E (Jan. 17, 1977). The Bogotá Declaration of 1976 was an attempt by eight countries to assert sovereign control over the portions of GEO orbits that extend above their state borders. The Declaration argued that GEO orbits are a natural resource subject to the sovereign control of the state under the Charter on Economic Rights and Duties of States, and that the definition of "outer space" contained within the Outer Space Treaty of 1967 does not explicitly include GEO orbits as part of "outer space." *Id.* at 18–19. The Declaration has received little international support, since the Outer Space Treaty makes clear that no part of space is subject to national appropriation. The original signatories of the Declaration are Brazil, Colombia, Congo, Ecuador, Indonesia, Kenya, Uganda, and Zaire. Haris A. Durrani, *The Bogotá Declaration: A Global Uprising?*, COLUM. U.: UPRISING 13/13/ BLOG (Jan. 21, 2018), http://blogs.law.columbia.edu/uprising1313/haris-a-durrani-the-bogota-declaration-a-global-uprising/ [https://perma.cc/B9D6-6HEP].

GEO orbits, the finite nature of EM-spectrum utilization in space is also a constrained resource prone to conflict, though likely to a lesser extent because of the International Telecommunications Satellite Organization's (ITSO) role in frequency allocation.[47]

Kinetic-energy attacks against space-based assets pose a special threat to the international community because of the residual debris that results from collisions. While directed-energy laser attacks and EM jamming can temporarily incapacitate or permanently destroy satellites,[48] kinetic breakups typically produce a debris field relative to the mass and velocity involved in the collision.[49] Debris trapped in LEO can persist for decades, depending on the orbit of the original object, and debris from a collision in GEO can remain indefinitely.[50] As the amount of debris trapped in orbit increases, the likelihood of an accidental collision increases as well. The United Nations (U.N.) Committee on the Peaceful Uses of Outer Space (COPUOS) has published debris mitigation guidelines that specifically address intentional breakups, though the guidelines are nonbinding best practices to avoid unnecessary pollution of outer space.[51] Based on current projections of debris in LEO, an accidental collision is expected to occur every five to nine years.[52] Collisions, whether intentional or accidental, and the resulting debris will continuously increase the risks to all assets in orbit. As the amount of debris and operational space assets in orbit increases, so too does the risk of the phenomenon known as the Kessler Syndrome. The Kessler Syndrome posits that a chain re-

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47 Frequency allocation is managed by the International Telecommunications Satellite Organization (ITSO) and the associated private company Intelsat, S.A. INT'L TELECOMMUNICATIONS SATELLITE ORG. [ITSO], *About Us*, https://itso.int/about-us/more/ [https://perma.cc/WZ4L-PKMA] (last visited Mar. 19, 2020). The United States issues licenses for the C- and Ku- bands, while the United Kingdom manages the Ka- band. *Id.*

48 JP 3-14, SPACE OPERATIONS, *supra* note 16, at I-6.

49 Meghan R. Plantz, Note, *Orbital Debris: Out of Space*, 40 GA. J. INT'L & COMP. L. 585, 595 (2012).

50 *See* PETER STUBBE, STATE ACCOUNTABILITY FOR SPACE DEBRIS 32 (2018).

51 *See* Comm. on the Peaceful Uses of Outer Space, Rep. of Sci & Tech. Subcomm. on Its Fifty-Third Session, Progress Report of the Working Group on Space Debris, U.N. Doc. A/AC.105/C.1/L.284, at 4 (2006) [hereinafter Progress Report of the Working Group on Space Debris].

52 *Space Situational Awareness: Examining Key Issues and the Changing Landscape: Hearing of the H. Subcomm. on Space & Aeronautics of the H. Comm. on Sci. & Tech.*, 116th Cong. 5 & n.13 (2020) (statement of Brian Weeden, Director of Program Planning, Secure World Foundation).

action of orbital breakups may occur from debris colliding with either space assets or other debris, potentially causing a cascading effect and significantly reducing the number of viable orbits.[53]

Tracking current orbital debris to avoid unintentional collisions has become a major concern for states and institutions operating space assets. Currently, only the United States and Russia have comprehensive space debris tracking systems at their disposal.[54] The Space Surveillance Network (SSN), operated by the Joint Space Operations Center, is considered the most capable system, with the ability to catalogue objects 10 centimeters and larger in LEO and 1 meter and larger in GEO.[55] Like the SSN, Russia's Space Surveillance System (SSS) uses a combination of phased-array radars and electro-optical telescopes to track objects; however, the SSS maintains a smaller catalogue of objects than the SSN.[56] Private companies such as LeoLabs have begun developing commercial space tracking systems, with the goal of increasing detection resolution to 2 centimeters.[57] Other countries also have various specialized sensors with particular missions to aid in providing a complete assessment of the debris orbiting the planet.[58] Additionally, Russia appears to be developing both ground- and air-based laser systems with a focus on ASAT missions.[59]

The first recorded natural collision between objects in orbit occurred in 1991, when the Russian satellite *Cosmos 1934* was struck by a piece of debris from *Cosmos 926*, producing minimal debris but highlighting the dangers presented by orbiting wreck-

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[53] Plantz, *supra* note 49, at 596–97.

[54] *See* STUBBE, *supra* note 50, at 44.

[55] *Id.* at 44–45.

[56] *Id.* at 45; BRIAN WEEDEN ET AL., GLOBAL SPACE SITUATIONAL AWARENESS SENSORS 5 (2010), https://swfound.org/media/15274/global%20ssa%20sensors-amos-2010.pdf [https://perma.cc/96JJ-MYWG].

[57] Telephone Interview with Dan Ceperly, Chief Exec. Officer, LeoLabs (Sept. 5, 2018).

[58] STUBBE, *supra* note 50, at 45. France operates both GRAVES radar and the TAROT telescopes. GRAVES performs catalogue maintenance for LEO debris, while TAROT telescopes are aimed at the GEO belt. *Id.* The German TIRA radar system is used for collision avoidance and tracking spacecraft reentering the atmosphere. *Id.* The ESA operates a 1.5-meter resolution telescope located at the Teide Observatory in the Canary Islands. *See Teide Observatory*, INSTITUTO DE ASTROFÍSICA DE CANARIAS, https://www.iac.es/en/observatorios-de-canarias/teide-observatory [https://perma.cc/YE45-KVG3] (last visited Mar. 19, 2020).

[59] *See* O'Connor, *supra* note 33.

age.[60] Three other such collisions have occurred. In 1996, an operational *Cerise* satellite collided with a residual fragment from an exploded upper-stage *Ariane* rocket.[61] In 2005, a Chinese launch vehicle hit a U.S. rocket segment.[62] The most notable collision occurred in 2009, when the operational *Iridium 33* communications satellite collided with *Cosmos 2251*, with catastrophic results.[63] The collision completely destroyed both spacecraft, producing 1,875 pieces of debris larger than 10 centimeters.[64]

The dangers posed by inadvertent collisions substantially increase when factoring in ASAT attacks. Several intentional breakups have occurred in recent decades, significantly contributing to the debris population in orbit. In 1985, the United States tested an air-launched missile aimed at the P78-1 *Solwind* satellite, successfully destroying it in orbit.[65] In 2008, the National Reconnaissance Office lost control of satellite *USA-193*, and fearing the uncontrolled reentry of the toxic hydrazine fuel tanks on board, used an SM-3 missile launched from the USS *Lake Erie* to destroy the satellite as it entered the atmosphere.[66] The most significant debris-producing event occurred in 2007, when China launched a direct-ascent ASAT missile at a defunct weather satellite in polar LEO, the *Feng Yun-1C* (*FY-1C*).[67] The resulting collision produced an estimated 35,000 pieces of indi-

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60 *See Space Smash: Simulating When Satellites Collide*, EUROPEAN SPACE AGENCY (Apr. 24, 2018), https://www.esa.int/Our_Activities/Preparing_for_the_Future/Discovery_and_Preparation/Space_smash_simulating_when_satellites_collide [https://perma.cc/TRC4-G9C5].

61 *Id.*

62 STUBBE, *supra* note 50, at 18.

63 *Id.*; *see also Space Smash: Simulating When Satellites Collide*, *supra* note 60.

64 *See* Brian Weeden, *2009 Iridium-Cosmos Collision Fact Sheet*, SECURE WORLD FOUND., https://swfound.org/media/6575/swf_iridium_cosmos_collision_fact_sheet_updated_2012.pdf [https://perma.cc/9BJW-WD7D] (last updated Nov. 10, 2010).

65 *See* Lt. Col. James Mackey, *Recent US and Chinese Antisatellite Activities*, AIR & SPACE POWER J., Fall 2009, at 82, 84.

66 *Id.* at 87. While the main concern of *USA-193*'s reentry was the hydrazine fuel tanks onboard, other satellites carry much more dangerous power sources, including nuclear reactors. In 1978, the nuclear-powered *Cosmos 954* experienced an uncontrolled reentry into the Earth's atmosphere. *See* STUBBE, *supra* note 50, at 40. The satellite partially broke apart upon reentry, scattering radioactive debris across an 800-kilometer by 50-kilometer swath of northern Canadian wilderness. *Id.*

67 T.S. KELSO, ANALYSIS OF THE 2007 CHINESE ASAT TEST AND THE IMPACT OF ITS DEBRIS ON THE SPACE ENVIRONMENT 321 (2007), http://amostech.com/TechnicalPapers/2007/Orbital_Debris/Kelso.pdf [https://perma.cc/5USE-8L6Q].

vidual debris 1 centimeter and larger, including 2,087 pieces catalogued by the SSN (a 20% increase in catalogue size), and it forced the *Terra* environmental spacecraft to alter its orbit.[68] In total, the resulting debris placed 700 spacecraft in LEO at a heightened risk of unintentional collision, and an estimated 85% of the debris will likely remain in orbit for 100 years or more.[69]

III. ASAT WEAPONS IN THE *CORPUS JURIS SPATIALIS* AND STATE PRACTICE

The majority of law governing space is contained in the five U.N. treaties and the five U.N. General Assembly resolutions adopted as principles of space exploration and utilization.[70] Various other regional and bilateral agreements add to the body of law, albeit with somewhat limited recognition as governing norms. Recently, there has been a distinct shift in state approach to regulating activities in space. In the twenty-two years following the creation of COPUOS in 1958, five international treaties were negotiated and concluded through the U.N.[71] Since 1980, states have relied on nonbinding principles and

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68 *See id.* at 325; *see also* Mackey, *supra* note 65, at 85; Gene V. Milowicki & Joan Johnson-Freese, *Strategic Choices: Examining the United States Military Response to the Chinese Anti-Satellite Test*, 6 ASTROPOLITICS 1, 3–4 (2008).

69 Milowicki & Johnson-Freese, *supra* note 68, at 3. The *Terra* craft was boosted 1.3 kilometers in altitude a week after the destruction of *FY-1C* to avoid a 40-centimeter piece of debris. *Id.*

70 The five U.N. treaties are: the Outer Space Treaty, *supra* note 14; the 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; the Liability Convention, *supra* note 15; Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15; Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1363 U.N.T.S. 3 [hereinafter Moon Agreement]. The five U.N. resolutions are: G.A. Res. 1962 (XVIII), Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space (Dec. 13, 1963) [hereinafter Declaration of Legal Principles]; G.A. Res. 37/92, Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting (Dec. 10, 1982); G.A. Res. 41/65, Principles Relating to Remote Sensing of the Earth from Outer Space (Dec. 3, 1986); G.A. Res. 47/68, Principles Relevant to the Use of Nuclear Power Sources in Outer Space (Dec. 14, 1992); G.A. Res. 51/122, Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries (Dec. 13, 1996).

71 Brian Wessel, *The Rule of Law in Outer Space: The Effects of Treaties and Nonbinding Agreements on International Space Law*, 35 HASTINGS INT'L & COMP. L. REV. 289, 291–93 (2012).

agreements, rather than broad, multiparty treaties, to regulate activities.[72] Further, for the purposes of ASAT regulation, U.S.–U.S.S.R. bilateral agreements negotiated during the Cold War have had a disproportionate effect on the development and utilization of ASAT weapons because of the near indistinguishability between ASAT and ballistic missile defense systems.[73]

Notwithstanding five decades of treaty negotiations, the current body of space law anchored by the Outer Space Treaty is insufficient to constrain intentional breakups in outer space, despite the danger this activity poses to other states through the creation of debris. The 1972 Liability Convention expands upon the Outer Space Treaty's liability provisions; its application to ASAT weapons is limited in scope to testing outside of an armed conflict.[74] Since current technology can only track orbiting objects 10 centimeters or larger, claims under the Liability Convention also face potential attribution issues depending on the size of debris created. Environmental protection regimes found in Additional Protocol I (AP I), the Environmental Modification Convention, and the Rome Statute specifically prohibit widespread, long-term, and severe modification to the natural environment, but they are unlikely to overcome the mens rea, proportionality, and distinction element analyses when imputing liability to a military commander. Finally, agreements designed to limit ASAT use presented to the Conference on Disarmament have stalled due to definitional problems and in-

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72 *Id.* at. 289–90. A notable wrinkle in this trend is the Declaration of Legal Principles, which was adopted as G.A. Res. 1962 (XVIII). However, this assertion can be reconciled since the Declaration of Legal Principles became the framework for the Outer Space Treaty adopted in 1967. *See* Michael C. Mineiro, FY-1C *and* USA-193 *ASAT Intercepts: An Assessment of Legal Obligations Under Article IX of the Outer Space Treaty*, 34 J. SPACE L. 321, 328, 331 (2008).

