THE ANTI-SATELLITE THREAT—AND HOW STATES CAN RESPOND

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On February 5, 2022, Russia launched Cosmos 2553 into orbit. On December 5, 2024, the world learned that the satellite carried a dummy nuclear warhead, designed to test components for a nuclear-armed anti-satellite (ASAT) weapon. That satellite, if detonated in space, would have the potential to destroy the infrastructure on which much of modern life depends. Although the prospect of a nuclear-armed anti-satellite weapon is new, the threat to satellites is not. As satellite technologies have proliferated to facilitate civilian and military operations around the globe, so too have ASAT weapons. China, Russia, India, and the United States have all tested ASAT weapons, which can create millions of pieces of space debris in a realm where anything larger than one centimeter may damage spacecraft.

These new threats raise pressing questions that legal scholarship is only beginning to answer: Does the deployment of some or all ASAT weaponry violate international law? What lawful responses are available to states facing such threats? Do threats from weapons positioned in space meaningfully differ from those posed by ground-based systems? At what point may states lawfully invoke the right of self-defense and use force to counter these threats? This Essay aims to fill this gap. It begins by describing the novel threats posed by the rise of ASAT weaponry and outlining the legal framework governing spacefaring and hostilities. It then presents a framework to determine the lawful measures states can take to respond to ASAT threats and examines the threshold at which states may lawfully invoke their right of self-defense. The Essay urges caution in responding to novel ASAT technology, arguing that overreacting to space-based threats might trigger the very global catastrophe that states hope to avoid.

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INTRODUCTION

On February 5, 2022, Russia launched Cosmos 2553 into orbit. U.S. officials later warned that the satellite was designed to test components for a nuclear-armed anti-satellite (ASAT) weapon. That satellite, if deployed and detonated in space, would have the potential to destroy thousands of satellites, and, with it, the infrastructure on which much of modern life depends.[1] Two years after the launch, the Biden Administration publicly disclosed these concerns, warning that the weapon could destroy not only civilian communications but also U.S. and allied military command-and-control systems and surveillance capabilities.[2] The threat posed by the space-based nuclear weapon is, as then-Assistant Secretary of Defense for Space Policy John Plumb warned, "a thing apart."[3]

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[1] W.J. Hennigan, Opinion, *The Warning*, N.Y. TIMES (Dec. 5, 2024), https://www.nytimes.com/interactive/2024/12/05/opinion/nuclear-weapons-space.html [https://perma.cc/RMR8-W7RN]; *see also* Christopher J. Borgen, *Russia's Alleged Nuclear Anti-Satellite Weapon: International Law and Political Rhetoric*, LIEBER INST.: ARTICLES OF WAR (July 31, 2024), https://lieber.westpoint.edu/russias-nuclear-anti-satellite-weapon-international-law [https://perma.cc/A565-D99D].

[2] Julian E. Barnes, Karoun Demirjian, Eric Schmitt & David E. Sanger, *Russia's Advances on Space-Based Nuclear Weapon Draw U.S. Concerns*, N.Y. TIMES (Feb. 14, 2024), https://www.nytimes.com/2024/02/14/us/politics/intelligence-russia-nuclear.html [https://perma.cc/6V4K-KF37]; Clementine G. Starling-Daniels & Mark J. Massa, *Russian Nuclear Anti-Satellite Weapons Would Require a Firm US Response, Not Hysteria*, ATL. COUNCIL: NEW ATLANTICIST (Feb. 15, 2024), https://www.atlanticcouncil.org/blogs/new-atlanticist/russian-nuclear-anti-satellite-weapons-would-require-a-firm-us-response-not-hysteria [https://perma.cc/3V7Z-7H8T].

[3] Sandra Erwin, *Defense Space Policy Chief Calls Russia's Space Nuke Threat "A Thing Apart,"* SPACENEWS (May 10, 2024), https://spacenews.com/defense-space-policy-chief-calls-

Although the prospect of Sput-nuke—as some have called it[4]—is new, the threat to satellites is not. As satellite technologies have proliferated to facilitate civilian and military operations around the globe, so too have ASAT weapons.[5] China recently simulated a space operation targeting the private satellite company Starlink, finding that it could "effectively approach nearly 1,400 Starlink satellites within 12 hours using just 99 Chinese satellites" equipped with lasers, microwaves, and other instruments.[6] The Chinese satellites could perform reconnaissance, tracking, or other operations against the Starlink system.[7] China is not alone. Both Russia and the United States have tested satellites with similar capabilities.[8]

It does not take a nuclear explosion in space to critically disrupt satellite systems. The use of even one ASAT weapon in a kinetic attack can create millions of pieces of space debris.[9] In a realm where anything larger than one centimeter can damage or destroy other space objects, millions of pieces of debris scattered in orbit can have catastrophic consequences in the aftermath of an attack.[10] The trajectory that ASAT weapons follow can further increase and prolong the risk. When a projectile pushes debris further out into orbit, it can take decades for the debris to burn up in the atmosphere, cluttering space and impeding spacefaring.[11]

The threat of a nuclear explosion multiplies the risk many times over.

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russias-space-nuke-threat-a-thing-apart [https://perma.cc/XD9G-HNJJ].

4 Hennigan, *supra* note 1.

5 *See* David A. Koplow, *ASAT-isfaction: Customary International Law and the Regulation of Anti-Satellite Weapons*, 30 MICH. J. INT'L L. 1187, 1200–01 (2009) (arguing that the leading spacefaring countries began pursuing ASAT weapons immediately following their investment in satellites).

6 Stephen Chen, *Chinese Scientists Simulate 'Hunting' Starlink Satellites in Orbit*, S. CHINA MORNING POST (Jan. 12, 2025), https://www.scmp.com/news/china/science/article/3294047/chinese-scientists-simulate-hunting-starlink-satellites-orbit [https://perma.cc/E6CK-HCL3].

7 *Id.*

8 Hennigan, *supra* note 1.

9 When China tested an ASAT weapon in 2007, the test created more than two million pieces of debris, of which 150,000 were one to ten centimeters in diameter, and 2,500 were larger than ten centimeters. David Wright, *Fact Sheet: Space Debris from Anti-Satellite Weapons*, UNION OF CONCERNED SCIENTISTS 1 (Apr. 2008), https://www.ucsusa.org/sites/default/files/2019-09/debris-in-brief-factsheet.pdf [https://perma.cc/4BFE-SWTD].

10 *Id.* at 2. Any debris larger than one centimeter can damage or destroy a satellite because in orbit, these pieces are traveling at 17,000 miles per hour, or 30 times the speed of a commercial airplane. For further discussion of ASAT weapons and the threat posed by space debris, see Koplow, *supra* note 5, at 1202–08; Olivia Farrar, *This Astronomer is Sounding a Warning on 'Space Junk,'* HARV. MAG. (June 26, 2025), https://www.harvardmagazine.com/2025/06/harvard-smithsonian-jonathan-mcdowell-space-junk [https://perma.cc/DP5Y-ZUQR]; Vicky Stein, *Hazardous Space Junk is Piling Up. Can This Satellite Help?*, PBS (Oct. 25, 2018), https://www.pbs.org/newshour/science/hazardous-space-junk-is-piling-up-can-this-satellite-help [https://perma.cc/3MYV-NQBY].

11 *See* Wright, *supra* note 9, at 1 ("Since debris at high altitudes can stay in orbit for decades or longer, it accumulates as more is produced.").

When the United States conducted a test of the effect of nuclear weapons in space in 1962, known as Starfish Prime, it destroyed nine of the twenty-five satellites then in orbit.[12] If a modern nuclear weapon exploded in space today, the debris and shell of radiation would last for weeks, if not years, likely destroying or disabling most low Earth orbit satellites and rendering low Earth orbit—which houses the International Space Station, the Hubble telescope, and four thousand Starlink satellites[13]—unusable for an unknown period of time.[14]

These new threats raise pressing questions that international law has yet to clearly answer: Does the deployment of some or all ASAT weaponry violate international law? What lawful responses are available to states facing such threats? In the eyes of the law, do threats from weapons positioned in space meaningfully differ from those posed by ground-based systems? At what point may states lawfully invoke the right of self-defense and use force to counter these threats? This Essay seeks to answer these questions.

These questions have thus far received little attention in legal scholarship, in part because the most significant threats are so new. The robust international law literature on self-defense[15] has largely ignored ASAT weapons, and legal scholarship addressing the threat posed by nuclear-armed ASAT weapons is only beginning to emerge. Likewise, the literature on nuclear weapons is underdeveloped as to the unique threats posed by satellites armed with nuclear warheads and lawful responses to those threats.[16] Though a scholarly effort to elaborate on the international

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12 Ajey Lele, *Remembering Starfish Prime*, SPACE REV. (July 8, 2024), https://www.thespacereview.com/article/4822/1 [https://perma.cc/7KWJ-YPCA].

13 Lisa Sodders, *LEO, MEO or GEO? Diversifying Orbits Is Not a One-Size-Fits-All Mission (Part 1 of 3)*, SPACE OPERATIONS COMMAND (July 18, 2023), https://www.spoc.spaceforce.mil/News/Article-Display/Article/3462529/leo-meo-or-geo-diversifying-orbits-is-not-a-one-size-fits-all-mission-part-1-of [https://perma.cc/T9W5-25X6].

14 Hennigan, *supra* note 1.

15 *See, e.g.*, TOM RUYS, 'ARMED ATTACK' AND ARTICLE 51 OF THE UN CHARTER: EVOLUTIONS IN CUSTOMARY LAW AND PRACTICE (2010); D.W. BOWETT, SELF-DEFENSE IN INTERNATIONAL LAW (Lawbook Exch., Ltd. 2009) (1958); Chris O'Meara, *Reconceptualising the Right of Self-Defence Against 'Imminent' Armed Attacks*, 9 J. ON USE FORCE & INT'L L. 278 (2022). Much of the literature on self-defense in the last two decades has focused on the right of self-defense against non-State actor groups. *See, e.g.*, Daniel Bethlehem, *Principles Relevant to the Scope of a State's Right of Self-Defense Against an Imminent or Actual Armed Attack by Nonstate Actors*, 106 AM. J. INT'L L. 1, 6–8 (2012) (outlining proposed principles to govern States' exercise of their right of self-defense against non-State actors); Monica Hakimi, *Defensive Force Against Non-State Actors: The State of Play*, 91 INT'L L. STUD. 1, 4–8 (2015) (explaining plausible positions States could take on the use of defensive force against non-State actors in operations in Syria).

16 The discussion thus far is either decades old or in the form of short online blog posts. *See, e.g.*, Charlie JP Bennett, *Nuclear Space-Based ASAT Weapons – A Brief International Legal Perspective*, EJIL: TALK! (Feb. 27, 2024), https://www.ejiltalk.org/nuclear-space-based-asat-weapons-a-brief-international-legal-perspective [https://perma.cc/Z8BZ-WH34] (setting forth a

law of military space activities and operations dubbed the "Woomera Manual" considers how the law of self-defense applies in space, it only discusses anti-satellite weapons in passing; it includes no discussion of nuclear-armed ASAT weapons.[17] The most significant treatments of ASAT weapons in legal scholarship to date do not consider the full scope of legal issues raised here,[18] in particular when states may use force in self-defense against ASAT weapons, including those armed with nuclear warheads.[19]

This Essay proceeds in three parts: Part I outlines the rise of ASAT weapons and the new threat of nuclear-armed ASAT weapons. Part II summarizes the key sources of international law that govern these developments. Part III considers what responses states may undertake to respond to the proliferation of ASAT weapons. It shows how states might lawfully respond to various threat scenarios. In the process, the Essay grapples with identifying the threshold at which states may lawfully invoke the right to self-defense. The Essay concludes by considering the limits of existing law to deal with unprecedented threats.

I
THE RISE OF ANTI-SATELLITE WEAPONS

On February 26, 2022, two days after the launch of Russia's full-scale

short overview of the emerging threat of space-based nuclear weapons); Brian D. Green, *Countering Space-Based Weapons of Mass Destruction*, LIEBER INST.: ARTICLES OF WAR (Jan. 31, 2025), https://lieber.westpoint.edu/countering-space-based-weapons-mass-destruction-2 [https://perma.cc/247K-5X2U] (providing a summary analysis of legal responses to space-based nuclear weapons); James M. Acton, Commentary, *Space Nukes Are Bad*, CARNEGIE ENDOWMENT FOR INT'L PEACE (Oct. 8, 2024), https://carnegieendowment.org/posts/2024/10/russia-space-nukes-bad?lang=en [https://perma.cc/E4SH-6Z4E] (describing a hypothetical race between Russia to detonate a nuclear-armed satellite and the United States to destroy it); THE ARMS RACE IN THE ERA OF STAR WARS (David Carlton & Carlo Schaerf eds., 1988) (addressing a range of arms control issues as they relate to space).

17 THE WOOMERA MANUAL ON THE INTERNATIONAL LAW OF MILITARY SPACE ACTIVITIES & OPERATIONS 229–30, 302–04 (Jack Beard & Dale Stephens eds., 2024) [hereinafter WOOMERA MANUAL]. The less detailed *McGill Manual* also includes no discussion of ASAT weapons. [1 RULES] MCGILL MANUAL ON INTERNATIONAL LAW APPLICABLE TO MILITARY USES OF OUTER SPACE (Ram S. Jakhu & Steven Freeland eds., 2022), https://www.mcgill.ca/iasl/files/iasl/mcgill_manual_volume_i_-_rules.pdf [https://perma.cc/LG2H-LC8H].

18 *See* Koplow, *supra* note 5 (considering the law governing ASAT weapons but not discussing the application of the UN Charter, the right of self-defense, countermeasures doctrine, or the norm of non-intervention to such weapons, whether conventional or nuclear-armed); Chris O'Meara, *Self-Defence in Outer Space: Anti-Satellite Weapons and the* Jus Ad Bellum, LEIDEN J. INT'L L. (2025) (theorizing how ASAT weapons may be used in compliance with jus ad bellum but not attempting to identify the threshold for imminence in the context of ASAT weapons).

19 This Essay focuses on the jus ad bellum. *See generally* O'Meara, *supra* note 18, at 3 (explaining that the "jus ad bellum" refers to the concept "which governs when states may lawfully use force in their international relations"). Any resort to armed force between states would also be governed by international humanitarian law.

invasion of Ukraine, the Ukrainian Minister of Digital Transformation pleaded with Elon Musk over Twitter for access to Starlink: "@elonmusk, while you try to colonize Mars—Russia try to occupy Ukraine! While your rockets successfully land from space—Russian rockets attack Ukrainian civil people! We ask you to provide Ukraine with Starlink stations . . . ."[20]

Within hours, Musk activated Starlink service over Ukraine and began preparing terminals for delivery to the country.[21] Starlink satellites soon became critical to Ukraine's defense, and by May 2022, over 150,000 Ukrainians used the network daily for a range of military, government, and civilian communications.[22] Since then, Ukrainian forces have harnessed Starlink to coordinate drone strikes and gather intelligence using remotely piloted aerial vehicles.[23] The satellite technology now forms "the blood" of the country's communication capabilities.[24]

Ukraine is far from alone in its dependence on satellite technology. Today, over ten thousand active satellites orbit the Earth.[25] These satellites

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[20] Mykhailo Fedorov (@FedorovMykhailo), X (Feb. 26, 2022, 7:06 AM), https://x.com/FedorovMykhailo/status/1497543633293266944?s=20 [https://perma.cc/WA9S-QXY8]. Two days prior, Russia had carried out a cyber-attack that knocked out Ukraine's commercial satellite communications network, leaving thousands of civilians without internet and catastrophically disrupting Ukraine's battlefield command and control in the critical first few hours of the invasion. Wes J. Bryant, *When a CEO Plays President: Musk, Starlink, and the War in Ukraine*, IRREGULAR WARFARE INITIATIVE (Oct. 17, 2023), https://irregularwarfare.org/articles/when-a-ceo-plays-president-musk-starlink-and-the-war-in-ukraine [https://perma.cc/6RNS-V8QQ].

[21] Bryant, *supra* note 20.

[22] Amritha Jayanti, *Starlink and the Russia-Ukraine War: A Case of Commercial Technology and Public Purpose?*, HARV. KENNEDY SCH., BELFER CTR. FOR SCI. & INT'L AFFS. (Mar. 9, 2023), https://www.belfercenter.org/publication/starlink-and-russia-ukraine-war-case-commercial-technology-and-public-purpose [https://perma.cc/HR7Z-HAH2]. Starlink is rolling out direct-to-cell connectivity with Ukraine's leading cellphone operator. Reuters, *Ukraine's Kyivstar, Starlink to Roll Out Direct-to-Cell Services*, DAILY SABAH (Dec. 30, 2024), https://www.dailysabah.com/business/tech/ukraines-kyivstar-starlink-to-roll-out-direct-to-cell-services [https://perma.cc/NF2N-X66R].

[23] Jayanti, *supra* note 22.

[24] In a July 2023 interview with the *New York Times*, Ukrainian Minister Fedorov stressed the importance of Starlink for Ukrainian operations, stating that "Starlink is indeed the blood of our entire communication infrastructure now." Adam Satariano, Scott Reinhard, Cade Metz, Sheera Frenkel & Malika Khurana, *Elon Musk's Unmatched Power in the Stars*, N.Y. TIMES (July 28, 2023), https://www.nytimes.com/interactive/2023/07/28/business/starlink.html [https://perma.cc/3MBA-X8R9]; *see also* RON GURANTZ, SATELLITES IN THE RUSSIA-UKRAINE WAR 7 (2024), https://press.armywarcollege.edu/cgi/viewcontent.cgi?article=1967&context=monographs [https://perma.cc/82PE-G9VL]; Alex Horton & Serhii Korolchuk, *Whatever the Fuss over Elon Musk, Starlink Is Utterly Essential in Ukraine*, WASH. POST (Sept. 18, 2023), https://www.washingtonpost.com/world/2023/09/08/elon-musk-starlink-ukraine-war [https://perma.cc/7Z2A-SZEZ] (explaining how Ukrainian troops rely on Starlink for most tasks requiring digital communication).

[25] *See Space Debris by the Numbers*, EUR. SPACE AGENCY (May 5, 2025), https://www.esa.int/Space_Safety/Space_Debris/Space_debris_by_the_numbers

serve a range of civil and military uses: Energy networks rely on satellites to organize power grids; trains, aircraft, and cars use satellites for navigation; television and radio broadcasting rely on communication satellites; weather and storm forecasting depend on satellite imagery and atmospheric measurements; and militaries around the world rely on satellites for communications, surveillance, and intelligence gathering.[26]

The militarization of space has grown in tandem with the rising civilian dependence on satellites. The United States, Russia, and China have developed a variety of space capabilities ranging from technologies to jam or blind satellites, to those capable of shooting satellites down, to probes equipped with robotic arms to rip satellites from their predetermined orbits.[27] The U.S. Space Force emerged in 2019 primarily in response to the development of increasingly destructive ASAT weaponry by adversarial states.[28] This Part discusses the emergence of six types of anti-satellite weapons systems and the recent expansion of competition in space to launch nuclear-armed weapons—a development that places the entire array of satellites, and all that depends on them, at risk.

A. Six Types of Anti-Satellite Weapons

ASAT weapons function to destroy or incapacitate satellites in orbit. Space weapons can be classified by the domains in which they originate and act (Earth-to-space, space-to-space, and space-to-Earth) as well as whether they act through physical force (kinetic) or not (non-kinetic). Table 1 summarizes this typology, along with examples of ASAT weapons of each type.[29] In this Section, we explain how states have demonstrated capabilities

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[https://perma.cc/8FCY-2EU8] (recording 11,700 functioning satellites in space); *see also* Laurence Tognetti, *Watch a Real-Time Map of Starlink Satellites Orbiting Earth*, PHYS.ORG (Mar. 27, 2024), https://phys.org/news/2024-03-real-starlink-satellites-orbiting-earth.html [https://perma.cc/C8A8-XLH7] (providing an interactive map of Starlink satellites).

26 *See* ClearSpace, *Satellites – The Power Behind Our Modern World*, UK SPACE AGENCY BLOG (Nov. 30, 2023), https://space.blog.gov.uk/2023/11/30/satellites-the-power-behind-our-modern-world [https://perma.cc/GWF7-RNUQ] (explaining how almost every industry and business worldwide relies on satellites); *Satellites*, NAT'L WEATHER SERV., https://www.weather.gov/about/satellites [https://perma.cc/7LQC-CHQB].

27 Ellen Knickmeyer, Matthew Lee, Kevin Freking & Zeke Miller, *Russian Efforts to Create Anti-Satellite Weapons Are Cause for US Concern*, AP NEWS (Feb. 15, 2024), https://apnews.com/article/congress-national-security-6a4497fc2d74ebbe2ab3483ba43e09b3 [https://perma.cc/CX4W-YNN9].

28 *Id.*

29 This typology is based on earlier classifications of space weapons, but, unlike earlier work, it focuses on ASAT weapons. *Cf.* Rachel S. Cohen, *What's a Space Weapon? The Answer Can Be Complicated.*, AIR & SPACE FORCES MAG. (May 28, 2020), https://www.airandspaceforces.com/whats-a-space-weapon-the-answer-can-be-complicated [https://perma.cc/4JVZ-6VWV]; Aaron Mehta, *What Is a Space Weapon, and Who Has Them?*, C4ISRNET (May 27, 2020), https://www.c4isrnet.com/battlefield-tech/space/2020/05/27/defining-what-a-space-weapon-is-and-who-has-them

across several of these categories through public instances of testing, deployment, or use.[30]

TABLE 1. TYPES OF ASAT WEAPONS

	Earth-to-Space	Space-to-Space	Space-to-Earth
Kinetic	Direct-ascent ASAT missiles and drones	Conventional or nuclear-armed ASAT satellites, weapons capable of grappling satellites or missiles	Weapons capable of attacking satellite ground stations from space
Non-Kinetic	Laser dazzlers, uplink jammers, cyber-attacks aimed at satellites	Weapons capable of dazzling, jamming, or cyber-attacks	Downlink jammers and lasers, cyber-attacks on satellite ground stations

1. Earth-to-Space Kinetic ASAT Weapons

These weapons include direct-ascent ASAT missiles and drones, which fire into space to physically collide with and destroy a satellite.[31] The United States, Russia, China, and India are the only countries that have successfully demonstrated direct-ascent ASAT capabilities.[32] The Soviet Union and the United States first developed these kinetic space weapons during the Cold War. In 1959, the United States deployed its *Bold Orion* air-launched ballistic missile to intercept the *Explorer VI* satellite—the first time in history that an "endoatmospherically-launched missile intercepted a target vehicle in space."[33] Both states continued testing destructive space weapons throughout the latter half of the twentieth century, with the tests producing varying levels of orbital debris.[34] In 2008, the United States used a missile defense system to destroy its own malfunctioning satellite.[35]

[https://perma.cc/3HBP-R6P3]; TODD HARRISON, CTR. FOR STRATEGIC & INT'L STUD., INTERNATIONAL PERSPECTIVES ON SPACE WEAPONS 6 (May 2020), https://aerospace.csis.org/wp-content/uploads/2020/05/Harrison_IntlPerspectivesSpaceWeapons-compressed.pdf [https://perma.cc/8BC6-UDM8]; Blake Stilwell, *These Air Force 'Rods from God' Could Hit with the Force of a Nuclear Weapon*, MILITARY.COM: OFF DUTY (Dec. 22, 2020), https://www.military.com/off-duty/2020/12/22/these-air-force-rods-god-could-hit-force-of-nuclear-weapon.html [https://perma.cc/2LP6-N595]; *see also* STEVE MIRMINA & CARYN SCHENEWERK, INTERNATIONAL SPACE LAW AND SPACE LAWS OF THE UNITED STATES 281 (2022).