73 Ballistic missile defenses (BMD) were heavily regulated during the Cold War as part of the efforts to maintain the status quo of Mutually Assured Destruction. *See* Joan Johnson-Freese, *The Viability of U.S. Anti-Satellite (ASAT) Policy: Moving Toward Space Control*, *in* 30 OCCASIONAL PAPER 1, 4 (U.S. Air Force Inst. for Nat'l Sec. Studies., 2000), https://www.hsdl.org/?view&did=487481 [https://perma.cc/7D6W-F566]. The United States and Russia wanted to ensure that BMD networks did not give the adversary an advantage when choosing to initiate a first strike, since an effective BMD network would theoretically degrade any retaliatory strike launched. *Id.* at 11. The Anti-Ballistic Missile (ABM) Treaty prescribed the number and placement of BMD networks. *See* Treaty on the Limitation of Anti-Ballistic Missile Systems, U.S.–U.S.S.R., May 26, 1972, 23 U.S.T. 3435 [hereinafter Anti-Ballistic Missile Treaty]. The United States withdrew from the ABM Treaty in 2002.

74 *See infra* section IV.B.

compatible state objectives with regard to space-based asset protection.[75]

A. The Outer Space Treaty of 1967

The Outer Space Treaty (OST) of 1967 marks the initial efforts to establish binding norms for the exploration and use of outer space.[76] The OST has been called a "constitution for outer space," and it places several restrictions and positive obligations upon states conducting activities in outer space.[77] Article III requires that state parties carry out activities in space "in accordance with international law, including the Charter of the United Nations."[78] Significant debate has occurred about the interactions between *juris spatialis* and international law, though it is generally accepted that space law is *lex specialis* in cases of specific regulation, with general international law complementing areas with deficient regulation.[79] Article IV prohibits the placement of nuclear weapons and other weapons of mass destruction in orbit or on celestial bodies.[80] Article IV further prohibits the installation of military facilities, testing of weapons, or con-

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75 The Moon Agreement of 1979 entered into force in July of 1984. *See* Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Fifty-Eighth Session, Status of International Agreements Relating to Activities in Outer Space as at 1 January 2019, at 2, U.N. Doc. A/AC.105/C.2/2019/CRP.3 (Apr. 1, 2019). Currently, only eighteen states have ratified the treaty, and none of them are significant contributors to space lift capability (with the exception of Kazakhstan, where the former U.S.S.R. cosmodrome Baikonur is located. Baikonur remains leased to the Russian Federation). *See id.* at 10; DNEPR User's Guide, *supra* note 45, at 12.

76 Prior to the Outer Space Treaty of 1967, the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space, and Under Water entered into force in 1963. *See* Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space, and Under Water, Aug. 5, 1963, 14 U.S.T. 1313, 480 U.N.T.S. 43. The treaty is relevant to ASAT conversations, since the initial ASAT systems were nuclear-tipped interceptors. Nuclear-tipped intercontinental ballistic missiles (ICBMs) remain the crudest yet arguably most effective ASAT weapon and are accessible to a larger number of states than direct-ascent kinetic weapons. *See* Clayton K.S. Chun, *Shooting Down a "Star": Program 437, the US Nuclear ASAT System and Present-Day Copycat Killers*, Air University 37–38 (2000).

77 *See* Wessel, *supra* note 71, at 292.

78 Outer Space Treaty *supra* note 14, art. III.

79 Pierfrancesco Breccia, *Article III of Outer Space Treaty and Its Relevance in the International Space Legal Framework*, at 4, IAC Doc. No. IAC-16.E7.1.2, Int'l Astronautical Congress (2016), http://iislweb.org/docs/Diederiks2016.pdf [https://perma.cc/74MM-MBTM]; *see also* Sadeh, *supra* note 8, at 45–46 (arguing that the OST is a limited legal framework that falls short of fully addressing all collective action problems in space).

80 Outer Space Treaty, *supra* note 14, art. IV.

duct of military maneuvers on celestial bodies.[81] Combining these provisions, the OST would not prohibit the placement of conventional weapons in orbit, so long as they did not meet the definition of weapons of mass destruction (WMD).[82] The U.S. Strategic Defense Initiative's *Star Wars* program is a direct reflection of this position,[83] and Chinese negotiating positions consistently agree with this interpretation.[84]

Article VI of the OST establishes state responsibility for both governmental and nongovernmental activities conducted in outer space.[85] Article VII further establishes international liability for damage to another state caused by the launching state and the state whose territory or facility was used to launch the object, if applicable.[86]

Article IX is perhaps the most important provision contained in the OST with respect to ASAT controls, placing several positive obligations on states conducting activities in outer space.[87] Michael Mineiro identifies four positive obligations stemming from the Article IX language: (1) a "principle of due regard" to the corresponding interests of all other state parties; (2) an "obligation to avoid harmful contamination" of outer space; (3) an "obligation to avoid adverse changes" in the Earth's environment; and (4) an obligation "to undertake international consultations" when a state believes an activity may cause harmful

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81 *Id.*

82 If a state were to consider placing conventional weapons in orbit, such as in a space-asset defense role, it would need to consider relevant definitions of a weapon of mass destruction. The U.N. Office for Disarmament Affairs (UNODA) recognizes three classes of WMDs: nuclear, chemical, and biological. *See* S.C. Res. 1540, at 1 (Apr. 28, 2004). Directed-energy and EM weapons do not fall in one of the three UNODA weapon classes but could theoretically cause similar effects. Hypervelocity Rod Bundles are also conventional weapons that could produce destruction on the scale of recognized WMDs. *Cf.* Milowicki & Johnson-Freese, *supra* note 68, at 7. For analysis concluding that the OST authorizes military activities in the void between celestial bodies, including Earth's orbit, see Steven A. Mirmina, *The Ballistic Missile Defense System and Its Effects on the Outer Space Environment*, 31 J. SPACE L. 287, 296–98 (2005).

83 *See* Johnson-Freese, *supra* note 73, at 8–10.

84 *See* Permanent Mission of the People's Republic of China to the United Nations Office at Geneva and Other International Organizations in Switzerland, Existing International Legal Instruments and Prevention of the Weaponization of Outer Space (Aug. 26, 2004), http://www.china-un.ch/eng/cjjk/cjjblc/cjlc/t154641.htm [https://perma.cc/S7PE-UP3V].

85 Outer Space Treaty, *supra* note 14, art. VI.

86 *Id.* art. VII. The damage can be the result of the object or its components, and it can occur on the Earth, in the air, or in outer space. *See id.*

87 *See id.* art. IX.

interference.[88] ASAT operations that create debris are arguably contrary to the provisions contained in Article IX, since the resulting debris is undeniably harmful contamination when it places other spacecraft at risk. However, the duty is to *avoid* harmful contamination rather than to outright ban any contamination.[89] The treaty lacks a definition of contamination and metrics to evaluate whether states are avoiding contamination in a manner that comports with good faith adherence to treaty obligations.[90] Additionally, current state practice is, at worst, ambivalent to continued ASAT operations, considering the mixed response from states following recent weapons tests and the destruction of *USA-193*.[91] Article IX of the OST places an obligation on the launching state to notify other parties whose space assets may be threatened if the experiment or activity planned would cause potential interference.[92] Arguably, given the results of several ASAT weapons tests in recent decades, states should be aware that a kinetic-energy weapon directed against a satellite is likely to produce large amounts of debris, and therefore it must notify other states whose assets may be affected.[93] The issue may then become whether the state purports to have taken all reasonable precautions against unnecessary risk to other space assets so as to not trigger the international consultations requirements of Article IX.[94]

Two caveats to the consultation provision significantly undercut an argument that Article IX continues to impose broad restrictions on ASAT operations. First, Article IX obligations (and Article VII liability concerns) are subject to the other bodies of international law set forth in Article III, likely resulting in Article IX obligations being preempted by the law of armed conflict or

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88 *See* Mineiro, *supra* note 72, at 332–33, 339, 340–41 (arguing that due regard to the corresponding interests of states is the prime obligation, with the other three obligations acting as benchmarks for how states' interests are to be protected).

89 *See id.* at 340.

90 *Id.* at 339–40.

91 *See* David A. Kaplow, *ASAT-isfaction: Customary International Law and the Regulation of Anti-Satellite Weapons*, 30 MICH. J. INT'L L. 1187, 1237–38 (2009).

92 *See* Outer Space Treaty *supra* note 14, art. IX.

93 *See* Mineiro, *supra* note 72, at 354.

94 *Cf.* Mackey, *supra* note 65, at 88–89. The engagement of *USA-193* was purposefully delayed until the satellite was at an altitude that minimized both initial and residual debris. *Id.* at 88. The statement from India's Ministry of External Affairs states that India's test was also conducted "in the lower atmosphere to ensure that there is no space debris." *See also* Frequently Asked Questions on Mission Shakti, *supra* note 5.

the U.N. Security Council during a lawful engagement.[95] Second, the destruction of *FY-1C* was the only ASAT engagement that drew significant international condemnation for disregarding the provisions of Article IX.[96] Seven countries and the European Union joined the United States in protesting China's actions and called for consultations as provided by Article IX.[97] During the multiple decades that the United States and U.S.S.R. conducted ASAT tests during the Cold War, neither state undertook consultations prior to any activity, arguably creating recognized state practice under Article 31(3)(B) of the Vienna Convention on the Law of Treaties (VCLT) that now negates any possible obligation under Article IX when conducting an ASAT test.[98] This conclusion seems to be supported by India's actions relative to *Microsat-R*; India issued a public declaration acknowledging the ASAT weapons test after the conclusion of the engagement, but no consultations occurred prior to launch.[99]

B. THE LIABILITY CONVENTION OF 1972

While the OST addresses liability in Article VII, the provision contains little substance about how a claim would be submitted

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95 *See* Michel Bourbonniere, *National-Security Law in Outer Space: The Interface of Exploration and Security*, 70 J. AIR L. & COM. 3, 7–14 (2005); Mineiro, *supra* note 72, at 334–35, 344 n.38.

96 *See* Mike Gruss, *U.S. Official: China Turned to Debris-Free ASAT Tests Following 2007 Outcry*, SPACENEWS (Jan. 11, 2016), https://spacenews.com/u-s-official-china-turned-to-debris-free-asat-tests-following-2007-outcry/ [https://perma.cc/HPL2-5C5U]. Pakistan's Foreign Office issued a statement condemning the Indian *Microsat-R* engagement, asserting that the test jeopardized the peaceful use of outer space. *See* Miglani & Das, *supra* note 2.

97 Mineiro, *supra* note 72, at 346–47.

98 *See id.* at 345–46.

99 India did issue a Notice to Airmen (NOTAM) prior to the launch of the missile from Dr. Abdul Kalam Island, in accordance with International Civil Aviation Organization requirements. *See* Ankit Panda, *India Conducted a Failed Anti-Satellite Test in February 2019*, DIPLOMAT (Mar. 30, 2019), https://thediplomat.com/2019/04/exclusive-india-conducted-a-failed-anti-satellite-test-in-february-2019/ [https://perma.cc/GC32-JHDZ]. The NOTAM established a restricted danger zone encompassing the area of the Indian Ocean where debris was projected to reenter the atmosphere. *Id.* The NOTAM did not specify that the missile was an ASAT weapon or provide any other information as to the associated danger. *Id.* The NOTAM classified the event, using common terminology, as an "experimental flight trail." Daniel L. Oltrogge et al., *Characterizing the India ASAT Debris Evolution Using Diverse, Complementary Tools* 2 (Am. Astronautical Soc'y, Paper No. AAS 19-889, Aug. 14, 2019), http://celestrak.com/publications/AAS/19-889/AAS-19-889-pp.pdf [https://perma.cc/53G4-W9MM].

or arbitrated, leaving injured nations little recourse in obtaining a judgment and reparations for damage sustained as a result of another state's activities in space. The initial proposal for Liability for Space Vehicle Accidents was submitted to COPOUS by the United States in 1962.[100] By 1969, the International Law Commission recognized that a further distinction needed to be made between state responsibility and state liability, specifically "responsibility for risk arising out of the performance of certain lawful activities, such as spatial and nuclear activities."[101]

Non-spacefaring states were especially concerned with the negative consequences of space activities by the two major space powers at the time.[102] In stark contrast to the vagueness of Article VII, the Liability Convention text established specific forms of liability for state action in space, the atmosphere, and joint enterprise action to place objects in space. In this sense, the Liability Convention supplements Article VII of the OST, determining liability for actions depending on the physical location of the injury.[103] While this may seem to contradict a reading of Article VII as imposing strict liability regardless of location, two arguments defeat a general application of strict liability to all situations. First, the specific provisions of the Liability Convention should supersede the generalized language contained in Article VII under the principle of *lex specialis derogat legi generali.*[104] Second, Article 31(3)(A) of the VCLT recognizes that subsequent agreements made by state parties inform the interpretation of the previous agreement.[105] Supporting the *lex specialis* argument, the Liability Convention represents a subsequent agreement used to interpret the generalized provision contained in Article VII of the OST.

The Liability Convention defines "space object" to include the physical launch vehicle, parts of the launch vehicle, and components of the space object.[106] This definition clearly encompasses parts of a launch vehicle or space object designed to be separated, whether during flight or as part of the object's purpose once orbit has been achieved. It is less clear if "component parts

100 Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on the Work of Its First Session, at 6, U.N. Doc. A/AC.105/6 (1962).

101 STUBBE, *supra* note 50, at 108.

102 *Id.* at 127.

103 *Cf. id.* at 132–33.

104 *Id.* at 134.

105 *See* Mineiro, *supra* note 72, at 323–24.

106 Liability Convention, *supra* note 15, art. I(d).

of a space object" also includes debris from an intentional or unintentional breakup, though persuasive arguments exist that debris should be considered as components of a space object.[107] When damage to a state's space object results from the space activities of multiple states, Article IV of the Liability Convention addresses liability for that damage.[108] For example, if State A's launch activity damages State B's space object, and such damage then damages State C's object, reparations are apportioned between States A and B commensurate with the extent they were at fault.