30 Here, we draw on HARRISON, *supra* note 29, at 6 tbl.1.

31 *Id.*

32 *Id.* at 5–7.

33 J. Terry White, *Bold Orion's ASAT Mission*, WHITE EAGLE AEROSPACE (Oct. 7, 2015), https://www.whiteeagleaerospace.com/bold-orions-asat-mission [https://perma.cc/DE7R-94S6].

34 *See* Wright, *supra* note 9, at 2 ("[T]he United States and Soviet Union developed and tested destructive ASAT weapons during the 1970s and 1980s.").

35 *See* Staff Reporters, *Navy Hits Satellite with Heat-Seeking Missile*, SPACE.COM (Feb. 21, 2008), https://www.space.com/5006-navy-hits-satellite-heat-seeking-missile.html

The Department of Defense (DoD) outlines its approach to defending space systems against adversaries, particularly China and Russia, in its 2023 *Space Policy Review and Strategy on Protection of Satellites*.[36] The strategy document describes how China is "developing, testing, and fielding capabilities intended to target U.S. and allied satellites," including direct-ascent ASAT missiles.[37] It notes that Russia has developed similar capabilities.[38]

2. Earth-to-Space Non-Kinetic ASAT Weapons

Uplink jammers,[39] laser dazzlers and blinders,[40] and cyber-attacks constitute Earth-to-space non-kinetic means of warfare.[41] These space weapons disrupt or degrade satellite functioning without requiring physical contact. Various nations, including Iran, Libya, and Egypt, have faced accusations of using Earth-to-space jamming frequencies to disrupt satellites.[42] China has demonstrated ground-based laser systems that can "dazzle" satellites by flooding their electro-optical sensors.[43] China and Russia are also reported to be developing the capacity to use cyberwarfare tools against satellites.[44]

3. Space-to-Space Kinetic ASAT Weapons

The 2023 *Space Policy Review and Strategy on Protection of Satellites* warns of not only the growing capacity of China and Russia to deploy Earth-to-space kinetic weapons against satellites but also emerging threats posed by space-to-space weapons.[45] A co-orbital ASAT weapon—a satellite placed into orbit to intercept or attack another satellite in orbit—falls within this

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[https://perma.cc/2E7V-FSRD] (explaining the risk posed by the wayward satellite).

36 U.S. DEP'T OF DEF., SPACE POLICY REVIEW AND STRATEGY ON PROTECTION OF SATELLITES 2–3 (2023), https://media.defense.gov/2023/sep/14/2003301146/-1/-1/0/comprehensive-report-for-release.pdf [https://perma.cc/MF5V-BLAL].

37 *Id.*

38 *Id.* at 3.

39 An uplink jammer disrupts satellite communication by creating a signal (or "noise") on a busy frequency so "that the satellite cannot distinguish between the real signal and the noise." *Jamming: Uplink Jamming*, SPARTA, https://sparta.aerospace.org/technique/EX-0016/01 [https://perma.cc/PX4N-4KVD].

40 Laser dazzlers and blinders are lasers aimed at disabling and damaging satellites: "Dazzling causes sensors to temporarily lose their imaging capability by swamping them with light that is brighter than what they are trying to image. Blinding inflicts permanent damage to such systems." Bart Hendrickx, *Kalina: A Russian Ground-Based Laser to Dazzle Imaging Satellites*, SPACE REV. (July 5, 2022), https://www.thespacereview.com/article/4416/1 [https://perma.cc/APX5-FYL8].

41 HARRISON, *supra* note 29, at 6 tbl.1.

42 *Id.* at 7.

43 *Id.*

44 U.S. DEP'T OF DEF., *supra* note 36, at 2–3.

45 *Id.*

category.[46] The satellite may execute an attack in a variety of ways, including striking the targeted satellite directly, detonating a conventional warhead in its vicinity, or releasing a "cloud of pellets" into its path.[47] There is also growing concern about dual-use "rendezvous spacecraft," which can grapple a satellite for servicing but also grapple an adversary's satellite to change its orbit or disable it.[48] China has launched experimental satellites with robotic arms capable of grappling other satellites.[49] The Soviet Union began testing these capabilities during the Cold War, and Russia has continued to do so.[50]

On May 16, 2024, Russia launched the Cosmos 2576 satellite into low Earth orbit.[51] According to General Stephen Whiting, head of U.S. Space Command, the satellite was positioned in the same orbit as a U.S. "national security satellite,"[52] likely USA 314, a classified military imaging satellite.[53] "[T]hat doesn't seem to be accidental," Whiting noted.[54] Pentagon officials identified the Russian satellite as a counterspace weapon believed to be capable of attacking other satellites, thereby posing a direct threat to U.S. space assets.[55] Russia had launched similar satellites in 2019 and 2022.[56] However, Russia has denied U.S. allegations that it has placed attack weapons in near Earth orbit.[57]

4. Space-to-Space Non-Kinetic ASAT Weapons

These weapons, which include jamming frequencies or cyber-attacks from a co-orbital ASAT weapon, have not been observed or recorded in

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46 *See Kinetic Physical Attack: Co-Orbital ASAT*, SPARTA, https://sparta.aerospace.org/technique/EX-0017/02 [https://perma.cc/3ZQK-P9YM] (defining co-orbital ASAT weapon).

47 Bill Boothby, *Space Weapons and the Law*, 93 INT'L L. STUD. 179, 206 (2017).

48 Brian G. Chow & Brandon W. Kelley, Op-Ed, *Peace in the Era of Weaponized Space*, SPACENEWS (July 28, 2021), https://spacenews.com/op-ed-peace-in-the-era-of-weaponized-space [https://perma.cc/YC6U-MVLS].

49 Amir Husain, *China's Fast Growing Military Space Capabilities*, FORBES (Nov. 14, 2024), https://www.forbes.com/sites/amirhusain/2024/11/14/chinas-fast-growing-military-space-capabilities [https://perma.cc/MBX2-RE5N]; Chow & Kelley, *supra* note 48.

50 HARRISON, *supra* note 29, at 6–7.

51 Bill Chappell, *What to Know About the 'Space Weapon' the U.S. Says Russia Recently Launched*, NPR (May 30, 2024), https://www.npr.org/2024/05/30/nx-s1-4975741/what-to-know-russia-satellite-space-weapon-cosmos-2576 [https://perma.cc/7MYG-4M6U].

52 Sandra Erwin, *U.S. Space Command Ready for Potential Russian Satellite Attack, General Says*, SPACENEWS (June 24, 2024), https://spacenews.com/u-s-space-command-ready-for-potential-russian-satellite-attack-general-says [https://perma.cc/HVY8-AYUH].

53 Chappell, *supra* note 51.

54 Erwin, *supra* note 52.

55 Jaroslav Lukiv, *US Says Russia Likely Launched Anti-Satellite Weapon*, BBC (May 21, 2024), https://www.bbc.com/news/articles/cq55ww5j7e2o [https://perma.cc/2Z3U-PUHZ]; Chappell, *supra* note 51.

56 Chappell, *supra* note 51.

57 *Id.*

readily accessible open source materials.[58] However, the non-kinetic nature of these attacks, and the fact that they inflict the same effects through lasers or jammers as Earth-to-space weapons, means that these tests may occur but remain unobservable—or at least indistinguishable from the effects of parallel Earth-to-space capabilities. In addition, Russia, China, and the United States have all deployed inspector satellites, which have a variety of uses intended to monitor other nations' space objects. Inspector satellites can examine another country's satellite, intercept its communications, or try to block its capabilities.[59]

5. Space-to-Earth Kinetic ASAT Weapons

Space-to-Earth kinetic weapons have not yet, to public knowledge, been developed by the United States or other nations.[60] If developed, these weapons would have the potential to inflict catastrophic harm due to their distinct ability to condense the period of time from weapon release to target strike.[61] The tactical advantages of space-based weapons would enable prompt global strikes on surface targets, making them attractive in an escalating space weaponization race.

These weapons could be placed into orbit for an indeterminate amount of time and, upon command, reenter the Earth's atmosphere to physically strike a target on the planet's surface.[62] The space-based armaments could strike and destroy terrestrial targets either by using their own mass or by delivering conventional or nuclear munitions upon reentry.[63] The United States first conceived of such a hypersonic weapon—dubbed "rods from God"—during the Cold War.[64] Dropped from orbit, and reaching a velocity far surpassing the speed of sound, the rods would effectively penetrate deep beneath the Earth's surface to destroy underground bunkers or caches within

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58 HARRISON, *supra* note 29, at 6 tbl.1.

59 Chappell, *supra* note 51.

60 HARRISON, *supra* note 29, at 6 tbl.1.

61 *See* Clayton Swope, *The Future of Military Power Is Space Power*, CTR. FOR STRATEGIC & INT'L STUD., AEROSPACE SEC. PROJECT (Apr. 10, 2025), https://aerospace.csis.org/the-future-of-military-power-is-space-power [https://perma.cc/VN4U-MW8D] (estimating that a space-based weapon could reach Earth within "mere minutes," compared to the "about 30 minutes" it takes for an intercontinental ballistic missile to reach its target).

62 *See* BOB PRESTON, DANA J. JOHNSON, SEAN J.A. EDWARDS, MICHAEL MILLER & CALVIN SHIPBAUGH, SPACE WEAPONS, EARTH WARS, at xviii–xix (2002), https://www.rand.org/content/dam/rand/pubs/monograph_reports/2011/RAND_MR1209.sum.pdf [https://perma.cc/9656-WA2W] (explaining how space-based weapons function when deployed against surface targets).

63 *Id.*

64 Blake Stilwell, *These Air Force 'Rods from God' Could Hit with the Force of a Nuclear Weapon*, MILITARY.COM (Dec. 22, 2020), https://www.military.com/off-duty/2020/12/22/these-air-force-rods-god-could-hit-force-of-nuclear-weapon.html [https://perma.cc/9YNP-6KK4].

15 minutes.[65] While there is no evidence that any country has developed this kind of weapon, Chinese researchers in 2023 studied the level of destruction such a weapon could inflict on a terrestrial target.[66] In theory, these weapons could penetrate deep-Earth targets that even ground-based nuclear weapons would struggle to reach, making them tactically superior for some purposes.[67]

States could use these catastrophic space-to-Earth capabilities to target the ground stations—sometimes called gateways or hubs—that form the backbone of the satellite system. Ground stations are responsible for relaying data from orbiting satellites to internet centers, sending operational and alignment commands to satellites, and managing network traffic.[68] Starlink, the largest global satellite constellation, has approximately 150 of these ground stations globally.[69] Still, no country has yet implemented these space-to-Earth kinetic weapons systems—instead prioritizing development and deployment of other space weapons.

6. Space-to-Earth Non-Kinetic ASAT Weapons

Space-based downlink jammers and lasers fall under this category. Deployed from a satellite in space, these non-kinetic weapons can interfere with radar or satellite ground stations and target satellites during launch.[70] As with its kinetic counterpart, such a space-based weapon would enable attacks on terrestrial targets without warning.

B. A Dangerous New Development: Nuclear-Armed ASAT Weapons

As mentioned at the outset of this Essay, a new development has raised the stakes of the ongoing arms race in space: Russia's launch of a satellite carrying a dummy warhead into space as part of its efforts to develop a nuclear anti-satellite weapon that could destroy "hundreds or even thousands of satellites" if detonated in orbit.[71] Security experts warn: "A nuclear

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65 *Id.*

66 Stephen Chen, *China's Hypersonic Tungsten Rod Experiment Challenges the US 'Rods from God' Space Weapon Concept*, S. CHINA MORNING POST (Aug. 7, 2023), https://www.scmp.com/news/china/science/article/3229990/chinas-hypersonic-tungsten-rod-experiment-challenges-us-rods-god-space-weapon-concept [https://perma.cc/T2PJ-SW3M].

67 Tucker Hamilton, *Space-Based Weapon Perils*, AM. SEC. PROJECT (Apr. 15, 2022), https://www.americansecurityproject.org/space-based-weapon-perils [https://perma.cc/7EQT-J5ZF].

68 *Starlink Ground Station: Backbone of Satellite Internet*, STARLINK INSTALLATION PROS (June 28, 2024), https://starlinkinstallationpros.com/starlink-ground-station-backbone-of-satellite-internet [https://perma.cc/8VXL-NH7P].

69 *Id.*

70 HARRISON, *supra* note 29, at 6 tbl.1.

71 Borgen, *supra* note 1; *see also* Hennigan, *supra* note 1 (explaining that "Cosmos 2553 isn't armed, but it does carry a dummy warhead" and that its purpose is to "test[] components for a

detonation in space would add significant radiation to orbits used by a number of US military satellites, causing them to degrade in the weeks and months following the detonation unless they are specifically hardened against radiation."[72] It would not be localized, like a missile strike, but rather "indiscriminate, affecting all nations."[73] A "high-altitude nuclear detonation against low-Earth orbit satellites (HALEOS) would also damage thousands of civilian satellites from all nations."[74] Russia's development of such a weapon seems inspired by the integral role that Starlink satellites have played in the war in Ukraine.[75] In response, the Pentagon has pledged $14 billion over five years to build new missile-targeting satellites.[76]

Nuclear-armed satellites could also launch nuclear weapons at Earth. If launched from low Earth orbit, a nuclear weapon could reach the ground in far less time than an intercontinental ballistic missile (ICBM), evade radar detection, and strike from unexpected directions.[77] A state could have mere minutes and few options to respond to an attack from a nuclear weapon pre-positioned in space, particularly an attack launched from above that, even if intercepted, could have nuclear fallout on the territory trying to defend itself.

Russian weapon under development that could obliterate hundreds, if not thousands, of critical satellites"); Victoria Samson & Seth Walton, *FAQ: What We Know About Russia's Alleged Nuclear Anti-Satellite Weapon*, SECURE WORLD FOUND. (June 11, 2024), https://www.swfound.org/news/insight-faq-what-we-know-about-russias-alleged-nuclear-anti-satellite-weapon [https://perma.cc/Y9ZB-867M] ("Most commercial satellites in LEO [low Earth orbit] and GEO [geosynchronous Earth orbit] have not been hardened against the radiation that would be released in a nuclear attack. Thus, if there was a nuclear explosion in those orbits, affected satellites in those regions would probably end up being eventually useless.").

72 Starling-Daniels & Massa, *supra* note 2.

73 Hennigan, *supra* note 1.

74 Starling-Daniels & Massa, *supra* note 2 (citing DEF. THREAT REDUCTION AGENCY, HIGH ALTITUDE NUCLEAR DETONATIONS (HAND) AGAINST LOW EARTH ORBIT SATELLITES ("HALEOS") (2001), https://spp.fas.org/military/program/asat/haleos.pdf [https://perma.cc/9P8Y-59AT]).

75 *See supra* notes 21–24 and accompanying text.

76 Hennigan, *supra* note 1; Eric Lipton, *Intelligence About Russia Puts Focus on New U.S. Satellite Push*, N.Y. TIMES (Feb. 15, 2024), https://www.nytimes.com/2024/02/15/us/politics/satellites-russia-us-intelligence.html [https://perma.cc/H53G-C54D].

77 ICBMs have predictable trajectories given their ballistic nature and are vulnerable to missile defense systems. Mark Zastrow, *How Does China's Hypersonic Glide Vehicle Work*, ASTRONOMY (Nov. 4, 2021), https://www.astronomy.com/space-exploration/how-does-chinas-hypersonic-glide-vehicle-work [https://perma.cc/Q4RS-MVQ8]. By contrast, nuclear-armed rockets placed in low Earth orbit, like fractional orbital bombardment systems (FOBS), stay relatively lower than ICBMs, evading traditional missile detection radars. *Id.* For weapons launched into low Earth orbit, such as FOBS, "the time required for payload delivery can be many minutes shorter than for a comparable ICBM payload." Ritwik Gupta, *Orbital Hypersonic Delivery Systems Threaten Strategic Stability*, BULL. ATOMIC SCIENTISTS (June 13, 2023), https://thebulletin.org/2023/06/orbital-hypersonic-delivery-systems-threaten-strategic-stability [https://perma.cc/Q4WZ-LV4U]. Though FOBS are distinct from conventional satellites because they do not complete a full orbit around the Earth, their placement in low Earth orbit and return to Earth is comparable to the back half of an ASAT weapon's trajectory. *Id.*

Though President Putin maintains that Russia is "categorically against . . . the placement of nuclear weapons in space,"[78] Russia vetoed a Security Council resolution reaffirming provisions in the Outer Space Treaty prohibiting the placement of nuclear weapons in space.[79] Because Russia already has the ability to launch nuclear weapons from Earth and to detonate them on Earth or in space, some security experts contend that nuclear-armed ASAT weapons "would not give Moscow significant new military capability" and "would not significantly revise the US-Russia balance of power."[80] That high level assessment appears correct: Whether on Earth or in space, Russia has access to nuclear weapons. However, placing such weapons in space would make them harder to intercept due to less predictable and potentially shorter and faster trajectories.[81]

A nuclear ASAT weapon, if detonated, could have grave consequences. It could destroy satellites used by Ukraine to fight Russia, such as those provided by Starlink. It also could damage the United States' command-and-control system, making war "take longer and cost many more American lives."[82] While a nuclear-armed ballistic missile housed on Earth could be detonated in space to effectuate the same results,[83] the place of origin of a space-based ASAT weapon has significant implications for the weapon's trajectory and states' response options. Moreover, even the prospect of deploying such weapons is escalatory. As James Acton put it,

> The danger of space-based nuclear weapons isn't just that Moscow might actually use them. It's that Washington knows Moscow might actually use them. As a result, the United States might attack Putin's space nukes before he can push the button—which, in turn, might incentivize Putin to jab his finger as fast as he can.[84]

In sum, placing a nuclear-armed ASAT weapon into space would be escalatory and destabilizing. Most alarmingly, it could lead to a race between the United States to disarm such weapons and Russia to deploy and perhaps even use them. However, as the rest of this Essay will show, despite catastrophic hypotheticals that evoke Cold War imagery, it is not clear that such weapons pose threats to U.S. space assets sufficiently distinguishable from the dangers posed by weapons already housed on Earth as to merit

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78 Borgen, *supra* note 1.

79 Shizuka Kuramitsu, *Russia Vetoes UN Resolution on Outer Space Treaty*, ARMS CONTROL ASS'N (May 2024), https://www.armscontrol.org/act/2024-05/news/russia-vetoes-un-resolution-outer-space-treaty [https://perma.cc/2798-4FGD].

80 Starling-Daniels & Massa, *supra* note 2.

81 *See supra* note 77 (describing the speed with which a weapon launched from low Earth orbit could reach the ground).

82 Acton, *supra* note 16.

83 *See id.* ("If detonated, it would wreak 'indiscriminate' destruction on the satellites that orbit closest to the Earth.").

84 *Id.*

distinct treatment under international law.

II
INTERNATIONAL LAW GOVERNING ASAT WEAPONS

International law is not silent on the weaponization of space. Here we review the existing international law governing the militarization of outer space that applies to ASAT weapons. We begin with two treaties specific to outer space: the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (OST)[85] and the 1972 Convention on International Liability for Damage Caused by Space Objects (Liability Convention).[86] We then turn briefly to the Partial Test Ban Treaty, which places limits on testing nuclear weapons in outer space.[87] Lastly, we examine how more broadly applicable international law—in particular, the UN Charter and customary international law governing the use of force—regulates the use of ASAT weapons in space.[88]

A. The Outer Space Treaty and Liability Convention

The OST governs the exploration and use of outer space. Its primary purpose is to guarantee that space is used "for the benefit and in the interests of all countries" and in "the province of all mankind."[89] The treaty requires the use of space to be "in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding."[90] It requires that states use celestial bodies "exclusively for peaceful purposes."[91] The 1967 treaty has 116 States Parties, including the United States, Russia, and China.[92]

Several of the treaty's provisions undergird the conception of outer space as a shared interest. The treaty prescribes that States Parties "shall be

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

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

87 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 [hereinafter PTBT].

88 *Rule 21: Use of Force*, *in* WOOMERA MANUAL, *supra* note 17, at 201.

89 OST, *supra* note 85, art. I, 18 U.S.T. at 2412, 610 U.N.T.S. at 207.

90 *Id.* art. III, 18 U.S.T. at 2413, 610 U.N.T.S. at 208.

91 *Id.* art. IV, 18 U.S.T. at 2414, 610 U.N.T.S. at 208.

92 *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, UNITED NATIONS OFF. FOR DISARMAMENT AFFS.: TREATIES DATABASE, https://treaties.unoda.org/t/outer_space/participants [https://perma.cc/4SUB-NU7B].

guided by the principle of co-operation and mutual assistance and shall conduct all their activities . . . with due regard to the corresponding interests of all other States Parties . . . ."[93] It requires "free access to all areas of celestial bodies" and "freedom of scientific investigation."[94] To that end, the treaty requires States Parties to study and explore space and celestial bodies in a manner "so as to avoid their harmful contamination."[95]

The treaty is clear that outer space is for the mutual benefit of all States Parties and that space should neither be contaminated nor altered in a way that would adversely impact the interests of other states. It proscribes the national appropriation of outer space by any means and expressly prohibits "plac[ing] in orbit . . . any objects carrying nuclear weapons or any other kinds of weapons of mass destruction" or stationing them in outer space in any other manner.[96] Though "in orbit" is not defined, there is a consensus view among states that placing a nuclear weapon into full orbit around Earth is prohibited but temporary transit by ballistic missiles is permissible.[97] However, there is no consensus as to whether transiting weapons through fractional orbits, such as by fractional orbital bombardment systems, contravenes the OST.[98] Further, the treaty prohibits "the testing of any type of weapons and the conduct of military maneuvers on celestial bodies."[99]

In addition to cooperation, the treaty mandates communication between States Parties regarding space activities. It requires States Parties to inform all parties to the treaty, or the United Nations, of any phenomena that pose a danger to the health of astronauts.[100] If a State Party "has reason to believe" that activities planned "would cause potentially harmful interference with activities" of other States Parties "in the peaceful exploration and use of outer space," it must first carry out international consultations.[101] In addition, if a state has reason to believe that another nation's activities may harmfully interfere with the use of outer space, that state may request consultations regarding the activity.[102] The treaty also contains an agreement between states to inform the United Nations and the international scientific

93 OST, *supra* note 85, art. IX, 18 U.S.T. at 2416, 610 U.N.T.S. at 209–10.

94 *Id.* art. I, 18 U.S.T. at 2413, 610 U.N.T.S. at 208.