C. The Environmental Modification Convention

The Environmental Modification Convention (ENMOD) prohibits the use of military or other hostile environmental modification techniques.[109] The treaty text specifically prohibits "deliberate manipulation of natural processes—the dynamics, composition or structure of the Earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space."[110] Arguments have been raised that the intentional breakup of objects in outer space may be a form of environmental modification prohibited by the treaty if the resulting modification to the environment was envisioned as a means of warfare.[111] Manipulation of the EM environment or the Van Allen radiation belts may also be prohibited by ENMOD if the effects of such an ASAT attack have "widespread, long-lasting or severe effects" on the natural environment.[112]

D. The Conference on Disarmament and Current ASAT Negotiations

In 1978, in conjunction with Presidential Directive 37 issued by President Carter, negotiations began with the U.S.S.R. over restricting ASAT weapons.[113] While no deal was reached by the

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107 *See* Mirmina, *supra* note 82, at 303–04.

108 Liability Convention, *supra* note 15, art. IV.

109 Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques art. I, Dec. 10, 1976, 31 U.S.T. 333, 1108 U.N.T.S. 151 [hereinafter ENMOD].

110 *Id.* art. II.

111 *Cf.* Christopher M. Petras, *The Debate over the Weaponization of Space—A Military-Legal Conspectus*, 28 Annals Air & Space L. 171, 195 (2003).

112 *See* ENMOD, *supra* note 109, art. I.

113 *See* Johnson-Freese, *supra* note 73, at 7; *see also* Michael Sheehan, The International Politics of Space 97 (2007).

time negotiations broke off after the Soviet invasion of Afghanistan in 1979, the U.S.S.R. continued to pursue restrictions on ASAT employment by presenting draft treaties to the U.N. in 1981 and 1983.[114] The draft Treaty on the Prohibition of the Use of Force in Outer Space and From Space Against the Earth proposed a prospective ban on the development of new ASAT systems, and it would require the destruction of all current systems in a state's inventory.[115] The Reagan administration opposed any restrictions on ASAT development, and it arguably reinterpreted the Cold War-era Anti-Ballistic Missile (ABM) Treaty in a manner that allowed the Strategic Defense Initiative (SDI) to continue development on defensive space-based ASAT and ballistic missile defense (BMD) systems.[116]

A combination of cost overruns, technological limitations, and the collapse of the Soviet Union led to the demise of SDI,[117] and with it, any contemporary concern for an ASAT treaty. Limited development occurred in the United States during the 1990s, with programs such as KE-ASAT and the MIRACL laser receiving scant attention and funding.[118] Following the unilateral withdrawal of the United States from the ABM Treaty in 2002, Russia and China became vocal proponents of negotiating further arms restriction in outer space, submitting a proposal to the 2002 meeting of the Conference on Disarmament that advocated for continuing the ad hoc committee on the Prevention of an Arms Race in Outer Space (PAROS).[119] China and Russia also submitted a joint working paper that contained the draft

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114 *Id.*

115 Conclusion of a Treaty on the Prohibition of the Use of Force in Outer Space and From Space Against the Earth, in letter dated Aug. 19, 1983 from the First Vice-Chairman of the Council of Ministers of the Union of Soviet Socialist Republics, Minister for Foreign Affairs of the USSR, to the Secretary-General, at 2, U.N. Doc. A/38/194 (Aug. 23, 1983) [hereinafter PPWT] (containing the draft of the Prevention of the Placement of Weapons in Outer Space Treaty (PPWT)).

116 Johnson-Freese, *supra* note 73, at 8, 13–14.

117 *See* Donald R. Baucom, *The Rise and Fall of Brilliant Pebbles*, 29 J. SOC. POL. & ECON. STUD. 143, 185 (2004).

118 Laura Grego, *A History of Anti-Satellite Programs*, UNION OF CONCERNED SCIENTISTS 6–8 (Jan. 2012), https://www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/a-history-of-ASAT-programs_lo-res.pdf [https://perma.cc/32DB-2E8G].

119 *See* Sadeh, *supra* note 8, at 52, 54; *see also Proposed Prevention of an Arms Race in Space (PAROS) Treaty*, CTR. FOR NONPROLIFERATION STUDIES (Sept. 29, 2017), https://www.nti.org/learn/treaties-and-regimes/proposed-prevention-arms-race-space-paros-treaty/ [https://perma.cc/X3FP-GKS2].

text for an international framework that would prevent the deployment of weapons in outer space,[120] which would expand the OST restrictions on WMDs to any conventional weapon.[121] Both proposals continue to be met with stiff resistance, despite significant support in annual U.N. General Assembly resolutions.[122]

Russia and China continued their pursuit of selective restrictions on ASAT and BMD systems with the Treaty on the Prevention of the Placement of Weapons in Outer Space (PPWT), submitted to the Conference on Disarmament in 2008.[123] The PPWT was a significant overhaul of the 2002 submission, containing comprehensive definitions and context-specific restraints that built upon the proposed PAROS framework, including a no-first-use provision of kinetic-energy ASAT weapons.[124] The U.S. delegation to the Conference raised substantial concerns, citing a lack of constraints or limitations in numerous areas, such as restraints on the research and development, production, and storage of ASAT weapons, or the operational deployment of ground-, sea-, and air-based counter-space weapons.[125] The U.S. delegation concluded that restrictions on

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120 *See* Letter dated June 27, 2002 from the Permanent Rep. of the People's Republic of China and the Permanent Rep. of the Russian Federation to the Conference on Disarmament addressed to the Secretary-General of the Conference Transmitting the Chinese, English and Russian Texts of a Working Paper Entitled "Possible Elements for a Future International Legal Agreement on the Prevention of the Deployment of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects," at 2–3, U.N. Doc. CD/1679 (June 28, 2002).

121 *See* Sadeh, *supra* note 8, at 54.

122 *See id.* at 54–55; *see also* Press Release, Preventing Outer Space Arms Race Would Avert Grave Danger; Possible New Verifiable Bilateral, Multilateral Agreements Needed, Says Draft Text in First Committee, U.N. Press Release GA/DIS/3371 (Oct. 20, 2008), https://www.un.org/press/en/2008/gadis3371.doc.htm [https://perma.cc/D5QU-5JPZ] [hereinafter PPWT Draft Text Press Release] (statement by Karen House); U.S. Mission to Int'l Orgs. in Geneva, Debate on Outer Space (Disarmament Aspects) of the General Assembly's First Committee (Oct. 22, 2010), https://geneva.usmission.gov/2010/11/03/outer-space/ [https://perma.cc/5LU3-KQV2] (statement by Ambassador Laura Kennedy).

123 *See* Sadeh, *supra* note 8, at 54.

124 *See* Letter dated Feb. 12, 2008 from the Permanent Rep. of the Russian Federation and the Permanent Rep. of China to the Conference on Disarmament addressed to the Secretary-General of the Conference Transmitting the Russian and Chinese Texts of the Draft "Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects (PPWT)" Introduced by the Russian Federation and China, at 2–3, U.N. Doc. CD/1839 (Feb. 29, 2008).

125 Letter dated Aug. 19, 2008 from the Permanent Rep. of the United States of America Addressed to the Secretary-General of the Conference Transmitting Comments on the Draft "Treaty on Prevention of the Placement of Weapons in

space-based weapons were designed to counter a real or perceived U.S. technological advantage in light of the decades-long work with SDI and *Star Wars*.[126] China and Russia responded to the criticisms set forth by the U.S. in a letter to the Conference dated August 18, 2009, clarifying that the PPWT was not designed to prohibit all use of force in outer space, only to restrict the use of force against space-based objects, with the exception of an Article 51 self-defense scenario.[127] Further, the letter pointed out that PPWT does not attempt to mitigate the issue of debris resulting from ground-, sea-, and air-based ASAT attacks.[128] The letter readily acknowledges that the draft PPWT text would allow a state to destroy its own satellite (or the satellite of another state) using any of the unrestricted means of engagement if it did not constitute a hostile use of force contrary to Articles I and II of the draft.[129]

In 2017, the U.N. General Assembly proposed establishing a Group of Governmental Experts (GGE) to make recommendations on substantive provisions of an internationally binding framework for the prevention of an arms race in outer space.[130] While the program of work has yet to conclude, on January 31, 2019, the chair of the committee issued a report that identified the recognized principles of international law in outer space.[131] While no comprehensive treaty has entered into force explicitly regulating the use of ASAT weapons, the principles identified in

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Outer Space and of the Threat or Use of Force Against Outer Space Objects (PPWT)" as Contained in Document CD/1839 of 29 Feb. 2008, at 7, U.N. Doc. CD/1847 (Aug. 26, 2008) [hereinafter U.S. Letter on the Draft PPWT].

[126] *Cf.* PPWT Draft Text Press Release, *supra* note 122.

[127] *See* Letter dated Aug.18, 2009 from the Permanent Rep. of China and the Permanent Rep. of the Russian Federation to the Conference on Disarmament addressed to the Secretary-General of the Conference Transmitting Answers to the Principal Questions and Comments on the Draft "Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects (PPWT)" Introduced by the Russian Federation and China and Issued as Document CD/1839 Dated 29 February 2008, at 3, U.N. Doc. CD/1872 (Aug. 18, 2009).

[128] *See id.* at 4.

[129] *Id.* at 4–5.

[130] *See* G.A. Res. 72/250, ¶ 3 (Dec. 24, 2017).

[131] *See* U.N. Office for Disarmament Affairs, Report by the Chair of the Group of Governmental Experts on Further Practical Measures for the Prevention of an Arms Race in Outer Space (Jan. 19, 2019), https://www.un.org/disarmament/wp-content/uploads/2019/02/oral-report-chair-gge-paros-2019-01-31.pdf [https://perma.cc/BSJ8-JEV4].

the GGE report are likely the most accurate contemporary statement with regard to state conduct in outer space.[132]

IV. DISCOURAGING KINETIC-ENERGY ASAT WEAPONS THROUGH DEBRIS LIABILITY

One proposed method for restricting the use of kinetic-energy ASAT weapons is to impose liability on the launching state for damage caused by any resulting debris. Depending on the property and context, liability can be determined on an intentional, strict, or negligence basis. For damage caused by kinetic-interceptor use, it is necessary to understand the intended target and purpose behind the launch before assessing liability. If the purpose of the launch and intended target are part of a larger armed conflict, an injured state would need to navigate the convoluted landscape of war claims to determine whether liability could be assessed against the launching state.[133]

In conditions outside of armed conflict (ASAT weapons testing, uncontrolled reentry of a satellite, etc.), where recovery is objectively more permissive, strict liability may be imposed under an assumption-of-risk doctrine.[134] Establishing strict liability for damage caused by such conditions would permit recovery for any damage to a satellite other than the intended target, such as a subsequent collision between a piece of debris and a third-party satellite.[135] Alternatively, accepting a threshold of negligence would permit recovery only in situations where the injured party could demonstrate that an ASAT operation was

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132 *See id.*

133 Arguments exist for whether combat-related damages should be recovered through international agreements and arbitration at the end of hostilities or through individual claims against the state. For example, Kenneth Bullock suggests that one avenue of recovery for tort-based human rights violations and war crimes during conflict is the Foreign Claims Act (FCA), even though the FCA has traditionally been used to compensate victims of noncombat-related death, injury, and property damage. Kenneth Bullock, *United States Tort Liability for War Crimes Abroad: An Assessment and Recommendation*, 58 L. & CONTEMP. PROBS. 139, 140–41, 154 (1995). Another example is the Commander's Emergency Response Program funds that the United States uses to compensate victims of collateral damage in combat-related actions. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-07-699, MILITARY OPERATIONS: THE DEPARTMENT OF DEFENSE'S USE OF SOLATIA AND CONDOLENCE PAYMENTS IN IRAQ AND AFGHANISTAN (2007); U.S. ARMY JUDGE ADVOCATE GENERAL'S LEGAL CTR. & SCH., OPERATIONAL LAW HANDBOOK 233–34 (2012).

134 *See* Mirmina, *supra* note 82, at 303–04.

135 *See id.*

conducted without due care.[136] If an ASAT test was conducted at a high altitude, or the intercept occurred at an upward (rather than at a downward) angle,[137] the result would be a larger portion of persistent debris and would place other spacecraft at increased risk of collision.

Orbiting debris poses an inherent threat to all spacefaring activities, as demonstrated by the multiple natural collisions recorded in the past couple decades. As the COPUOS debris mitigation guidelines suggest, states should exercise restraint over intentional orbital breakups in order to keep the amount of debris in orbit at a manageable level.[138] However, as previously noted, the guidelines are not legally binding mandates. Since states are not bound by the mitigation guidelines, creation of debris is constrained only by the level of risk that nations are willing to accept when conducting operations in space, as well as the costs they may incur from damage to their vessels.

Since the immediate space around Earth containing LEO, MEO, and GEO orbits can be treated as a closed system that does not produce any waste on its own, any debris in orbit is a result of human space activity.[139] In this closed system, there is a negative externality derived not only from the intentional creation of debris but also from an increased likelihood of additional collisions envisioned by the Kessler Syndrome.[140] By imposing high liability costs on the intentional creation of debris resulting from kinetic impacts, states should alter their behavior and choose to develop and employ ASAT weapons that do not require kinetic impact to achieve the desired degradation of adversary space capability. This theory is founded on the liability provisions contained in the OST and the Liability Convention and can potentially incorporate transboundary harm norms through Article IX of the OST. However, as demonstrated by several intentional breakups in the past two decades, the current liability provisions are not enough to dissuade states

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136 *See* Plantz, *supra* note 49, at 605.

137 *See* Marco Langbroek, *Why India's ASAT Test Was Reckless*, DIPLOMAT (Apr. 30, 2019), https://thediplomat.com/2019/05/why-indias-asat-test-was-reckless/ [https://perma.cc/H5GN-8YME].

138 *See* Progress Report of the Working Group on Space Debris, *supra* note 51, at 4.

139 The system is not completely closed, as debris in LEO and MEO will eventually degrade into the Earth's atmosphere depending on the altitude of the debris.