95 *Id.* art. IX, 18 U.S.T. at 2416, 610 U.N.T.S. at 210.

96 *Id.* art. IV, 18 U.S.T. at 2413, 610 U.N.T.S. at 208.

97 *Rule 5: Weapons of Mass Destruction*, *in* WOOMERA MANUAL, *supra* note 17, at 71–72 (citing OFF. OF GEN. COUNS., U.S. DEP'T OF DEF., DEPARTMENT OF DEFENSE LAW OF WAR MANUAL 955–56 (2023) [hereinafter LAW OF WAR MANUAL], https://media.defense.gov/2023/Jul/31/2003271432/-1/-1/0/DOD-LAW-OF-WAR-MANUAL-JUNE-2015-UPDATED-JULY%202023.PDF [https://perma.cc/QX58-XJ8B]).

98 *Id.* at 72 & n.266.

99 OST, *supra* note 85, art. IV, 18 U.S.T. at 2414, 610 U.N.T.S. at 208.

100 *Id.* art. V, 18 U.S.T. at 2414, 610 U.N.T.S. at 209.

101 *Id.* art. IX, 18 U.S.T. at 2416–17, 610 U.N.T.S. at 210.

102 *Id.*

community of the nature, location, and results of space exploration "to the greatest extent feasible and practicable."[103]

The treaty creates liability for states' spacefaring activities. States "bear international responsibility for national activities in outer space," regardless of whether the government or another entity carries out those activities.[104] Further, states that launch objects into outer space are "internationally liable for damage to another State Party . . . or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space."[105] While the treaty is clear that states are liable for the damage caused by components on Earth, in the atmosphere, and in outer space, it remains extremely difficult to establish liability in particular cases.[106]

To tackle the difficulties in establishing liability and to better define the liability regime put forth by the OST, states adopted the Convention on International Liability for Damage Caused by Space Objects in 1972.[107] As of January 2025, 100 states had become parties to the Liability Convention, including the vast majority of the 116 states that are party to the OST.[108] The Liability Convention builds on and expands the liability regime in space, providing that a state "shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the [E]arth or to aircraft in flight."[109] The Liability Convention defines damage as "loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations."[110] In essence, no matter what caused the space object to damage the Earth or commercial flight, the state that launched that object into space is liable, even if there are intervening

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103 *Id.* art. XI, 18 U.S.T. at 2418, 610 U.N.T.S. at 210.

104 *Id.* art. VI, 18 U.S.T. at 2415, 610 U.N.T.S. at 209.

105 *Id.* art. VII, 18 U.S.T. at 2415, 610 U.N.T.S. at 209.

106 James P. Lampertius, Note, *The Need for an Effective Liability Régime for Damage Caused by Debris in Outer Space*, 13 MICH. J. INT'L L. 447, 455–60 (1992) (detailing "the weaknesses of the current liability system and the reasons critics find the system largely meaningless as applied to damage caused in outer space").

107 Liability Convention, *supra* note 86. However, this treaty does not fully resolve the liability issues. *See* Trevor Kehrer, Comment, *Closing the Liability Loophole: The Liability Convention and the Future of Conflict in Space*, 20 CHI. J. INT'L L. 178, 195 (2019) ("[T]he Liability Convention's focus on strict liability is not only inconsistent with the general understanding of state responsibility in international law, but also creates an unworkable standard that is highly unlikely to be enforced or relied upon.").

108 Comm. on the Peaceful Uses of Outer Space Legal Subcomm., Status of International Agreements Relating to Activities in Outer Space as at 1 January 2025, U.N. Doc. A/AC.105/C.2/2025/CRP.9, at 5–10 (May 5, 2025), https://www.unoosa.org/res/oosadoc/data/documents/2025/aac_105c_22025crp/aac_105c_22025crp_9_0_html/AC105_C2_2025_CRP09E.pdf [https://perma.cc/LFW3-ZP2U].

109 Liability Convention, *supra* note 86, art. II, 24 U.S.T. at 2392, 961 U.N.T.S. at 189.

110 *Id.* art. I, 24 U.S.T. at 2392, 961 U.N.T.S. at 189.

acts by other states.[111] For damage caused to objects in outer space, a state is liable "only if the damage is due to its fault."[112]

States Parties that use ASAT weapons in ways that contaminate space, impede its peaceful use, or cause damage to the property of other states would violate their obligations under both the OST and Liability Treaty.[113] States that deploy any space object carrying nuclear weapons would also clearly contravene the OST.[114] However, the treaties provide only for non-forceful measures in response to such violations. Specifically, states harmed by a violation may request compensation for damages from the state responsible.[115]

B. The Partial Test Ban Treaty

The 1963 Partial Test Ban Treaty (PTBT) prohibits States Parties from conducting, causing, or encouraging nuclear weapons tests in outer space, in the atmosphere, under water, or "in any other environment if such explosion causes radioactive debris to be present outside the territorial limits of the State under whose jurisdiction or control such explosion is conducted."[116] The United States, Russia, China, and India are all parties to the treaty.[117] Testing nuclear ASAT weapons in outer space would violate their obligations under the PTBT. However, the treaty does not set out any provisions regarding penalties or other responses to violations of the agreement, meaning that any lawful response to violations of the treaty must rely on other sources of law—likely including countermeasures doctrine.[118]

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111 *See* Kehrer, *supra* note 107, at 184–85 (explaining derivative liability assigned to Country B if Country A's satellite is manipulated by third-party X, causing it to crash into Country B's satellite which then causes harm to Country C, "even if Country B can show that the damage was not within its control").

112 Liability Convention, *supra* note 86, art. III, 24 U.S.T. at 2392, 961 U.N.T.S. at 190.

113 The use of non-nuclear ASAT weapons in space would not violate the OST if used solely for lawful purposes (e.g., a state uses an ASAT to dismantle its own malfunctioning satellite in a manner that does not contaminate space or cause damage to the property of other states).

114 *See* Borgen, *supra* note 1 ("Article IV does ban the deployment of nuclear weapons and weapons of mass destruction . . . in space or on celestial bodies, such as the Moon or asteroids.").

115 Liability Convention, *supra* note 86, art. VIII, 24 U.S.T. at 2395, 961 U.N.T.S. at 191.

116 PTBT, *supra* note 87, art. I, 14 U.S.T. at 1316–17, 480 U.N.T.S. at 45.

117 *Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water*, UNITED NATIONS TREATY COLLECTION, https://treaties.un.org/pages/showDetails.aspx?objid=08000002801313d9 [https://perma.cc/4WDU-5TNK].

118 "Under the doctrine of countermeasures, a harmed State may take an action that would otherwise be unlawful—a 'countermeasure'—against a state that is responsible for an internationally wrongful act in order to induce that state to comply with its legal obligations." Oona A. Hathaway, Maggie M. Mills & Thomas M. Poston, *War Reparations: The Case for Countermeasures*, 76 STAN. L. REV. 971, 977 (2024) [hereinafter Hathaway et al., *War Reparations*] (citing Int'l Law Comm'n, Draft Articles on Responsibility of States for Internationally Wrongful Acts, with Commentaries, U.N. Doc. A/56/10, art. 49 (2001) [hereinafter

The one nuclear test that has taken place in space, the 1962 test conducted by the United States known as Starfish Prime, took place the year before the Partial Test Ban Treaty went into effect.[119] Had the treaty been in effect for the United States at the time, that test would have violated the treaty. No other state is known to have successfully conducted such a test.

C. Use of Force and the Right of Self-Defense

In addition to space-specific international agreements, states must adhere to general principles of international law in their exploration and use of outer space. The UN Charter (the Charter) and the customary right of self-defense govern the use of force (jus ad bellum) in space as on Earth.[120] Under the Charter, which the OST specifically reaffirms,[121] states maintain an obligation to refrain from the threat or use of force against the territorial integrity or political independence of any state, or in any other manner inconsistent with the purposes of the United Nations.[122]

Article 51 of the Charter carves out an exception to this prohibition, establishing a tightly constrained right to self-defense under international law "if an armed attack occurs against a Member of the United Nations."[123] While the Charter does not define an "armed attack," the 1986 International Court of Justice in *Military and Paramilitary Activities in and Against Nicaragua* determined that only "the most grave forms of the use of force" constitute an armed attack, while "less grave forms" (such as frontier incidents) do not.[124]

Draft Articles]).

119 Lele, *supra* note 12.

120 *Rule 26: Self-Defense*, *in* WOOMERA MANUAL, *supra* note 17, at 250–51.

121 *See* OST, *supra* note 85, art. III, 18 U.S.T. at 2413, 610 U.N.T.S. at 208 ("States Parties to the Treaty shall carry on activities in the exploration and use of outer space . . . in accordance with international law, including the Charter of the United Nations . . . .").

122 U.N. Charter art. 2, ¶ 4.

123 *Id.* art. 51.

124 Military and Paramilitary Activities in and Against Nicaragua (Nicar. v. U.S.), Judgment, 1986 I.C.J. 14, ¶ 191 (June 27). The United States rejected the court's jurisdiction, attempted to withdraw from the case, and has not acknowledged that the decision is binding upon it. In part as a result, the United States treats the Article 2(4) and Article 51 thresholds as coterminous. It is an international outlier in holding to this view. *See* Harold Hongju Koh, Legal Advisor, U.S. Dep't of State, International Law in Cyberspace, Remarks at the U.S. Cyber Command Inter-Agency Legal Conference (Sept. 18, 2012), https://opiniojuris.org/2012/09/19/harold-koh-on-international-law-in-cyberspace [https://perma.cc/NK3H-7Q3V] ("To cite just one example of this, the United States has for a long time taken the position that the inherent right of self-defense potentially applies against any illegal use of force."). A use of force that does not meet the "most grave" threshold nonetheless violates the principle of non-intervention, which establishes the right of every sovereign state to conduct its affairs without interference from another state. Nicar. v. U.S., 1986 I.C.J. at ¶ 202. The principle forbids all states from directly or indirectly interfering in the internal or external affairs of other states. The ICJ in *Nicaragua* established that "[t]he element of coercion, which defines, and indeed forms the very essence of, prohibited intervention, is particularly obvious

States and scholars disagree as to which actions and effects meet the "most grave" threshold to qualify as an armed attack and thus allow for self-defense. A strict reading confines its meaning to kinetic violence—encompassing actions that inflict physical destruction and cause human injury or death—while excluding non-kinetic damage, such as cyber-attacks without adverse physical impacts.[125] According to the U.S. Department of Defense *Law of War Manual*, the United States "has long taken the position that the inherent right of self-defense potentially applies against any illegal use of force."[126] Other states "would be inclined to draw more of a distinction between 'armed attacks' and uses of force that do not give rise to the right to use force in self-defense."[127] Uncertainty extends beyond identifying which past actions allow for self-defense.

By its terms, Article 51 requires an armed attack in order to trigger a state's right of self-defense, but most international law scholars acknowledge that there may be instances where states can respond to a threat that has not yet fully materialized. The devil, of course, is in the details: What level of threat is necessary—and how immediate or "imminent" it must be—to constitute a sufficient threat to permit a right of self-defense has been a matter of significant debate and disagreement.