140 The negative externality is the threat posed to third-party space systems that are at risk of collision from debris created by intentional or unintentional breakups.

from conducting kinetic-energy ASAT tests. Since space tracking technology is currently limited to resolving debris at 10 centimeters or larger, attribution for damage can be an issue, since an impact with a piece of debris much smaller than 10 centimeters can still have a catastrophic impact on a satellite.[141]

Under the OST and Liability Convention, liability for damage occurring in outer space requires a showing of fault on the part of the launching state or must occur as a result of an internationally wrongful act under the Liability Convention.[142] Transboundary harm norms require the state to take appropriate measures to mitigate any potential harm, and states can argue that recent kinetic-energy intercepts have been intentionally designed to mitigate harm.[143] Finally, with the exception of an impermissible use of force under the U.N. Charter, the liability costs discussed here exist only outside of an international armed conflict.

A. Are Sufficient Costs Imposed on States for Negative Externalities Resulting from Use of Kinetic-energy ASAT Weapons?

Both the OST and the Liability Convention address the issue of responsibility for damage to a spacecraft, establishing liability for situationally dependent contexts. Article VI of the OST provides:

> States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty.[144]

The language clearly imputes international responsibility for activities of governments and their persons conducted in outer space. But international responsibility does not equate to international liability until Article VI is read in conjunction with Article VII, which provides:

> 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, and each State Party from whose territory

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141 *See* Plantz, *supra* note 49, at 595–96, 605.
142 *Id.* at 603–05.
143 *See* Stubbe, *supra* note 50, at 4–6.
144 Outer Space Treaty, *supra* note 14, art. VI.

> 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.[145]

The Liability Convention, treated as *lex specialis* in the context of damage resulting from launch activities, provides for strict liability when damage occurs on the Earth's surface or to an aircraft.[146] Article III of the Liability Convention imputes liability on a state for damage that occurs in outer space only if the damage is "due to its fault or the fault of persons for whom it is responsible."[147] Article VI, in paragraph 2, prohibits exoneration of claims for state activities "where the damage has resulted from activities conducted by a launching State which are not in conformity with international law including, in particular, the Charter of the United Nations and the [Outer Space Treaty]."[148]

There is support for treating the previously mentioned provisions—Articles VI and VII of the OST and Article VII of the Liability Convention—as a distinct legal regime that provides remedies specific to the conduct of states in outer space.[149] If damage occurs on the surface of the Earth or to an aircraft in flight, a state's liability is absolute under Article VII of the OST and Article II of the Liability Convention, while liability for damage that occurs in space must be established by a determination of fault under OST Article VI and Liability Convention Article III.[150] Therefore, a state that suffers damage as a result of a kinetic-energy ASAT launch that is not in conformity with international law should have a remedy through Article VII of the OST and Article IV of the Liability Convention, even if the spacecraft suffering damage is not the intended target of the operation.[151] However, no international prohibition on the use of kinetic-energy ASAT weapons currently exists, so the only likely situation where an ASAT engagement is ineligible for exoneration would

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145 *Id.* art. VII.

146 *See* STUBBE, *supra* note 50, at 133–34.

147 Liability Convention, *supra* note 15, art. III.

148 *Id.* art. VI(2).

149 *Cf.* STUBBE, *supra* note 50, at 139–40.

150 Outer Space Treaty, *supra* note 14, arts. VI–VII; Liability Convention, *supra* note 15, arts. II–III; *see* STUBBE, *supra* note 50, at 133 & n.352.

151 Liability Convention, *supra* note 15, art. IV.

be an attack not in conformity with the use of force under the U.N. Charter.[152]

Even for damage caused by kinetic-energy ASAT launches that are in conformity with international law, liability still could be assigned to the state under a theory of failing to prevent transboundary harm. As early as 1969, the International Law Commission (ILC) recognized that certain internationally lawful activities should be conducted with an inherent understanding of the associated heightened risks, such as spatial activities and the operation of nuclear power sources.[153] The resulting work in developing the "responsibility of risk" concept was adopted as the ILC Draft Articles on Prevention (Prevention Articles)[154] and the Draft Principles on the Allocation of Loss (Principles of Allocation).[155] The Prevention Articles "apply to activities not prohibited by international law,"[156] and Article 3 further places a positive obligation on states to mitigate transboundary harms, which provides: "The State of origin shall take all appropriate measures to prevent significant transboundary harm or at any event to minimize the risk thereof."[157]

Article 7 requires an assessment of the possible transboundary harms from an activity, including an assessment of potential environmental harm.[158] Article 8 further requires a state to notify any potentially affected states if the Article 7 risk assessment indicates transboundary harm is likely.[159] These provisions are reminiscent of, and are likely reinforced by, OST Article IX obligations to conduct international consultations when a state's activities in space may interfere with the activities of another. If

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152 *See id.* art. VI(2).

153 *Report of the International Law Commission to the General Assembly*, 24 U.N. GAOR Supp. No. 10, at 233, U.N. Doc. A/7610/Rev.1 (1969), *reprinted in* [1969] 2 Y.B. Int'l L. Comm'n 203, U.N. Doc. A/CN.4/220. The concept of transboundary harm was established in *Trail Smelter Arbitration.* Trail Smelter (U.S. v. Can.), 3 R.I.A.A. 1905, 1965 (Perm. Ct. Arb. 1941); *see* STUBBE, *supra* note 50, at 5.

154 *Report of the International Law Commission on the Work of Its Fifty-Third Session*, 56 U.N. GAOR Supp. No. 10, at 148–70, U.N. Doc. A/56/10 (2001), *reprinted in* [2001] 2 Y.B. Int'l L. Comm'n 26, U.N. Doc. A/CN.4/SER.A/2001/Add.1 pt. 2 [hereinafter *Draft Articles on Prevention*].

155 *Report of the International Law Commission on the Work of Its Fifty-Eighth Session*, 61 U.N. GAOR Supp. No. 10, at 106–82, U.N. Doc. A/61/10 (2006), *reprinted in* [2006] 2 Y.B. Int'l L. Comm'n 58, U.N. Doc. A/CN.4/SER.A/2006/Add.1 pt .2 [hereinafter *Draft Principles of Allocation*]; *see* STUBBE, *supra* note 50, at 110–11.

156 *Draft Articles on Prevention*, *supra* note 154, at 149, art. 1.

157 *Id.* at 153, art. 3.

158 *Id.* at 157, art. 7.

159 *Id.* at 159, art. 8(1).

previous kinetic-energy engagements are any indication, the use of such a weapon is very likely to produce debris in orbit, which in turn should inform a state's assessment of the potential risks. In a hypothetical kinetic-energy ASAT operation, Article 7 requires a state to conduct a risk assessment of potential transboundary harms and then notify potentially affected states through international consultations in accordance with Article 8 of the Prevention Articles and Article IX of the OST.[160] Principle 3 of the Principles of Allocation ensures prompt and adequate compensation for transboundary harms,[161] though since the specific harm discussed here occurs in the course of space activities, states can also rely on Article III and the associated remediation measures contained in the Liability Convention.[162]

B. Present Liability Regimes Are Insufficient Constraints in the Context of Nonaggression and Are Inapplicable During Armed Conflict

The liability regime, as it presently exists, imposes inadequate costs to restrain the continued use of kinetic-energy ASAT weapons. The question of compensation for damage resulting from a kinetic-energy weapon remains a hypothetical one, as no state has had an opportunity to present such a claim. Since kinetic-energy attacks are not internationally wrongful if conducted in a nonaggressive manner (such as testing against a state's own satellite), an injured state must either be able to attribute the cause of damage to the kinetic-energy attack or argue that the launching state failed to mitigate transboundary harms and ensure its activities did not cause harmful interference with another state's space activities.

If one accepts the argument that debris created from a kinetic-energy intercept is a "space object" under the definition contained in the Liability Convention, states are likely liable for

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160 *See id.*; Outer Space Treaty, *supra* note 14, art. IX.

161 *Draft Principles of Allocation*, *supra* note 155, at 108, princ. 3.

162 The only attempt to obtain compensation under the Liability Convention came after *Cosmos 954* scattered radioactive debris across a section of Canadian wilderness. *See* Joseph A. Burke, *Convention on International Liability for Damage Caused by Space Objects: Definition and Determination of Damages After the* Cosmos 954 *Incident*, 8 FORDHAM INT'L L.J. 255, 256 (1984). Canada included two theories of compensation when it presented its claim to the U.S.S.R.: one under the Liability Convention and one under the generally recognized principles of international law. *Id.* at 273–74. Canada was partially successful in recovering on its claim, though the effectiveness of the Liability Convention's compensation measures remains questionable. *Id.* at 279–80.

any damage caused by collisions with said debris. The intercepts of *FY-1C*, *USA-193*, and *Microsat-R* involved the owning state launching a kinetic-energy interceptor at its own satellite; if further collisions had resulted from the debris produced, the injured state would likely have a claim under Article III of the Liability Convention.[163] The issue becomes attributing fault to a state following a collision. As previously noted, the SSN is capable of tracking debris 10 centimeters or larger in LEO, and its electro-optical telescopes are capable of 1-meter resolution in GEO. Debris smaller than 10 centimeters is still capable of causing immense damage to a satellite, especially as the relative size disparity between the piece of debris and the satellite decreases (e.g., a collision between a sub-10-centimeter piece of debris and a cubesat). Since a collision with a space object can happen years after an intentional breakup produced the debris, a state would likely need to use persistent tracking to determine the lifecycle of the debris that caused the damage. For pieces catalogued by the SSN or equivalent space mapping systems, this is relatively easy to demonstrate.[164] For pieces of debris that are not catalogued due to their size, it becomes much more difficult to attribute the source. For example, the *Cosmos 1934* collision occurred in 1991, but the collision was not understood until 2005 upon further examination by the NASA Orbital Debris Program Office.[165] As a result of the *FY-1C* breakup, a projected 35,000 pieces of debris 1 centimeter and larger were produced; the SSN can only reliably track 2,087 of those pieces, about 6% of the estimate.[166] Further estimates place the amount of tracka-

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[163] Liability Convention, *supra* note 15, art. III. OST Article VI places international responsibility for activities conducted in outer space by nongovernmental entities on the state of origin. Outer Space Treaty, *supra* note 14, art. VI. The OST also requires that activities carried out by such entities are "authoriz[ed] and continu[ously] supervis[ed] by the appropriate State Party to the Treaty." *Id.* If a corporate-owned satellite was damaged as a result of a kinetic energy ASAT test, the sovereignty in which the corporation is a legal entity would likely need to espouse the claim in order to recover, since the Liability Convention is an international agreement between sovereigns and does not contain provisions for private action or arbitration. *See* Liability Convention, *supra* note 15, art. III.

[164] *See* STUBBE, *supra* note 50, at 44–45. If the piece of debris is catalogued, it would also be possible to avoid the collision if the satellite was equipped with maneuvering capabilities. *See id.* at 49–50, 49 n.195.

[165] *Accidental Collisions of Catalogued Satellites Identified*, ORBITAL DEBRIS Q. NEWS, Apr. 2005, at 1, 1, https://orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnv9i2.pdf [https://perma.cc/EP27-L6PS].

[166] KELSO, *supra* note 67, at 325.

ble debris in LEO at 10% of the total debris present.[167] Since 90% of the debris remains unaccounted for, a collision between a space object and an untracked piece of debris is quite possible. And when such a collision occurs, the injured state will have no recourse under the fault standard contained in Article III of the Liability Convention.

Transboundary harm norms recognize that some activities, while not internationally prohibited, still present significant risks during their operation. States are still required to mitigate the risk of harm under the Prevention Articles when conducting such activities. When evaluating whether a kinetic-energy engagement resulting in fragmentation caused transboundary harm, states would likely argue that the engagements were intentionally designed to reduce the longevity of any debris created by deliberately targeting satellites at minimal altitude above the atmosphere to capture a majority of debris on reentry.[168] This argument can be treated as evidence of states taking appropriate measures to reduce resulting debris, satisfying the risk assessment obligations under the Prevention Articles. India would likely argue that it met any obligations contained in Article 3 and Article 7 of the Prevention Articles by issuing a Notice to Airmen (NOTAM), which created a restricted danger area prior to the engagement.[169] India also stated that it intentionally designed the engagement of *Microsat-R* to take place in low orbit and in a downward intercept trajectory.[170] If the international community does not accept that designing a kinetic-energy engagement in an intentionally downward manner satisfies a risk assessment of transboundary harms under Article 7 of the Prevention Articles,[171] then that should trigger OST Article IX international consultation and notification obligations under

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[167] *See* Manimuthu Gandhi, *Towards a Legal Regime for the Protection of Space Assets*, *in* RECENT DEVELOPMENTS IN SPACE LAW, *supra* note 8, at 117, 123.

[168] Statements made by the U.S. and Indian governments relating to the engagement of *USA-193* and *Microsat-R* both purport to have taken deliberate steps to mitigate any resulting debris, albeit with mixed actual results. *See* Mineiro, *supra* note 72, at 349; Frequently Asked Questions on Mission Shakti, *supra* note 5.

[169] *See supra* text accompanying note 99.

[170] *See* Analytical Graphics, Inc., *2019 Indian Anti-Satellite Weapon Test – 3/28/2019 Update*, YOUTUBE (Mar. 28, 2019), https://www.youtube.com/watch?v=PZhtc-rFbvM [https://perma.cc/QZ2R-G2BD]. A "downward intercept" occurs when a kinetic energy weapon impacts the target during the downward portion of its trajectory arc. This type of intercept is assumed from the resulting debris created and tracked following the *Microsat-R* engagement. *See id.*

[171] *See Draft Articles on Prevention*, *supra* note 154, art. 7.

Article 8 of the Prevention Articles.[172] However, the OST fails to expound upon what actions satisfy the consultation requirement. State practice has also failed to clarify any expectations for international consultations. While the United States, Russia, China, and India have all conducted a kinetic-energy intercept of a satellite, no state has engaged in an open dialogue prior to the operation.[173] China publicly acknowledged the intercept of *FY-1C* twelve days after the event,[174] while India issued statements acknowledging the intercept of *Microsat-R* only hours after launch.[175] The United States publicly announced plans to destroy *USA-193*, but commentators have since raised concerns that simply announcing the operation did not go far enough towards reinforcing a norm of Article IX consultations.[176] Without concrete expectations of what satisfies Article IX obligations, a launching state has immense latitude in defining what constitutes risk to other nations when addressing both OST obligations and an assessment of risk for transboundary harms. Since failing to conduct Article IX consultations does not impute liability onto the launching state, the state can currently point to intentional design of the intercept as evidence of appropriate mitigation actions and rely upon previous state practice when faced with a hypothetical transboundary harm claim.[177]

Finally, the liability regime also assumes a kinetic-energy engagement that does not occur during an international armed conflict. Article III of the OST states that activity in outer space is subject to the recognized principles of international law and the Charter of the United Nations;[178] outer space activities conducted during a time of internationally sanctioned armed conflict would be peremptorily governed by the laws of armed conflict. Further, a state is likely not liable as a result of transboundary harm that occurs during wartime.[179] While neither the Prevention Articles nor the Principles of Allocation exonerate transboundary harms that occur during wartime, similar legal

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172 *See id.* art. 8; Outer Space Treaty, *supra* note 14, art. IX.

173 *See* Mineiro, *supra* note 72, at 346.

174 *See* Milowicki & Johnson-Freese, *supra* note 68, at 3.

175 *Cf.* Miglani & Das, *supra* note 2.

176 *See* Mineiro, *supra* note 72, at 352–53 (arguing that the United States missed an opportunity to clarify and guide future international consultations under Article IX).

177 *See id.* at 353.

178 *See* Outer Space Treaty, *supra* note 14, art. III.

179 *See* Kaplow, *supra* note 91, at 1245.

frameworks do recognize exoneration from liability under wartime conditions.[180]

V. RESTRICTIONS ON THE USE OF KINETIC-ENERGY ASAT WEAPONS UNDER THE RECOGNIZED PRINCIPLES OF THE LAW OF ARMED CONFLICT

Another option advanced for constraining the use of kinetic-energy ASAT weapons is an argument that their use may violate the recognized principles of the law of armed conflict (LOAC). The use of kinetic-energy weapons in space produces persistent hazards to other space objects that cannot be rendered harmless by incorporating comparable planning considerations as when arms are directed against terrestrial targets. Collateral damage with typical conventional weapons can be mitigated through precision guidance, positive identification prior to release, and other actions taken in furtherance of distinction and proportionality assessments required by international humanitarian law. Dual-use satellites also present a challenge to military commanders in that commanders must demonstrate the military advantage gained from destroying the object.[181] However, destroying or degrading an adversary's ability to communicate, navigate, or collect intelligence through a space-based asset will almost certainly justify damage to a civilian object used for military purposes.[182] The debris created from kinetic-energy engagements presents an entirely different problem, since the risk it poses may not be realized for years after the engagement. Nonetheless, a potentially unrealized risk of collision with a space object is unlikely to outweigh a proportionality balancing test for determining whether the attack was indiscriminate. Since methods of engagement that decrease the resulting debris exist, and targeting both military and dual-use satellites will undoubtedly provide a concrete military advantage for a commander, the

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[180] *See* Protocol to Amend the 1963 Vienna Convention on Civil Liability for Nuclear Damage, art. 6(1), Sept. 12, 1997, 2241 U.N.T.S. 270 (establishing exoneration from liability as a result of nuclear damage due to an act of armed conflict or hostilities); International Convention on Civil Liability for Oil Pollution Damage, art. III(2)(a), Nov. 29, 1969, 973 U.N.T.S. 3 (establishing exoneration from liability as a result of an oil spill due to an act of war or hostilities).

[181] *See* Bourbonniere & Haeck, *supra* note 42, at 6, 9.

[182] *See id.* at 6. Examples of dual-use satellites include some communications satellites, weather satellites, and Global Positioning System satellites.

principles of LOAC would likely not prevent the use of kinetic-energy ASAT weapons.

A. Are Kinetic-energy ASAT Weapons Legal Means and Methods of Warfare?

Article 22 of the 1907 Convention Respecting the Laws and Customs of War on Land (Hague IV) states that "[t]he right of belligerents to adopt means of injuring the enemy is not unlimited."[183] Over time, this has become codified as a recognized principle of international law, contained in numerous international agreements regulating the conduct of warfare.[184] Article 36 of the Geneva Convention Additional Protocol I (AP I) places a positive obligation on states to investigate the legality of new weapons, means, and methods of warfare in the course of their adoption.[185] When evaluating whether a particular means or method is lawful in the course of armed conflict, the International Committee for the Red Cross suggests the following analysis: (Element 1) evaluate whether the state is restrained from using the means or method because of any obligation under international treaty law; (Element 2) evaluate specific prohibitions on the means or method under principles of customary international law (CIL); and (Element 3) investigate any general restrictions contained in treaty law or CIL.[186] It is unlikely that any of the established CIL prohibitions on specific weapons, Element 2, apply to kinetic-energy ASAT weapons.[187] Element 1,

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[183] Convention Respecting the Laws and Customs of War on Land art. 22, Oct. 18, 1907, 36 Stat. 2277 [hereinafter Hague IV].

[184] *See* Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I) art. 35(1), June 8, 1977, 1125 U.N.T.S. 3 [hereinafter Additional Protocol I]; *see also* Treaty on the Prohibition of Nuclear Weapons pmbl., July 7, 2017, U.N. Doc. A/CONF.229/2017/8; Convention on Cluster Munitions pmbl., May 30, 2008, 2688 U.N.T.S. 39; Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction pmbl., Sept. 18, 1997, 2056 U.N.T.S. 211; Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects pmbl., Oct. 10, 1980, 1342 U.N.T.S. 137.

[185] Additional Protocol I, *supra* note 184, art. 36.

[186] *See* Int'l Comm. of the Red Cross, A Guide to the Legal Review of New Weapons, Means and Methods of Warfare 11 (2006), https://e-brief.icrc.org/wp-content/uploads/2016/09/12-A-Guide-to-the-Legal-Review-of-New-Weapons.pdf [https://perma.cc/D4QT-Q92G].

[187] *See* Jean-Marie Henckaerts & Louise Doswald-Beck, 1 Customary International Humanitarian Law: Rules 251–96 (2005). Customary international law rules relevant to this analysis are discussed in this section.

treaty obligations establishing restrictions, may be applicable to kinetic-energy ASAT weapons as a result of the debris produced if unlawful environmental modifications are made during the conduct of armed conflict; Element 1 will be discussed in Section V of this Article. Military necessity, proportionality, and distinction analyses under Element 3 are applicable to continued employment of kinetic-energy ASAT weapons, though ultimately do not prevent their use.

1. *Military Necessity*

Military necessity is generally understood to be the means "indispensable for securing the ends of the war."[188] Military necessity contains two elements: a "military requirement to undertake a certain measure," and that the measure is "not forbidden by the laws of war."[189] The concept of military necessity first appeared in Articles 15 and 16 of the Lieber Code, promulgated as General Orders No. 100 in 1863.[190] Article 15 allowed for "all destruction of property, and obstruction of the ways and channels of traffic, travel, or communication," but it was restrained by Article 16's prohibition against "wanton devastation of a district."[191] As Marco Sassòli stated, "[t]o allow attacks on persons other than combatants would violate the principle of necessity, because victory can be achieved by overcoming only the combatants of a country . . . ."[192] Military necessity is not a prohibition on destruction per se but an instruction that the person or object attacked must concretely contribute to victory in armed conflict.

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[188] Burrus M. Carnahan, *Lincoln, Lieber and the Laws of War: The Origins and Limits of the Principle of Military Necessity*, 92 AM. J. INT'L L. 213, 215 (1998); *see* U.S. ARMY JUDGE ADVOCATE GENERAL'S LEGAL CTR. & SCH., LAW OF ARMED CONFLICT DESKBOOK 133–34 (David Lee ed., 5th rev. ed. 2015) ("That principle which justifies those measures not forbidden by international law which are indispensable for securing the complete submission of the enemy as soon as possible.").

[189] *See* LAW OF ARMED CONFLICT DESKBOOK, *supra* note 188, at 134.

[190] *See id.* at 96.

[191] *See* FRANCIS LIEBER, GENERAL ORDERS NO. 100, INSTRUCTIONS FOR THE GOVERNMENT OF ARMIES OF THE UNITED STATES IN THE FIELD, arts. 15–16 (Apr. 24, 1863) [hereinafter LIEBER CODE].

[192] Marco Sassòli, *Targeting: The Scope and Utility of the Concept of "Military Objectives" for the Protection of Civilians in Contemporary Armed Conflicts*, *in* NEW WARS, NEW LAWS?: APPLYING THE LAWS OF WAR IN 21ST CENTURY CONFLICTS 181, 202 (David Wippman & Matthew Evangelista eds., 2005).

2. *Proportionality*

Jus in bello proportionality balances military expediency against countervailing humanitarian interests, such as when targeting dual-use infrastructure or evaluating expected collateral damage.[193] AP I Article 51(5)(b) states that an attack is disproportionate if the incidental loss of civilian life or damage to civilian objects is "excessive in relation to the concrete and direct military advantage" expected as a result of the attack.[194] Article 57(2) requires commanders to minimize incidental loss or damage when evaluating the proportionality of an attack.[195] Previous judicial decisions evaluating proportionality afford military commanders broad discretion in their perceptions of expectant advantage.[196] The Final Report to the Prosecutor by the Committee Established to Review the NATO Bombing Campaign in Kosovo came to the conclusion that experienced military commanders and human rights lawyers are likely to assign different values to military advantage gained from a strike, and it suggested that the determination of the value of the strike be "that of the 'reasonable military commander.'"[197]

3. *Distinction*

The principle of distinction requires military commanders to distinguish between civilian objects and military objectives when targeting an adversary's infrastructure during armed conflict.[198] Military objectives are defined as "objects whose 'destruction,

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193 *See* Michael A. Newton, *Reframing the Proportionality Principle*, 51 VAND. J. TRANSNAT'L L. 867, 872 (2018).

194 Additional Protocol I, *supra* note 184, art. 51(5)(b).

195 *Id.* art. 57(2)(a)(ii). The U.S. position prefers the term "all practicable precautions" rather than "all feasible precautions" so as not to place the burden of employing precision-guided munitions on every engagement. *See* LAW OF ARMED CONFLICT DESKBOOK, *supra* note 188, at 148.

196 *See* Newton, *supra* note 193, at 875–78. Professor Newton's article states that "[t]he use of markedly strong modifiers is a core truism that recurs in virtually every contextual application." *Id.* at 875. This mirrors the "clearly excessive" evaluation standard used by the International Criminal Court (ICC), and it likely affords similar deference to military commanders and their perceptions of present military necessity. *See id.* at 878.

197 *See Final Report to the Prosecutor by the Committee Established to Review the NATO Bombing Campaign Against the Federal Republic of Yugoslavia* ¶ 50, 39 I.L.M. 1257 (Int'l Crim. Trib. for the Former Yugoslavia, June 8, 2000) [hereinafter *Final Report to the Prosecutor*]. For an evaluation of the "reasonable" standard in the LOAC context, see Geoffrey S. Corn, *Humanitarian Regulation of Hostilities: The Decisive Element of Context*, 51 VAND. J. TRANSNAT'L L. 763, 768–72 (2018).

198 *See* Additional Protocol I, *supra* note 184, art. 48.

capture or neutralization' . . . 'offers a definite military advantage'" at the time of the action.[199] AP I Article 51 prohibits indiscriminate attacks, specifically attacks not directed at a precise target, attacks whose effects are not directed against a military objective or cannot be limited as required, and attacks that do not discriminate between military and civilian objects.[200] The International Committee of the Red Cross's *Commentary of 1977* suggests that weapons whose effects "cannot be limited as required"[201] refers primarily to biological or nuclear weapons, or in the alternative, describes the manner in which weapons are employed.[202] This suggests that there are means and methods that become indiscriminate depending on how they are employed, rather than LOAC acting as a prophylactic ban on certain weapons outside of other treaty obligations.

While some satellites are purely military infrastructure in nature, others are dual-use objects that provide services to both military and civilian components of a state.[203] In such cases, the most restrictive assessment of distinction would require a causal link between the object and the actual degradation to the adversary's military capability.[204] The NATO bombing of Radio Television Serbia (RTS) is an example of assessing the causal link between dual-use objects and the expected military advantage.[205] Following a review of the strike by the International Criminal Tribunal for the Former Yugoslavia (ICTY) and the European Court of Human Rights, the tribunal determined that because the station served to transmit military communications, it was a legitimate military target, despite the deaths of sixteen civilians inside.[206]

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199 Ganesh Sitaraman, *Counterinsurgency, the War on Terror, and the Laws of War*, 95 VA. L. REV. 1745, 1783 (2009) (quoting Additional Protocol I, art. 52(2)).

200 Additional Protocol I, *supra* note 184, art. 51(4).

201 *Id.*

202 INT'L COMM. OF THE RED CROSS, COMMENTARY ON THE ADDITIONAL PROTOCOLS OF 8 JUNE 1977 TO THE GENEVA CONVENTIONS OF 12 AUGUST 1949, at 623 (Yves Sandoz et al. eds., 1987) [hereinafter COMMENTARY OF 1977].

203 *See* Kaplow, *supra* note 91, at 1247.

204 *See* Sitaraman, *supra* note 199, at 1784–85.

205 *See id.* at 1786.

206 *See id.* at 1786–87. However, the ICTY went on to state that the destruction of RTS and the resulting civilian deaths would not have been justified if the station had only been broadcasting propaganda. *See* Final Report to the Prosecutor, *supra* note 197, at 1278.