Some point to the 1837 *Caroline* incident as shaping states' customary right of self-defense in the absence of an armed attack.[128] The incident is sometimes read to establish that a state has a right to anticipatory self-defense subject to two conditions. First, the state must demonstrate self-defense is necessary. Second, necessity is tightly tied to the imminence of the attack, with the close temporal proximity of the danger necessitating the state's action to prevent the harm. As U.S. Secretary of State Daniel Webster stated in his exchange with Lord Ashburton: "It will be for that Government to

in the case of an intervention which uses force," whether the force is direct or indirect. *Id.* ¶ 205.

125 *See, e.g.*, Matthew C. Waxman, *Self-defensive Force Against Cyber Attacks: Legal, Strategic and Political Dimensions*, 89 INT'L L. STUD. 109, 111 (2013) ("A strict reading of 'armed attack' would confine its meaning to kinetic violence, as opposed to non-physical violence or harm with no physical damage . . . and cyber attacks might therefore be considered as unable ever—on their own—to trigger armed self-defense rights."); THOMAS RID, CYBER WAR WILL NOT TAKE PLACE 1–10 (2013) (arguing that no cyber offense on record has constituted an act of war); Laurie R. Blank, *Irreconcilable Differences: The Thresholds for Armed Attack and International Armed Conflict*, 96 NOTRE DAME L. REV. 249, 253–56 (2020) (defining a cyber-attack that constitutes an armed attack as one that is "sufficiently grave"); FRANÇOIS DELERUE, *The Threshold of Cyber Warfare: From Use of Cyber Force to Cyber Armed Attack*, *in* CYBER OPERATIONS AND INTERNATIONAL LAW 273, 276–77 (2020) (arguing that only cyber operations that qualify as a threat or use of force under Article 2(4) constitute cyberwarfare).

126 LAW OF WAR MANUAL, *supra* note 97, at 47.

127 *Id.* at 47–48.

128 *See, e.g.*, CRAIG FORCESE, DESTROYING THE CAROLINE: THE FRONTIER RAID THAT RESHAPED THE RIGHT TO WAR, at xix (2018) ("The Caroline's destruction is the event with the most lasting impact on international law ever to have commenced on Canadian soil.").

show a necessity of self-defence, instant, overwhelming, leaving no choice of means, and no moment for deliberation."[129] In short, the attack must be sufficiently imminent that there is no time to pursue alternative measures that do not involve the use of force to prevent or deter the attack.[130]

Modern legal literature reflects the ongoing centrality of imminence to questions of when and what kind of force may be used in self-defense. The DoD *Law of War Manual* claims that, under Article 51 and customary international law, states have "the right to take measures in response to imminent attacks."[131] The DoD cites the 2004 remarks of the then-UK Attorney General, Lord Peter Henry Goldsmith, who argued in House of Commons Debates that "it has been the consistent position of successive United Kingdom Governments over many years that the right of self-defence under international law includes the right to use force where an armed attack is imminent."[132] The *Manual* also cites Goldsmith's assertion that Article 51 recognizes the inherent right of self-defense in customary international law, "which included the right to use force in anticipation of an imminent armed attack."[133]

This interpretation of Article 51 is far from universal. Many scholars argue that the international community rejected the notion of anticipatory self-defense in adopting the text of Article 51, which specifically references

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129 Letter from Dan Webster, U.S. Sec'y of State, to Lord Ashburton (Apr. 24, 1841), http://avalon.law.yale.edu/19th_century/br-1842d.asp [https://perma.cc/TNY9-Y79Q].

130 For more on the *Caroline* incident, see Matthew C. Waxman, *The 'Caroline' Affair in the Evolving International Law of Self-Defense*, LAWFARE BOOK REV. (Aug. 28, 2018), https://www.lawfaremedia.org/article/caroline-affair [https://perma.cc/AWE5-6NT9]; BOWETT, *supra* note 15, at 58–59; ALBERT B. COREY, THE CRISIS OF 1830–1842 IN CANADIAN-AMERICAN RELATIONS 61–69 (1941); Martin A. Rogoff & Edward Collins, Jr., *The Caroline Incident and the Development of International Law*, 16 BROOK. J. INT'L L. 493, 494–95 (1990); R.Y. Jennings, *The Caroline and McLeod Cases*, 32 AM. J. INT'L L. 82, 82–92 (1938). When states act in self-defense, they must also observe the principles of necessity and proportionality. *See* Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, ¶ 41 (July 8) ("The submission of the exercise of the right of self-defence to the conditions of necessity and proportionality is a rule of customary international law.").

131 LAW OF WAR MANUAL, *supra* note 97, at 47.

132 *Id.* at 47 n.229 (quoting HC Deb (21 Apr. 2004) (660) cols. 370–71 (oral answers to questions by Lord Peter Henry Goldsmith, Att'y Gen. of the United Kingdom)). The widely cited document known as the "Bethlehem Principles" on non-international armed conflict reflects the alignment of U.S. and UK conceptions. It outlines their shared view that imminence enables the right of self-defense: "States have a right of self-defense against an *imminent* or actual armed attack by nonstate actors." Daniel Bethlehem, *Principles Relevant to the Scope of a State's Right of Self-Defense Against an Imminent or Actual Armed Attack by Nonstate Actors*, 106 AM. J. INT'L L. 1, 6 (2012) (emphasis added). However, "there are some respects in which the new principles risk departing from international law" and they "remain controversial." Elizabeth Wilmshurst & Michael Wood, *Self-Defense Against Nonstate Actors: Reflections on the 'Bethlehem Principles*,*'* 107 AM. J. INT'L L. 390, 393 (2013).

133 LAW OF WAR MANUAL, *supra* note 97, at 47 n.229 (quoting HC Deb (21 Apr. 2004) (660) cols. 370–71).

an "armed attack" as the precondition for a unilateral right of self-defense.[134] They criticize the United States' assertion of a broad right to "preemptive self-defence" to justify its use of force against future threats.[135] Under a broad conception of the right of self-defense, the "Bush Doctrine" claimed that preemption must extend to include preventive attacks (often referred to as "preventive self-defense"[136]) to counter threats to national security. The Bush Doctrine asserted the United States' right to take "anticipatory action to defend [itself], even if uncertainty remains as to the time and place of the enemy's attack."[137] Many states, scholars, and international organizations view the United States' exercise of preventive self-defense in the Iraq invasion as an unlawful use of force not justified under Article 51.[138] Even

134 "As the majority of legal scholars pointed out, Article 51 allows a state to invoke the right to self-defence only *after* an armed attack has taken place." Vasja Badalič, *The War Against Vague Threats: The Redefinitions of Imminent Threat and Anticipatory Use of Force*, 52 SEC. DIALOGUE 174, 175 (2020); *see also* ROSALYN HIGGINS, THE DEVELOPMENT OF INTERNATIONAL LAW THROUGH THE POLITICAL ORGANS OF THE UNITED NATIONS 197–203 (1963); HANS KELSEN, THE LAW OF THE UNITED NATIONS: A CRITICAL ANALYSIS OF ITS FUNDAMENTAL PROBLEMS 797–98 (2000); Michael J. Glennon, *The Fog of Law: Self-Defense, Inherence, and Incoherence in Article 51 of the United Nations Charter*, 25 HARV. J.L. & PUB. POL'Y 539, 546–47 (2002); Nicholas Rostow, *International Law and the Use of Force: A Plea for Realism*, 34 YALE J. INT'L L. 549, 550–51 (2009); Helmut Philipp Aust, *Article 51*, *in* 4 THE CHARTER OF THE UNITED NATIONS: A COMMENTARY 1801–05 (Bruno Simma, Daniel-Erasmus Khan, Georg Nolte & Andreas L. Paulus eds., 2024).

135 Badalič, *supra* note 134, at 175–76.

136 While the Bush administration characterized its approach as "preemptive," scholars have since recognized its assertion of a distinctly expansive right of self-defense as "preventive" self-defense, since it aims to prevent more general threats from manifesting rather than to preempt specific imminent threats. *See, e.g.*, Miriam Sapiro, *Iraq: The Shifting Sands of Preemptive Self-Defense*, 97 AM. J. INT'L L. 599, 599 (2003).

137 *See* THE NATIONAL SECURITY STRATEGY OF THE UNITED STATES OF AMERICA 6, 15 (2002), https://2009-2017.state.gov/documents/organization/63562.pdf [https://perma.cc/HFA6-JUAR] (stating that the United States "will not hesitate to act alone, if necessary, to exercise [its] right of self-defense by acting preemptively against" terrorists and asserting the United States' right to, "if necessary, act preemptively" to prevent hostile acts by adversaries).

138 UN Secretary-General Kofi Annan declared the attack unlawful. *Lessons of Iraq War Underscore Importance of UN Charter – Annan,* UN NEWS (Sept. 16, 2004), https://news.un.org/en/story/2004/09/115352 [https://perma.cc/6LF6-MZYB]. In remarks to the UN Security Council, Russia called the Iraq invasion "[a]n unprovoked military action" that was "in violation of international law and in circumvention of the Charter." U.N. SCOR, 58th Sess., 4726th mtg. at 26, U.N. Doc. S/PV.4726 (Resumption 1) (Mar. 27, 2003). China categorized the invasion as "a violation of the basic principles of the Charter of the United Nations and of international law." *Id.* at 28. Tanzania declared "the decision to resort to the use of force against Iraq is null and void, as it goes against [the] United Nations Charter." *Id.* at 9. Saudi Arabia opposed the occupation and called for the immediate withdrawal of forces. *Id.* at 7. German Deputy Chancellor and Minister for Foreign Affairs Joschka Fischer declared in remarks to the United Nations that "under the current circumstances, the policy of military intervention had no credibility . . . [and t]here was no basis in the Charter for a regime change with military means." Press Release, Security Council, Importance of Humanitarian Aid for Iraq Stressed, As Security Council Members Voice Different Views on Disarmament Process, U.N. Press Release SC/7696 (Mar. 19, 2003), https://press.un.org/en/2003/sc7696.doc.htm [https://perma.cc/9K57-4GHR]. New Zealand Prime

today, the United States embraces a more permissive interpretation of the scope of the right of self-defense compared to other states.[139]

There is now significant agreement that a state may lawfully take unilateral action to respond to an imminent threat under certain conditions.[140] Yet even among those who accept the right of self-defense against an "imminent" attack, substantial disagreement remains regarding the context in which such a right may be exercised.[141] Some define the legality of self-defense based on the liminal space between preemptive and preventive. Others use the terms interchangeably. Chris O'Meara asserts that "[i]t is uncontroversial that imminence, as it relates to pre-emptive self-defence, must refer to an 'objectively verifiable, concretely imminent attack,' rather

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Minister Helen Clark called the U.S. position on the legality of a U.S.-led strike on Iraq "highly debatable" under international law. Jarrett Murphy, *War Threat Divides the World,* CBS NEWS (Mar. 21, 2003), https://www.cbsnews.com/news/war-threat-divides-world/ [https://perma.cc/S9EU-2ZD2]; *see also* Peter Slevin, *Legality of War Is a Matter of Debate,* WASH. POST (Mar. 18, 2003), https://www.washingtonpost.com/archive/politics/2003/03/18/legality-of-war-is-a-matter-of-debate/e509f1a6-a970-4868-9552-751d0c2627e8/ [https://perma.cc/QC4C-62ZD] (describing Bush's arguments for legal authority over war in Iraq and reactions).