B. Analysis of a Hypothetical Kinetic-energy ASAT Engagement

The principle of necessity would likely not prevent an attack on a military satellite, so far as the military commander could identify how the destruction of the objective furthered the war effort. Necessity, however, may dictate the means and methods employed to destroy the target satellite. Just as the Lieber Code's principle against unnecessary suffering was applied to the ban on small-caliber explosive bullets in 1868,[207] destruction of property must not rise to a wanton level. David Kaplow uses the example of a state that possesses both a directed-energy weapon and a kinetic-energy ASAT interceptor: if both weapons can cause the desired "hard-kill" destruction of a satellite,[208] an argument exists that using a kinetic-energy interceptor would result in wanton destruction because of the debris resulting from the collision.[209] However, this argument imputes a definition of "necessary" into military necessity that does not reflect the principles contained in the Lieber Code or subsequent international agreements.[210]

Arguably, if a state faces a choice between destruction of an orbital satellite and an attack on the ground control segment of the satellite network, a military necessity analysis should weigh against the destruction of the satellite and consequently eliminates any debris that would otherwise result from the satellite's destruction. However, this argument changes the calculus of the attack, trading the potential for loss of human life operating the ground segment for the avoidance of additional debris. However, if the military advantage gained from the destruction of the ground segment is no greater than the destruction of the satellite, this calculus is contrary to the underlying principles of the law of armed conflict, which seek to humanize conflict when

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207 *See* Carnahan, *supra* note 188, at 215.

208 "Hard kills" are measures that physically counterattack an incoming threat by destroying the threat in a way that severely impedes or kills the threat.

209 *See* Kaplow, *supra* note 91, at 1248.

210 *See id.*; Carnahan, *supra* note 188, at 226 (arguing that military necessity was a restraint on general seizure of property, but it allowed the seizure or destruction of property that contributed to the adversary's war efforts). *See generally* Annex to the Convention Regulations Respecting the Laws and Customs of War on Land, Oct. 18, 1907, 36 Stat. 2227, *reprinted in* The Laws of Armed Conflicts: A Collection of Conventions, Resolutions and Other Documents 75 (Dietrich Schindler & Jirí Toman eds., 3d rev. ed. 1988).

possible.[211] Because the described situation is plausible in a hypothetical future conflict, it is impossible to adopt a per se rule against targeting an orbital asset.

A reasonable military commander would likely assign a relatively high value to a kinetic-energy ASAT strike that crippled or disrupted an adversary's communications, navigation, or targeting infrastructure, though the commander would need to balance the relatively high value of the attack against the potential hazards of debris remaining in orbit. Further difficulty arises when attempting to evaluate the adverse effects of such an engagement. Computer modeling may be able to predict, with some accuracy, the amount and characteristics of debris produced, but it is quite possible that the negative impact of the debris remaining in orbit will not be fully realized until decades after the engagement. Facing a choice between the destruction of an adversary's signals intelligence satellite and the incalculable probability that a fragment from the engagement will collide with another space asset, a commander is likely justified in accepting this hypothetical risk for the immediate and concrete advantage gained.

For an ASAT engagement against a dual-use satellite, commanders would need to ensure that the purpose behind targeting the satellite is to degrade the adversary's ability to effectively execute military operations. In an age where Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) satellites are essential to perform a multitude of military actions,[212] targeting the GPS, communications, and imagery satellites that perform C4ISR functions almost certainly satisfies the causal link analysis of distinction. The expected military advantage of degrading such networks will only increase as modern militaries become further dependent on space-based assets. The bombing of RTS during the Kosovar conflict and the resulting post hoc review provide a benchmark for legitimate targeting of dual-use objects in a modern context.[213]

An argument exists that the collateral damage resulting from a kinetic-energy ASAT engagement makes such a weapon inherently indiscriminate, likening the second-order effects of orbital

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[211] *See* Hague IV, *supra* note 183, arts. 22, 25; Sitaraman, *supra* note 199, at 1756.

[212] *See* Benjamin S. Lambeth, *The Synergy of Air and Space*, AIRPOWER J., Summer 1998, at 5, 6–7.

[213] *See supra* notes 203–206 and accompanying text.

debris to foreseeable after effects of other conventional, chemical, biological, and nuclear weapons.[214] However, the argument is predicated on the so far unrealized potential for collateral damage in congested orbits, and it must still be weighed against the anticipated military advantage at the time of the operation. Utilizing kinetic-energy ASAT weapons in a downward-intercept manner is intended to reduce or minimize the amount of debris that remains in orbit after the impact, which is compatible with the purpose of the limited effects provision and the associated text contained in the *Commentary of 1977*.

VI. PROHIBITIONS ON WIDESPREAD, LONG-TERM, AND SEVERE DAMAGE TO THE NATURAL ENVIRONMENT

A further suggestion for constraining the use of kinetic-energy ASAT weapons has been through environmental protection regimes that prohibit certain damage to the natural environment as a result of warfare. These regimes have grown in conjunction with international humanitarian law's restrictions on means and methods of warfare, but they are also specialized regimes that seek to address hostile use of environmental modification techniques as a means of warfare. In their original form, these regimes were designed to protect the natural environment, since humanity depends on it for survival. Future iterations have removed the human considerations and seek to protect intentional damage to the natural environment. Kinetic-energy ASAT operations have undoubtedly contributed to the modification of the natural environment, placing thousands of pieces of persistent debris in orbit, resulting in intentional and unintentional pollution. Despite this modification from artificial debris, existing environmental protection regimes provide minimal recourse to prevent future kinetic engagements that fall outside of using them as a means of warfare designed to adapt outer space as a weapon.

While ENMOD specifically address the modification of the atmosphere and outer space, it only prohibits intentional use of environmental modification as a weapon against an adversary, and it does not adequately constrain methods of warfare that

214 *See* Kaplow, *supra* note 91, at 1245 (arguing that the foreseeability of latent damage from cluster munitions, nuclear fallout, and other persistent effects is similar to lingering debris in orbit that presents a collision hazard to other objects in space); *see also* Additional Protocol I, *supra* note 184, art. 51(5)(b).

modify the environment as a derivative result. AP I Articles 35 and 55 prohibit both intentional and expected damage to the natural environment under the vague "widespread, long-term and severe" standard, but Article 55 requires that the attack "prejudice the health or survival of the population."[215] Article 8(2)(b)(iv) of the Rome Statute of the International Criminal Court places the additional barrier of a proportionality test for liability, carrying forward this vague standard of damage while also requiring that the damage be "clearly excessive" when compared to the anticipated overall military advantage of the strike.[216]

A. Environmental Protections Under AP I, ENMOD, and Rome Statute Article 8(2)(b)(iv).

There are traditionally two approaches to protecting the environment: anthropocentric and ecocentric legal regimes.[217] Prior to the entry into force of ENMOD, all previous international agreements protecting the environment were anthropocentric, protecting the environment for its ability to sustain human life.[218] Examples of anthropocentric regimes include Hague IV and the 1949 Geneva Convention Relative to the Protection of Civilian Persons in Time of War (Geneva Convention IV).[219] Attacks that only damaged parts of the environment that were not used for human sustainment were exclusively questions of domestic jurisdiction and enforcement, since the anthropocentric

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215 Additional Protocol I, *supra* note 184, arts. 35, 55. The terms "widespread," "long-term," and "severe" are present in all environmental protection regimes, but they are not defined. Commentaries provide incongruent definitions that have resulted in a vague standard. This section discusses the various definitions offered.

216 Rome Statute of the International Criminal Court art. 8(2)(b)(iv), July 17, 1998, 2187 U.N.T.S. 90 [hereinafter Rome Statute].

217 *See* Jessica C. Lawrence & Kevin Jon Heller, *The First Ecocentric Environmental War Crime: The Limits of Article 8(2)(b)(iv) of the Rome Statute*, 20 Geo. Int'l Envtl. L. Rev. 61, 64 (2007).

218 *Id.* at 65–66.

219 *See* Lawrence & Heller, *supra* note 217, at 65–66; *see also* Geneva Convention Relative to the Protection of Civilian Persons in Time of War art. 53, Aug. 12, 1949, 6 U.S.T. 3516, 75 U.N.T.S. 287 [hereinafter Geneva Convention IV]; Hague IV, *supra* note 183, arts. 23, 55. Article 23 of Hague IV prohibits destruction of property unless the destruction is a military necessity, and Article 55 requires an occupying state to act as an administrator and usufructuary of the enemy state's resources, including forests. *See* Hague IV, *supra* note 183, arts. 23, 55. Article 53 of Geneva Convention IV provides similar protections for state and personal property as Article 23 of Hague IV, excusing destruction only for military necessity. *See* Geneva Convention IV, *supra*, art. 53.

regimes identified above prohibit attacks only when they harmed human beings—and only when they were contrary to the principles of military necessity.[220]

Following the devastating defoliation campaign that occurred during the Vietnam War, a new regime emerged that sought to protect attacks on the natural environment even in the absence of direct harm to human beings.[221] ENMOD of 1976 and the AP I established quasi-ecocentric regimes that restricted military actions that cause "widespread," "long-lasting," and "severe effects" to the natural environment.[222] While common language exists between AP I and ENMOD, defining widespread, long-lasting, and severe varies across the instruments. For interpreting ENMOD, the Committee on Disarmament provided the following definitions to the thirty-first session of the U.N. General Assembly:

(a) "widespread": encompassing an area on the scale of several hundred square kilometres;
(b) "long-lasting": lasting for a period of months, or approximately a season;
(c) "severe": involving serious or significant disruption or harm to human life, natural and economic resources or other assets.[223]

The *Commentary of 1977* on AP I indicates that the purposes behind Article 35(3) and Article 55 diverged during working group negotiations.[224] While both Article 35 and Article 55 contain "widespread, long-lasting and severe" language, the intent of Article 35 was to provide ecocentric environmental protections while Article 55 was to provide anthropocentric protections to human sustainability.[225] While the *travaux préparatoire*

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[220] *See* Lawrence & Heller, *supra* note 217, at 65–70; *see also* LIEBER CODE, *supra* note 191, arts. 16, 70 (prohibiting the "wanton devastation of a district" and "use of poison in any manner, be it to poison wells, or food, or arms").

[221] Lawrence & Heller, *supra* note 217, at 66.

[222] *See* ENMOD, *supra* note 109, art. 1; Additional Protocol I, *supra* note 184, arts. 35(3), 55(1).

[223] *See* Rep. of the Conference of the Comm. on Disarmament on Its Thirty-First Session, 31 U.N. GOAR Supp. No. 27, at 91, U.N. Doc. A/31/27 (Vol. 1) (1976).

[224] *See* COMMENTARY OF 1977, *supra* note 202, at 417–18.

[225] *See id.*; Rep. to Comm. III on the Work of the Working Group Submitted by the Rapporteur, CD Doc. No. CDDH/III/293 (1975), *in* 15 OFFICIAL RECORDS OF THE DIPLOMATIC CONFERENCE ON THE REAFFIRMATION AND DEVELOPMENT OF INTERNATIONAL HUMANITARIAN LAW APPLICABLE IN ARMED CONFLICTS, at 357, 358–59, CD Doc. No. CDDH/215/Rev.1 (1977).

indicates that the drafters envisioned long-term damage would encompass damage that was not "incidental to conventional warfare" (such as artillery bombardment), there was no consensus on defining a period of time that embodied the language "long-lasting."[226] No definitions for "widespread" and "severe" are contained in the commentary or *travaux*.[227] The U.S. Army Judge Advocate General's *Operational Law Handbook* provides the following definitions: "the term 'widespread' probably means several hundred square kilometers, as it does in ENMOD. 'Severe' can be explained by [AP I] Article 55's reference to any act that 'prejudices the health or survival of the population.'"[228]

The apparent overlap of provisions contained in ENMOD and AP I was discussed within the Conference of the Committee on Disarmament, though the U.S. position during negotiations was that AP I was aimed at protecting the natural environment during international armed conflict, while ENMOD is designed to prevent the use of the environment as a military weapon.[229] In this light, a significant distinction between ENMOD and AP I is that ENMOD is a single-element violation, while AP I requires the presence of all three elements due to the conjunctive "and" in Article 35(3) and Article 55.[230] Further, violations of AP I Articles 35 and 55 are not grave breaches, and along with ENMOD and Hague IV, produce state responsibility only for illegal attacks.[231]

While ENMOD is a single-element liability regime, it requires a higher threshold of knowledge when imposing liability compared to AP I. ENMOD Article II requires that the environmental modification technique is employed *deliberately* by a state to change the dynamic, composition, or structure of the Earth, including the atmosphere and outer space.[232] AP I Article 35(3) prohibits methods or means of warfare *intended, or that may be expected* to cause the requisite environmental harm.[233] This broader scope of application is discussed at length in the *Com-*

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[226] *Id.* at 268–69. Some delegates suggested twenty to thirty years as the minimum amount of time, while the Biotope report suggested a reasonable definition was damage that lasted over ten years. *Id.*

[227] *See* Lawrence & Heller, *supra* note 217, at 71–73.

[228] Operational Law Handbook, *supra* note 133, at 326.

[229] *See* Commentary of 1977, *supra* note 202, at 414–15.

[230] Lawrence & Heller, *supra* note 217, at 72–73; *see also* Operational Law Handbook, *supra* note 133, at 326.

[231] Lawrence & Heller, *supra* note 217, at 67, 70.

[232] *See* ENMOD, *supra* note 109, art. 2.