139 *See* Oona A. Hathaway, *How the Expansion of "Self-Defense" Has Undermined Constraints on the Use of Force*, JUST SEC. (Sept. 18, 2023), https://www.justsecurity.org/88346/the-expansion-of-self-defense/ [https://perma.cc/VZ47-83ZC] (describing the "United States' increasingly permissive interpretation of the scope of the right of self defense"); Oona A. Hathaway, *How the Erosion of U.S. War Powers Constraints Has Undermined International Law Constraints on the Use of Force*, 14 HARV. NAT'L SEC. J. 336, 337 (2023) (arguing that "ever-expanding claims to act in 'self-defense' have had the effect, perhaps unintended, of eroding the international law prohibition on the use of force").

140 "[T]he view that States have a right to act in self-defence in order to avert the threat of an *imminent* attack—often referred to as 'anticipatory self-defence'—is widely, though not universally, accepted." Elizabeth Wilmshurst, *The Chatham House Principles of International Law on the Use of Force in Self-Defense*, 55 INT'L & COMP. L.Q. 963, 964 (2006).

141 In 2019, for example, Turkey launched an assault on Kurdish forces in northern Syria, an incursion it justified using "the right of self-defense as outlined in Article 51 of the Charter of the United Nations, to counter the *imminent* terrorist threat, to ensure Turkey's border security, to neutralize terrorists." Permanent Rep. of Turkey to the U.N., Letter dated October 9, 2019 from the Permanent Rep. of Turkey to the United Nations addressed to the President of the Security Council, at 1, U.N. Doc. S/2019/804 (Oct. 9, 2019) (emphasis added). Though Turkey is a NATO ally of the United States, Turkey attacked U.S. partner forces. *See* Oona Hathaway, *Turkey Is Violating International Law. It Took Lessons from the U.S.*, WASH. POST (Oct. 22, 2019), https://www.washingtonpost.com/outlook/2019/10/22/turkey-is-violating-international-law-it-took-lessons-us/ [https://perma.cc/66VV-Q3E2] (criticizing legal basis for Turkey's attack on the Kurdish-led Syrian Democratic Forces). Likewise, the day Russia launched its full-scale invasion of Ukraine in February 2022, its Permanent Representative to the United Nations notified the UN Secretary-General that the military action was "taken in accordance with Article 51 of the Charter of the United Nations in the exercise of the right of self-defence," citing concerns about the expansion of NATO and the threats that expansion posed to Russia. Permanent Rep. of the Russian Federation to the U.N., Letter dated February 24, 2022 from the Permanent Rep. of the Russian Federation to the United Nations addressed to the Secretary-General, U.N. Doc. S/2022/154 (Feb. 24, 2022). These echoes of the Bush Doctrine demonstrate some of the risks of embracing an overbroad interpretation of imminence and the right of self-defense.

than to unmaterialized and speculative threats, which are the domain of unlawful preventive self-defence."[142] Noam Lubell takes a more permissive approach, arguing that states can use force to prevent an "impending attack over which there is a reasonable level of certainty that it will occur in the foreseeable future" if the threat is "specific and identifiable."[143] Vasja Badalič, meanwhile, advocates a more traditional definition of imminence: An imminent threat is both immediate and concrete.[144]

The proverbial example of an imminent threat justifying self-defense is an adversary amassing tanks on a border where it is clear the adversary plans to attack the following day. The threat is impending, and there is no practical alternative to avert the harm other than a defensive use of force. This example also demonstrates how meeting the imminence threshold requires that the threat emanates from an actor that has not only the *capability* to attack but also the clear *intention* to do so.[145] The capability to attack, absent the clear intent to do so, is insufficient to warrant a defensive use of force. It is when the actor has both the capability and the clear intent to attack on a timescale and in a manner that forecloses the use of non-forceful avenues of prevention that a state may lawfully employ force in self-defense.

To determine if the threat forecloses the use of non-forceful preventive measures, analysts consider the broader context,[146] including the gravity, nature, and immediacy of the threat.[147] To evaluate the gravity of an impending attack, a state might consider the type of weapons the adversary would employ. Conventional weapons, for example, would likely be less catastrophic than weapons of mass destruction (WMDs).[148] To determine the

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142 Chris O'Meara, *Reconceptualising the Right of Self-Defence Against 'Imminent' Armed Attacks*, 9 J. ON USE FORCE & INT'L L. 278, 295 (2022) (quoting 2 *Report of the Independent International Fact-Finding Mission on the Conflict in Georgia*, at 254 (Sept. 2009), https://www.mpil.de/files/pdf4/IIFFMCG_Volume_II1.pdf [https://perma.cc/XL9U-2MG4]).

143 *Id.* (quoting Noam Lubell, *The Problem of Imminence in an Uncertain World*, *in* THE OXFORD HANDBOOK ON THE USE OF FORCE IN INTERNATIONAL LAW 697, 702–05, 718 (Marc Weller ed., 2015)). "[Lubell's] position is not generally shared by scholars, nor in the state practice referred to herein from the USA, UK and Australia. As set out in this article, imminence is best understood as pertaining to necessity." *Id.* at 295 n.86.

144 Badalič, *supra* note 134, at 176–77.

145 O'Meara, *supra* note 142, at 310–11; *see also* ELIZABETH WILSMHURST, PRINCIPLES OF INTERNATIONAL LAW ON THE USE OF FORCE BY STATES IN SELF-DEFENCE 5–6 (2005); Marko Milanovic, *When Did the Armed Attack Against Ukraine Become 'Imminent'?*, EJIL:TALK! (Apr. 20, 2022), https://www.ejiltalk.org/when-did-the-armed-attack-against-ukraine-become-imminent/ [https://perma.cc/WF8L-P97J] (discussing capability and intent in the context of Russia and Ukraine).

146 O'Meara, *supra* note 142, at 296.

147 Wilmshurst, *supra* note 140, at 967; Nico Schrijver & Larissa van den Herik, *Leiden Policy Recommendations on Counter-Terrorism and International Law*, 57 NETH. INT'L L. REV. 531, 543 (2010) ("Whether an attack may be regarded as imminent falls to be assessed by reference to the immediacy of the attack, its nature, and gravity."); CHRISTIAN HENDERSON, THE USE OF FORCE AND INTERNATIONAL LAW 298 (2018).

148 HENDERSON, *supra* note 147, at 298.

nature of the attack, a state could assess the potential consequences of making an error in estimating the danger[149] and consider if the attack is likely to occur without warning.[150] However, while these criteria may be relevant in determining whether a threat is imminent,[151] they neither negate nor supplant the requirement of temporal proximity that makes the state's preventive action *necessary* to avert the attack.[152] It is the immediacy of the danger, along with the capability and intent of the aggressor, that precludes any peaceful means of resolution. These criteria trigger the *necessity* of *proportionate* preemptive action by the state. The accuracy of these determinations depends largely on evidence gathered through intelligence operations,[153] which must provide a "reasonable and objective basis for concluding that an attack will be launched."[154] Ultimately, a properly applied imminence standard requires that "the defending state must provide clear and convincing evidence that an armed attack is about to happen."[155]

In addition, consensus has been forming around the extension of states' right of self-defense to satellites in orbit. The right of self-defense has traditionally been a right tied to a state's territory. However, international law and state practice have demonstrated that the right of self-defense can apply to certain objects under the jurisdiction of the state, such as national ships.[156] Under the Convention on Registration of Objects Launched into Outer Space (the Registration Convention), the state that launches a space object into orbit must register it in a national registry and provide information

149 *Id.*

150 Wilmshurst, *supra* note 140, at 967.

151 Even among states and scholars who accept the right of anticipatory self-defense against an imminent armed attack, the definition of "imminence" remains highly contested. HENDERSON, *supra* note 147, at 307. The lack of a universally accepted definition of "imminence" means "the precise parameters" necessary to determine conclusively that an attack is imminent and that the use of force in self-defense is necessary "remain unclear." *Id.*

152 *See id.* at 305 (distinguishing imminence from necessity).

153 *See* Paul H. Robinson & Adil Ahmad Haque, *Advantaging Aggressors: Justice & Deterrence in International Law*, 3 HARV. NAT'L SEC. J. 143, 180 (2011) (emphasizing high evidentiary burden to justify use of force).

154 Schrijver & van den Herik, *supra* note 147, at 543.

155 Badalič, *supra* note 134, at 177.

156 *See* Oil Platforms (Iran v. U.S.), Judgment, 2003 I.C.J. Rep. 161, ¶ 72 (Nov. 6) ("The Court does not exclude the possibility that the mining of a single military vessel might be sufficient to bring into play the 'inherent right of self-defence . . . .'"); *see also Jurisdiction Over Vessels*, NAT'L OCEANIC & ATMOSPHERIC ADMIN. (Oct. 4, 2022), https://www.noaa.gov/jurisdiction-over-vessels [https://perma.cc/A3ZX-2NNB] (describing how states exercise jurisdiction over vessels); *Protecting Crews and Ships From Piracy by Arming Merchant Vessels for Self Defense*, SQUIRE SANDERS & DEMPSEY L.L.P. (May 2009), https://www.squirepattonboggs.com/~/media/files/insights/publications/2009/05/maritime-alert/files/maritime_alert_protecting_crews_and_ships_from_p__/fileattachment/maritime_alert_protecting_crews_and_ships_from_p__.pdf [https://perma.cc/Q52X-QDU8] (providing information about the right to self-defense on ships).

about the asset to the United Nations.[157] The state of registry maintains jurisdiction and control over the object in space.[158] This exercise of jurisdiction, scholars have asserted, extends the right of self-defense to space assets.[159] The 2008 and 2014 drafts of the Treaty on the Prevention of the Placement of Weapons in Outer Space (PPWT), sponsored by China and Russia, both recognize the right to self-defense against attacks targeting objects in outer space.[160] NATO has similarly stated that "attacks to, from or *within* space" could result in the invocation of Article 5 of the NATO Treaty, which contemplates the exercise of individual or collective self-defense by NATO Member States.[161] Many states thus would consider a destructive or irreversible attack against a satellite under their jurisdiction equivalent to a similarly destructive attack on state territory—and could claim a right of self-defense in response.[162]

III
WHAT CAN STATES DO?

Having reviewed the relevant bodies of international law, we now turn to examining how they apply to ASAT weapons. Historically, we explain, violations of international law via ASAT weaponry have been met with no

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157 U.N. Convention on Registration of Objects Launched into Outer Space arts. II, IV, Jan. 14, 1975, 1023 U.N.T.S. 15.

158 *Rule 7: Jurisdiction*, *in* WOOMERA MANUAL, *supra* note 17, at 85–87.

159 *See* Anne-Sophie Martin, *State's Right to Self-Defence in Outer Space*, J. JOINT AIR POWER COMPETENCE CTR. (JAPCC), Spring/Summer 2020, at 31–32, https://www.japcc.org/wp-content/uploads/JAPCC_J30_screen.pdf [https://perma.cc/XN7X-U7FC] (arguing that "[i]n case of aggressive or hostile action against a space asset, the right of self-defence in outer space arises"); *see also* Erin Pobjie, *Outer Space, Military Uses of*, *in* MAX PLANCK ENCYCLOPEDIAS OF INTERNATIONAL LAW ¶ 29 (2024) [hereinafter MPIL] https://opil.ouplaw.com/display/10.1093/law-epil/9780199231690/law-9780199231690-e2267 [https://perma.cc/4DMN-3EAP] ("States have a right to exercise self-defence under Art. 51 UN Charter and customary international law in response to an armed attack. This right extends to armed attacks that occur in outer space.").