[233] *See* Additional Protocol I, *supra* note 184, art. 35(3).

mentary of 1977, and it is a result of the deliberate exclusion of an "intentional" element in the French text of the treaty, leaving open the possibility of liability imputed from excessive use of conventional weapons that result in widespread, long-lasting, and severe harms to the environment.[234] While the same "may be expected" language is also contained in AP I Article 55, it further requires that the damage threaten a human population to violate the provision.[235]

Article 8(2)(b)(iv) of the Rome Statute is considered the most ecocentric iteration of an environmental protection regime to date.[236] The Article makes it a war crime to:

> Intentionally launch[ ] an attack in the knowledge that such attack will cause incidental loss of life or injury to civilians or damage to civilian objects or widespread, long-term and severe damage to the natural environment which would be clearly excessive in relation to the concrete and direct overall military advantage anticipated.[237]

Article 8(2)(b)(iv) carries forward the familiar "widespread, long-lasting and severe" language common to previous ecocentric regimes, but the Rome Statute also establishes individual criminal liability for intentionally launching such an attack.[238] Due to the relationship between the Rome Statute and the Geneva Conventions, such as the adoption of substantive war crimes and fundamental notions of due process from the latter, the International Criminal Court (ICC) would likely interpret Article 8(2)(b)(iv)'s "widespread, long-term and severe" language in line with AP I.[239] The *Elements of Crimes* relating to Article 8(2)(b)(iv) explains that the overall "military advantage" anticipated is not limited by geographic or temporal relation to the attack, inviting a proportionality assessment.[240] It is important to note that the actual result of the attack is not relevant for establishing individual criminal liability; proof of the *intentional* initiation of an attack that the individual *believed* would cause widespread, long-lasting, and severe environmental harm pro-

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234 *See* COMMENTARY OF 1977, *supra* note 202, at 418–19.
235 *See* Additional Protocol I, *supra* note 184, art. 55.
236 *See* Lawrence & Heller, *supra* note 217, at 70.
237 Rome Statute, *supra* note 216, art. 8(2)(b)(iv).
238 *Id.* art. 25.
239 *See* Lawrence & Heller, *supra* note 217, at 73. *See generally* Rome Statute, *supra* note 216, arts. 8(2)(a), 67 (adopting substantive war crimes provisions from Geneva Convention Common Article II in Article 8 and incorporating due process rights from Additional Protocol I Article 67).
240 *See* Newton, *supra* note 193, at 883.

duces liability.[241] In addition, the ICC must take into account the perceived overall military advantage expected by the individual at the time of initiation, and any post hoc assessment of the individual's action must be based only on the information available to the individual at the time of attack.[242]

B. Anthropocentric and Ecocentric Regimes Are Ineffective in Constraining Kinetic-energy ASAT Weapons

Anthropocentric protection regimes such as Hague IV and Geneva Convention IV are ineffective in restricting kinetic-energy ASAT weapons, since these regimes require damage to the environment that affects the sustainability of human life. AP I's quasi-ecocentric extension contained in Article 55 still contains a similar anthropocentric element as well; the resulting debris from a kinetic-energy engagement may pose a danger to human spaceflight, though it likely does not constitute a risk to "the health or survival of the population."[243] Ecocentric protections contained in AP I Article 35, ENMOD, and Rome Statute Article 8(2)(b)(iv) are also insufficient to prevent kinetic-energy attacks because of the muddled definitions of "widespread, long-term and severe." Further, the proportionality analysis when assessing liability under Article 8(2)(b)(iv), coupled with the intent requirement that the attack be directed against the natural environment, insulates a reasonable military commander from liability if the attack is directed against an adversary's satellite and is not intentionally designed to create a cascading set of collisions through the creation of debris.

Kinetic-energy ASAT weapons likely produce "widespread" harms under ecocentric regimes. The amount and size of debris

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241 *Id.* at 883–84.

242 *Id.* at 884–85. The inclusion of the word "overall" indicates that the perceived military advantage can incorporate the anticipated effects of other coordinated operations. *Id.* at 884. The modifier "clearly excessive" narrows the scope of collateral damage that can satisfy the elements of the crime, which complements an intentional knowledge requirement to initiate an attack for the purpose of causing widespread, long-term, and severe damage to the environment. *Id.*

243 *See* Additional Protocol I, *supra* note 184, art. 55. It would have to be argued that the astronauts/cosmonauts conducting human spaceflight are a population indiscriminately affected by debris from an ASAT engagement. According to the report of Committee III on AP I, the choice was made to eliminate any reference to "civilian" population; the term is intended to incorporate the entire population of an area, and the attacks prohibited could "affect the whole population without any distinction." *See* Commentary of 1977, *supra* note 202, at 663.

produced by a kinetic-energy ASAT engagement depends on many factors, including the mass of the satellite, the mass of the kinetic interceptor, the relative velocities of the objects, and the angle of intercept, among others.[244] Previous engagements have demonstrated that a significant portion of the resulting debris can continue to remain in the orbital period. Arguably, the area occupied by the debris would constitute "widespread" harm under both the ENMOD and AP I/Article 8(2)(b)(iv) definitions.[245]

The "long-term" prong of ecocentric harm regimes is also likely satisfied. Depending on the altitude of the engagement, debris can persist for upwards of one hundred years before decaying into the atmosphere,[246] remaining a threat to operational spacecraft and unintentional collisions until it reenters. Based upon the accepted definitions for "long-term" harm, debris that remains a collision hazard for decades exceeds the temporal limitations suggested in ENMOD, AP I, and Article 8(2)(b)(iv).[247]

The final prong, "severe," experiences the greatest disparity across the ecocentric regimes. The ENMOD definition encompasses "serious or significant disruption or harm to human life, natural and economic resources or other assets."[248] Since AP I and Article 8(2)(b)(iv) contain no inherent definition of "severe," and AP I Article 55 indicates that "severe" is meant in an anthropocentric manner,[249] defining a purely ecocentric meaning of "severe" damage outside of ENMOD's definition is problematic. Under ENMOD, there is an argument that debris resulting from a kinetic-energy ASAT attack could pose a severe threat to a state's economic assets in orbit.[250] Additionally, it could also be argued that denying the use of viable orbits, especially those in the GEO band, is a significant disruption or harm to natural resources.[251] These claims may be difficult to adjudicate, as the United Nations Compensation Commission's

[244] *See generally* K. Sakuraba et al., *Investigation and Comparison Between New Satellite Impact Test Results and NASA Standard Breakup Model*, 35 INT'L J. IMPACT ENGINEERING 1567 (2008).

[245] *See* ENMOD, *supra* note 109, art. I; Additional Protocol I, *supra* note 184, art. 35; Rome Statute, *supra* note 216, art. 8(2)(b)(iv).

[246] *See* KELSO, *supra* note 67, at 329.

[247] *See* COMMENTARY OF 1977, *supra* note 202, at 417.

[248] *Cf. id.* at 417 n.177.

[249] *Id.* at 414.

[250] *Cf.* Sadeh, *supra* note 8, at 47.

[251] *See id.*

(UNCC) experience showed when attempting to arbitrate category claims presented at the conclusion of the first Gulf War.[252] In many instances, the UNCC panel had difficulties determining attribution for the damages alleged, limiting or preventing restitution.[253] Claims resulting from debris collision in outer space would likely face similar challenges simply because of the debris tracking resolution of current technology.[254]

Thus far, ENMOD appears to be a viable regime for preventing the use of kinetic-energy weapons against satellites in orbit, aside from the potential difficulties of attribution when bringing forth a claim. As previously discussed, ENMOD's elements are disjunctive, requiring only one of the conditions to be met when assessing liability.[255] However, ENMOD Article II requires the *deliberate* manipulation of a natural process to satisfy the definitional use of environmental modification technique.[256] The destruction of a satellite in orbit is arguably not a deliberate manipulation of a natural process but the destruction of an artificial object. Therefore, ENMOD likely has limited application to kinetic-energy ASAT weapons because the use of these weapons is not a deliberate modification of the environment.[257] Indeed, this view is espoused as a basic position by China.[258]

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[252] *See* Meredith DuBarry Huston, Comment, *Wartime Environmental Damages: Financing the Cleanup*, 23 U. PA. J. INT'L ECON. L. 899, 911–13 (2002). The U.N. Security Council established the UNCC under Resolution 687 to handle compensation claims "for any direct loss, damage, including environmental damage and the depletion of natural resources, or injury to foreign Governments, nationals, and corporations, as a result of Iraq's unlawful invasion and occupation of Kuwait." *Id.* at 911. F4 claims encompassed several categories of claims, including "(e) Depletion of or damage to natural resources." *Id.* at 912–13.

[253] *Id.* at 913–14.

[254] The collision of *Cosmos 1934* with a fragment of *Cosmos 926* occurred in 1991 but was not recognized as a collision until over a decade later. *See Accidental Collisions of Catalogued Satellites Identified*, *supra* note 165. Space tracking technology has significantly improved in recent decades, but this collision provides an example of potential difficulties with attribution when the objects involved can be as small as 2 centimeters and orbiting at altitudes hundreds or thousands of kilometers above the Earth's surface.

[255] *See* Lawrence & Heller, *supra* note 217, at 72–73.

[256] *See* ENMOD, *supra* note 109, art. II.

[257] Kumar Abhijeet, *Arms Control in Outer Space: ASAT Weapons*, *in* RECENT DEVELOPMENTS IN SPACE LAW, *supra* note 8, at 129, 138. Some examples given of environmental modification techniques envisioned by the Conference include earthquakes, tsunamis, and deliberate changes in weather patterns, so as to cause destruction, damage, or injury to another state party. *See* COMMENTARY OF 1977, *supra* note 202, at 415 n.103.

[258] *See* Existing International Legal Instruments and Prevention of the Weaponization of Outer Space, *supra* note 84. According to the Permanent Mis-

On the other hand, Rome Satute Article 8(2)(b)(iv)'s elements have a conjunctive requirement; the damage to the environment must be "widespread, long-term *and* severe."[259] Kinetic-energy ASAT weapons likely produce widespread and long-term effects under definitions recognized by the ICC through AP I. Arguing that the weapons produce severe damage to the natural environment is less likely to succeed, since AP I recognizes the anthropocentric motivations behind protecting that natural environment's ability to sustain human life.[260] However, under Article 21(1) of the Rome Statute, the ICC shall apply:

(1) "In the first place, this Statute, Elements of Crimes and its Rules of Procedure and Evidence"; and

(2) "In the second place, where appropriate, applicable treaties and the principles and rules of international law, including the established principles of the international law of armed conflict."[261]

Since the *Elements of Crimes* does not expand upon the definitions of "widespread," "long-term," and "severe," one might argue that the accepted definitions under ENMOD *could* be applied in order to meet the threshold necessary for a "severe" attack.

Three issues remain when applying Article 8(2)(b)(iv) to a kinetic-energy ASAT engagement: specific intent, proportionality, and context. The *Elements of Crimes* for Article 8(2)(b)(iv) requires:

> The perpetrator knew that the attack would cause incidental death or injury to civilians or damage to civilian objects or widespread, long-term and severe damage to the natural environment and that such death, injury or damage would be of such an extent as to be clearly excessive in relation to the concrete and direct overall military advantage anticipated.[262]

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sion of the People's Republic of China to the United Nations, "[t]his provision bans only the use of environmental modification techniques in outer space, but other means of strike, damage and injury to other States are not dealt with." *Id.*

[259] *See* Rome Statute, *supra* note 216, art. 8(2)(b)(iv) (emphasis added).

[260] *See* COMMENTARY OF 1977, *supra* note 202, at 414.

[261] Rome Statute, *supra* note 216, art. 21(1)(a)–(b); *see* Mark A. Drumbl, *Waging War Against the World: The Need to Move from War Crimes to Environmental Crimes*, 22 FORDHAM INT'L L.J. 122, 138 (1998).

[262] Int'l Criminal Court [ICC], *Elements of Crimes*, *in* Official Records of the First Session, at 131–32, ICC Doc. No. ICC-ASP/1/3 (2002) [hereinafter *Elements of Crimes*].

This requires specific intent on the part of the perpetrator, and the intent must be to cause widespread, long-term, and severe damage to the natural environment. It is unlikely that, in the context of an ASAT engagement, the intent of the individual ordering the attack is to cause damage to the natural environment in orbit. Rather, it is much more plausible that the attack is specifically directed against a critical component of an adversary's communications, navigation, or targeting infrastructure. Perhaps the detonation of a nuclear device (a crude yet effective ASAT weapon) in orbit with the intention to harness the EMP effect and artificial radiation belts as destructive forces would satisfy this element, but such an attack is governed by a multitude of other regimes.[263]

A proportionality assessment requires that the damage to the natural environment must also be "clearly excessive" compared to the military advantage gained from the attack. Since there has yet to be a case brought forth before the ICC under Article 8(b)(2)(iv), the jurisprudence on what constitutes "clearly excessive" in relation to environmental damage is undeveloped. At present, the perpetrator must have knowledge of the disproportionate effect on the natural environment when evaluated against the perceived military advantage gained.[264] According to the *Elements of Crimes*, this requires a value judgment, and the ICC must only take into account the information available to the individual at the time.[265] The International Military Tribunal at Nuremberg considered the case of General Lothar Rendulic, charged with "wanton destruction of property" for employing scorched earth tactics in Poland to halt the advancing Russian Army.[266] Though the Committee on Facts and Evidence (Commission I) arrived at the conclusion that there was no actual military necessity for employing these tactics, Rendulic was acquitted based on the necessity he perceived based upon the

[263] Detonation of nuclear devices in orbit has been shown to create long-lasting artificial radiation belts, similar to the natural Van Allen belts, which would continue to pose dangers to space assets for years after creation. *See generally* J.L. Barth et al., *Space, Atmospheric, and Terrestrial Radiation Environments*, 50 IEEE TRANSACTIONS ON NUCLEAR SCI. 466, 470–72 (2003).

[264] *See* Newton, *supra* note 193, at 884.

[265] *Elements of Crimes*, supra note 262, at 131–32, 132 n.37.

[266] *See* Bronwyn Leebaw, *Scorched Earth: Environmental War Crimes and International Justice*, 12 PERSP. ON POL. 770, 773 (2014).

information available to him at the time.[267] Therefore, it is unlikely that the decision to employ a kinetic-energy ASAT weapon would satisfy the requirements in the *Elements of Crimes* because a military commander could reasonably believe that the destruction or disruption of an adversary's communications, navigation, or targeting infrastructure will not clearly result in excessive damage to the natural environment from the resulting fragmentation debris.

Finally, it should be noted that Article 8(2)(b)(iv) only applies to situations in which there is both an ongoing international armed conflict and an individual who ordered an attack who was aware of the factual circumstances establishing the existence of an armed conflict.[268] Therefore, Article 8(2)(b)(iv) would not constrain the testing of kinetic-energy ASAT weapons, such as the engagements of *FY-1C* and *Microsat-R*, regardless of any intentional or unintentional damage to the natural environment that results from these tests.

VII. REENGAGING RECIPROCITY: RESTRICTING KINETIC-ENERGY ASAT WEAPONS

Modern warfare relies on space-based assets to leverage full use of the systems that states currently employ. Operation Desert Storm demonstrated how space-based assets are a "force multiplier" for sharing targeting information, establishing communications, and guiding precision munitions.[269] As this shift in warfighting occurred, a shift in strategy to counter space assets has also emerged. U.S. dependence on GPS and communications satellites has made C4ISR systems the new center of gravity—the "hub of all power and movement, on which everything depends."[270]

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267 *See id.* at 774; *see also* Nobuo Hayashi, *Requirements of Military Necessity in International Humanitarian Law and International Criminal Law*, 28 B.U. INT'L L.J. 39, 123 n.334 (2010).

268 *See Elements of Crimes*, *supra* note 262, at 131–32.

269 *See* Lambeth, *supra* note 212, at 6–7.

270 CARL VON CLAUSEWITZ, ON WAR 595–96 (Michael Howard & Peter Paret, eds. & trans., Princeton Univ. Press 1976) (1832). The Department of Defense defines "center of gravity" as "[t]he source of power that provides moral or physical strength, freedom of action, or will to act." U.S. DEP'T OF DEF., JP 1-02, DICTIONARY OF MILITARY AND ASSOCIATED TERMS 29 (2010) (as amended through Feb. 15, 2016).

In the event that armed conflict breaks out between two or more states that possess contemporary, advanced militaries,[271] the existing legal regimes governing outer space activity will not prevent kinetic-energy engagements against space-based assets. Further, state practice continues to demonstrate an ambivalence towards operational testing of such weapons through a lack of enforcement of OST Article IX provisions for international consultations. While the current status of creating restrictions on kinetic-energy ASAT weapons appears to be at an impasse, it is in the international community's best interest to find an agreeable framework on restricting such weapons because of the debris they produce.[272]

Since the proposed PPWT has failed to gain traction because of U.S. objections to controls on ground-based ASAT weapons,[273] it is time to rethink the underlying framework and work toward a new regime that acknowledges both American and Russian desires for BMD systems and the dangers posed by the proliferation of space debris produced by intentional breakups.[274] When there exists a desire to rapidly create new international norms, expectations of reciprocity can serve as the rationale for the emergence of new customary international law.[275]

History has shown that international agreements founded upon reciprocity are effective at regulating the means and methods states use to conduct warfare.[276] Reciprocity is especially suc-

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271 In this context, the author defines an advanced military as one that leverages space-based assets for conducting warfighting functions (C4ISR, targeting, etc.).

272 *See generally, e.g.*, U.S. Letter on the Draft PPWT, *supra* note 125.

273 *See id.* at 7.

274 It is highly unlikely that any state with the capability will agree to dismantle their existing BMD systems in furtherance of an ASAT-restriction regime. Because of the near impossibility of distinguishing kinetic energy ASAT interceptors from BMD interceptors, any proposed framework will need to consciously address this fact and contain provisions that allow for interceptors in BMD mode while prohibiting kinetic engagements of space-based systems.

275 *See* Bruno Simma, *Reciprocity*, MAX PLANCK ENCYCLOPEDIA OF PUBLIC INTERNATIONAL LAW ¶ 3 (2008) (citing President Truman's continental shelf declaration as an example of a rapid recognition of a new international norm through state reciprocity).

276 *See* Eric A. Posner, *Human Rights, the Laws of War, and Reciprocity*, 6 L. & ETHICS HUM. RTS. 148, 150 (2012) (arguing that "reciprocity remains the logic of the laws of war."). *See generally* Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, June 17, 1925, 26 U.S.T. 571, 94 L.N.T.S. 65; 1868 St. Petersburg Declaration Renouncing the Use, in Time of War, of Explosive Projectiles Under 400

cessful in areas with comparatively limited institutionalized norms, such as *corpus juris spatialis*.[277] For reciprocity to be successful, both parties must receive mutual benefit from the proposed limitations placed on their sovereign freedom of action.[278] In this specific context, the mutual benefits received would be the continued access to orbits without a substantially increased fear of damage from rogue debris and the increased survivability of the C4ISR assets that enable warfighting.

The creation of a new reciprocity agreement would also address the problems identified in the previously considered regimes. Restricting engagements against space assets to EM, cyber, or directed-energy methods would significantly reduce the debris created compared to kinetic-energy attacks. The ensuing reduction in debris could potentially negate the issue of transboundary harms resulting from kinetic breakups and similarly reduce the problem of attribution for pieces of debris too small to persistently track with current surveillance networks. Further, as a binding international treaty, a proposed reciprocity agreement would preempt any assessment of the LOAC principles currently relied upon by military commanders to justify kinetic-energy engagements. Finally, it would significantly curb future pollution of the natural environment by removing any requirements of causing harm to human populations or intending to modify the environment in order to assess liability.

The United States should consider entering into bilateral negotiations with either China or the Russian Federation to de-

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Grammes Weight, Dec. 11, 1868, 18 Matens Nouveau Recueil (ser. 1) 474, *reprinted in* DOCUMENTS ON THE LAWS OF WAR 53 (Adam Roberts & Richard Guelff eds., 3d ed. 2000). The Strategic Arms Limitation Talks (SALT) I and II were bilateral agreements between the United States and the U.S.S.R. that reduced the operational number of nuclear weapons employed by both sides under a reciprocity framework. *See* Interim Agreement Between the United States of America and the Union of Soviet Socialist Republics on Certain Measures with Respect to the Limitation of Strategic Offensive Arms, U.S.–U.S.S.R., May 26, 1972, 23 U.S.T. 3462; Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Strategic Offensive Arms, U.S.–U.S.S.R., June 18, 1979, S. TREATY DOC. NO. 96-25 (not presented to the Senate for ratification following the Soviet invasion of Afghanistan; however, both states agreed to abide by the terms if reciprocated by the other). *But see* Treaty Between the United States and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles, U.S.–U.S.S.R., Dec. 8, 1987, 1657 U.N.T.S. 2; Anti-Ballistic Missile Treaty, *supra* note 73. While these treaties were in force for multiple decades, the United States has withdrawn from both, citing a lack of Russian compliance with the terms.

277 *See* Simma, *supra* note 275, ¶ 1.

278 *Id.* at ¶ 4; *see also* Posner, *supra* note 276, at 153.

velop a workable international framework that acknowledges the dangers of kinetic-energy interceptors while promoting transparency and confidence-building measures (TCBMs) that assist in distinguishing BMD systems from ASAT weapons.[279] Russia and China's previous attempts to create an ASAT control regime with the PPWT through PAROS facially indicate that both countries are willing to negotiate restrictions on ASAT testing and use. A retreat by either from engaging in further discussions or a refusal to become a party to an agreement based upon bilateral negotiations with the United States would expose previous proposals as insincere attempts to restrict U.S. ASAT capabilities as Russia and China continue to develop their own.

A concern with reciprocity agreements is that they create a system of "haves" and "have nots," similar to that of the nuclear weapon nonproliferation regimes. However, a moratorium on kinetic-energy ASAT testing and use does not inherently impede states from attacking or degrading an adversary's C4ISR network. Directed-energy weapons would continue to provide soft- and hard-kill options to space assets but without exacerbating the debris problem.[280] EM jamming and scrambling can be employed to temporarily disable communication between a satellite and the ground link—a strategy Russia and China are developing and integrating into their core warfighting functions.[281] Finally, satellites and their ground-link control stations rely on computer network connectivity to function, and they operate on hardware and software with similar vulnerabilities that continue to be exploited by cyberattacks.[282]

Of the four countries that have demonstrated a kinetic-kill capability against an orbiting object, the United States, China, and Russia are known to be developing or refining directed-energy

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[279] Reciprocity-based arms control treaties can generally be treated as a prisoner's dilemma problem, with additional requirement of monitoring compliance. *See* Francesco Parisi & Nita Ghei, *The Role of Reciprocity in International Law*, 36 CORNELL INT'L L.J. 93, 104 (2003). Without the addition of TCBMs, states will likely be unable to distinguish BMD systems from ASAT interceptors.

[280] Kaplow, *supra* note 91, at 1202.

[281] *See* ROGER N. MCDERMOTT, RUSSIA'S ELECTRONIC WARFARE CAPABILITIES TO 2025, at 17, (2017); TATE NURKIN, CHINA'S ADVANCED WEAPONS SYSTEMS 51–52 (2018).

[282] *See* Jan Kallberg, *Designer Satellite Collisions from Covert Cyber War*, 6 STRATEGIC STUD. Q. 124, 130 (2012). Satellites and their control systems may be especially vulnerable, since their hardware is generally unable to undergo upgrade after they are launched into space. *Id.* Some satellites still rely on ageing supervisory control and data acquisition (SCADA) systems that have been exploited by cyberattacks, such as Stuxnet. *See id.*

weapons and EM-jamming systems capable of affecting C4ISR networks. The current technological high-water mark for ASAT systems is directed-energy weapons, such as the U.S. Army's Mid-Infrared Advanced Chemical Laser (MIRACL).[283] On October 17, 1997, the U.S. Army "illuminated" an orbiting Air Force satellite, only temporarily blinding it, but demonstrating that a ground-based laser was capable of tracking and producing effects on an orbiting object.[284] The MIRACL system could also be used to perform a hard kill on spacecraft, focusing the directed-energy beam and transferring enough energy to the craft to physically destroy some or all of its components.[285] In 2006, China demonstrated a similar capability by blinding a U.S. satellite with a ground-based laser.[286] Further, Russia appears to be developing both ground- and air-based laser systems, with a primary focus on ASAT missions.[287]

Additional methods recognized to negate satellites in orbit include attacking the ground-control station, jamming the communications and control EM spectrum, and conducting cyberattacks directed either at the control station or the satellite's onboard equipment. Both Russia and China are developing advanced jamming technologies aiming at disrupting communications between satellites and ground forces, and it is likely that other states will pursue similar technologies in an at-

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[283] *U.S. Test-Fires 'MIRACL' at Satellite Reigniting ASAT Weapons Debate*, ARMS CONTROL ASS'N, https://www.armscontrol.org/act/1997_10/miracloct [https://perma.cc/L6UP-BQND] (last visited Apr. 1, 2020).

[284] *See id.* Illuminating a target means aiming a directed-energy weapon at an object, generally with minimal power and without the intention of physically altering the object. *See id.*

[285] *See* Maj. Thomas A. Summers, How Is U.S. Space Power Jeopardized by an Adversary's Exploitation, Technological Developments, Employment and Engagement of Laser Antisatellite Weapons? 30 (unpublished research paper, Air Command & Staff College, Apr. 2000), https://pdfs.semanticscholar.org/7a79/9cc933063ea408645a5e2c1ea07aa93cee39.pdf [https://perma.cc/UMT2-XAD3]. Ground-based directed-energy weapons are generally significantly limited in their field of view relative to objects in LEO. *See id.* at 14. This problem can be overcome by making the weapons system airborne (e.g., Airborne Laser Laboratory) or by installing the weapon in space. *Id.* at 16, 41. For a thorough explanation of laser systems applications to ASAT, see generally Summers, *supra.*

[286] *See* Milowicki & Johnson-Freese, *supra* note 68, at 4.

[287] *See* U.S. DEF. INTELLIGENCE AGENCY, CHALLENGES TO SECURITY IN SPACE 28–29 (2019), https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Space_Threat_V14_020119_sm.pdf [https://perma.cc/RB43-JBYW]; O'Connor, *supra* note 33, at 2.

tempt to counter states that rely heavily on space-based assets.[288] Cyber vulnerabilities have been exploited by state and non-state actors, and it is likely that states who do not currently possess kinetic-kill capability can still target space assets through cyberspace.[289] Cyberattacks are capable of causing material damage to physical hardware,[290] and they can more readily be employed by states that do not possess space launch capability.[291] A proposed framework banning kinetic-energy engagements should not dissuade states from refining these technologies, since the objective purpose is to reduce the proliferation of artificial debris in orbit. A framework that does not leave states viable options for negating an adversary's C4ISR network will likely result in states simply disregarding the ban when faced with active hostilities.

VIII. CONCLUSION

In the fifty-two years since the Outer Space Treaty established the framework for state activity and responsibility for activities conducted in outer space, over 22,000 pieces of trackable debris have been created in LEO alone. The international community has failed to enforce obligations under Article IX of the Outer Space Treaty, and the United States missed an opportunity to reinforce these key provisions during the *USA-193* engagement. The Liability Convention expanded upon state liability for damage caused by activities in outer space, yet the Convention has been unable to curb the creation of debris from intentional breakups. Accepted restrictions on the means and methods of warfare, including prohibitions on environmental modification and attacks that result in widespread, long-term, and severe damage to the environment—arguably a by-product of kinetic satellite kills—have had little impact on the testing and use of kinetic-energy anti-satellite weapons. Reciprocal agreements prohibiting testing and first use are a potential solution for reducing the proliferation of debris in orbit—especially in geostationary orbits where debris remains indefinitely. Finally, as more nations demonstrate the ability to intercept space objects using

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[288] *See* CHALLENGES TO SECURITY IN SPACE, *supra* note 287, at 33; O'Connor, *supra* note 33.

[289] *See* CHALLENGES TO SECURITY IN SPACE, *supra* note 287, at 33.

[290] The Stuxnet malware is an example of a cyberattack that caused physical damage to Iranian centrifuges at the Natanz nuclear facilities. *See* Thomas M. Chen, *Stuxnet, the Real Start of Cyber Warfare?*, IEEE NETWORK, Nov.–Dec. 2010, at 2, 3.

[291] *See* CHALLENGES TO SECURITY IN SPACE, *supra* note 287, at 20, 28, 33.

kinetic-energy weapons, the United States cannot allow near-peer competitors to establish customary international law norms that tolerate intentional breakups in orbit.