160 Draft Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects, transmitted by letter dated 29 February 2008 from the Permanent Representative of the Russian Federation and the Head of Delegation of the People's Republic of China to the Conference on Disarmament Addressed to the Secretary-General of the Conference, art. V, U.N. Doc. CD/1839 (Feb. 29, 2008); Draft Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects, transmitted by letter dated 10 June 2014 from the Permanent Representative of the Russian Federation and the Permanent Representative of China to the Conference on Disarmament Addressed to the Acting Secretary-General of the Conference, art. IV, U.N. Doc. CD/1985 (June 12, 2014); *see also* MPIL, *supra* note 159, ¶ 29 (comparing 2008 and 2014 drafts).

161 NATO, *Deterrence and Defense* (June 26, 2025), https://www.nato.int/cps/en/natohq/topics_133127.htm [https://perma.cc/G89U-TB9V] (emphasis added).

162 As a result, no state has ever conducted a destructive attack against another country's satellite. *See* RON GURANTZ, SATELLITES IN THE RUSSIA-UKRAINE WAR 22 (2024) (emphasizing restraint of both Russia and Ukraine in not attacking satellites).

meaningful response. Yet, as threats and fear escalate, determining lawful responses to the deployment and use of these weapons is essential to ensure future global stability. We thus aim to assess the lawful options available to states to respond to the growing threats they face from ASAT weapons.

A. Historical Responses

History suggests that prior violations of legal prohibitions have received little response. Several States Parties to the OST have violated the convention without consequence. Russia tested a direct-ascent ASAT weapon to destroy one of its old satellites in 2021.[163] The test generated debris that the U.S. Space Command determined would "pose a threat to activities in outer space for years to come, putting satellites and space missions at risk."[164] The debris endangered the crew aboard the International Space Station, including two Russians, who had to take shelter and seal off parts of the station as its orbit intersected with the debris.[165] By harmfully contaminating space and endangering the astronauts' lives, Russia's ASAT weapons test violated the OST.[166]

In 2007, China similarly violated the OST by launching a missile to collide with one of its non-operational weather satellites, which created a cosmic mass of debris that the United States continues to mitigate more than a decade later.[167] The United States, too, tested ASAT weapons in 1985 and 2008, first destroying an observatory satellite and then a malfunctioning satellite.[168] In 2019, India celebrated Mission Shakti, launching a missile to destroy an Indian satellite in low Earth orbit, which created a cloud of debris.[169] These tests collectively generated "significant orbital debris, which

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163 Emma Helfrich & Tyler Rogoway, *The U.S. Is Done Blowing Up Satellites with Missiles in Tests*, TWZ (Apr. 20, 2022, 7:23 PM), https://www.twz.com/u-s-says-its-done-blowing-up-satellites-with-missiles [https://perma.cc/L9CL-KL3G].

164 *Id.* (quoting U.S. Army Gen. James Dickinson, head of U.S. Space Command).

165 Shannon Bugos, *Russia ASAT Test Creates Massive Debris*, ARMS CONTROL TODAY (Dec. 2021), https://www.armscontrol.org/act/2021-12/news/russian-asat-test-creates-massive-debris [https://perma.cc/YHJ5-BFNY].

166 *See* OST, *supra* note 85, art. IX, 18 U.S.T. at 2416–17, 610 U.N.T.S. at 209–10 ("If a State Party . . . has reason to believe that an activity or experiment planned by it . . . in outer space . . . would cause potentially harmful interference . . . it shall undertake appropriate international consultations before proceeding . . . ."). The treaty also expressly prohibits weapons testing, though the prohibition is limited to testing on celestial bodies. *Id.* art. IV, 18 U.S.T. at 2413–14, 610 U.N.T.S. at 208; *see also* Koplow, *supra* note 5, at 1198 (arguing the OST's ban of military fortifications is limited to celestial bodies, and "parties are accordingly unrestricted in building forts, testing weapons, and conducting military maneuvers on artificial satellites or in the void of space").

167 Helfrich & Rogoway, *supra* note 163.

168 *Id.*

169 Doris Elin Urrutia, *India's Anti-Satellite Missile Test Is a Big Deal. Here's Why.*, SPACE.COM (Aug. 10, 2022), https://www.space.com/india-anti-satellite-test-significance.html [https://perma.cc/L9XR-LBPM].

is a problem for the wider international community of spacefaring nations."[170] By contaminating space in ways that impede its peaceful use, each of these actions violated the OST.

Though these tests violated international law, the United States, China, Russia, and India have faced no repercussions. However, increasing awareness of and concern for the threat posed by ASAT weapons have fueled growing efforts to ban such tests. In April 2022, then-Vice President Kamala Harris, who was also the Chair of the first National Space Council, announced that the United States would no longer engage in destructive direct-ascent ASAT weapons testing.[171] In late 2022, the UN General Assembly First Committee adopted a resolution calling for a ban on destructive ASAT missile tests.[172] While the United States spearheaded the effort, China and Russia voted against it. India abstained.[173] Despite 155 votes in favor of the resolution,[174] only 37 states have pledged to join a moratorium on direct-ascent ASAT testing.[175]

B. Lawful Responses to Conventional ASAT Threats

Given the rising threats from ASAT weapons, the "do nothing" approach is unlikely to remain the best option for most states when violations of the law take place. But what are they permitted to do? First, a state is always permitted to engage in lawful retorsions, including diplomatic measures, regardless of whether the launch of a weapon is lawful or not.[176] Second, states may use countermeasures if the launch or use of a weapon is unlawful: "[A] harmed State may take an action that would otherwise be unlawful—a 'countermeasure'—against a state that is responsible for an internationally wrongful act in order to induce that state to comply with its legal obligations."[177] Third, states may use force in self-defense if doing so is consistent with Article 51 of the UN Charter.[178]

Here, we walk through three hypothetical threat scenarios and what

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170 Starling-Daniels & Massa, *supra* note 2.

171 Helfrich & Rogoway, *supra* note 163.

172 Heather Foye & Gabriela R. Hernández, *UN First Committee Calls for ASAT Test Ban*, ARMS CONTROL TODAY (Dec. 2022), https://www.armscontrol.org/act/2022-12/news/un-first-committee-calls-asat-test-ban [https://perma.cc/A266-CGTN].

173 CHING WEI SOOI, SECURE WORLD FOUND., DIRECT-ASCENT ANTI-SATELLITE MISSILE TESTS: STATE POSITIONS ON THE MORATORIUM, UNGA RESOLUTION, AND LESSONS FOR THE FUTURE 1 (2023), https://www.swfound.org/publications-and-reports/direct-ascent-anti--satellite-missile-tests-state-positions-on-the-moratorium-unga-resolution-and-lessons-for-the-future [https://perma.cc/GH3V-823P].

174 U.N. GAOR, 77th Sess., 46th plen. mtg. at 9, U.N. Doc. A/77/PV.46 (Dec. 7, 2022).

175 SOOI, *supra* note 173, at 7.

176 *Rule 24: Retorsion*, *in* WOOMERA MANUAL, *supra* note 17, at 241–42.

177 Hathaway et al., *War Reparations*, *supra* note 118, at 977 (citing Draft Articles, *supra* note 118, art. 49).

178 U.N. Charter art. 2, ¶ 4; *id.* art. 51.

lawful responses states may take.

1. ASAT Weapons Deployed in Compliance with International Law

With the continued development of space weapons in the absence of any categorical prohibitions on the military use of outer space or the placement of conventional weapons in outer space, a critical question arises as to whether the placement of a weapon in space breaches the OST requirement that outer space be used for peaceful purposes.[179] The answer to this inquiry has significant implications for the future of space activity if such a breach exists and could lawfully warrant countermeasures or the exercise of anticipatory self-defense. However, the mere placement of non-nuclear ASAT weapons in space, though controversial, would not violate the OST if the weapons are intended to be used for lawful purposes. While the OST expressly prohibits the militarization of celestial bodies and space-based weapons of mass destruction, it does not expressly prohibit putting non-nuclear weapons into space.[180]

None of the treaties specifically governing the use of space—including the OST and the Partial Test Ban Treaty—nor the UN Charter categorically prohibit the placement of weapons other than nuclear weapons and weapons of mass destruction in outer space.[181] Launching ASAT weapons into orbit and maintaining space weapons thus do not violate these treaties (barring the deployment of a nuclear-armed ASAT weapon in space, which falls under the OST's explicit prohibition on stationing or utilizing nuclear-armed weapons in orbit under Article IV[182]). In addition, the placement of these weapons in space, by itself, does not meet the imminence requirement warranting anticipatory self-defensive measures.

Part of the complexity that has impeded measures to regulate or prohibit space-based non-nuclear ASAT weapons arises from the dual use nature of many space technologies. The capacity for dual use (that is, possessing both civilian and military uses) makes their capabilities and intended function ambiguous.[183] As a result, states cannot readily discern whether a satellite

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179 OST, *supra* note 85, art. IV, 18 U.S.T. at 2413–14, 610 U.N.T.S. at 208.

180 MIRMINA & SCHENEWERK, *supra* note 29, at 277, 279–81.

181 *Id.* at 280–81; *see also* Sa'id Mosteshar, *Space Law and Weapons in Space*, *in* OXFORD RESEARCH ENCYCLOPEDIA OF PLANETARY SCIENCE (2019), https://oxfordre.com/planetaryscience/display/10.1093/acrefore/9780190647926.001.0001/acrefore-9780190647926-e-74 [https://perma.cc/EB37-WDVS]. The OST provides that celestial bodies in outer space shall be used only for peaceful purposes. It prohibits the establishment of military bases or fortifications, weapons testing, or the conduct of military maneuvers on celestial bodies. However, the "use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited" nor shall "[t]he use of any equipment or facility necessary for peaceful exploration." OST, *supra* note 85, art. IV, 18 U.S.T. at 2414, 610 U.N.T.S. at 208.

182 *Rule 5: Weapons of Mass Destruction*, *in* WOOMERA MANUAL, *supra* note 17, at 71–72.

183 OST, *supra* note 85, art. IV, 18 U.S.T. at 2413–14, 610 U.N.T.S. at 208.

launched into space constitutes a benign space asset or a malicious weapon. Regulating the launch of ASAT weapons into orbit would require the ability to conclusively determine their capabilities and intended use.

In the absence of express prohibitions, states, including the United States, Russia, and China, have continued to contribute to the militarization of outer space through their respective development and testing of various space-oriented and space-based weapons. They have utilized such capabilities to destroy their own malfunctioning or outdated satellites.[184] As such, the development and stationing of these weapons has not been considered a breach of states' obligation under the OST to use outer space for peaceful purposes nor a violation of any other existing treaty.[185] Still, where states have launched weapons that harmfully contaminate space with debris and impede its peaceful use, such ASAT weapons tests do violate the OST.[186]

In addition, stationing a non-nuclear space weapon in orbit does not violate the UN Charter or trigger a right of self-defense under Article 51. Merely deploying or maintaining a capability in space that has the capacity to interfere with or destroy other satellites in orbit does not meet the imminence test. Indeed, countries including the United States have developed ground-based ASAT missiles with the capacity to target satellites. Possession of such capabilities has not been considered a breach of international law.[187]

ASAT weapons do present unique challenges to imminence assessments. The positioning of space-based ASATs can compress the window between weapon launch and target strike, potentially impacting states' assessment of the immediacy of the threat. Further, given states' surging reliance on satellite systems for everyday functions, both the kinetic and non-kinetic methods of attack have the capacity to blind military operations and destabilize critical civilian systems—possibly increasing the perceived gravity of the harm. Simultaneously, satellites in orbit are especially vulnerable in a frontier where defensive measures and countermeasures may be difficult to implement swiftly, particularly for states with less-developed space defense capabilities.

The mere deployment of an ASAT weapon does not necessarily constitute an imminent threat. An imminent ASAT threat arises only when an adversary demonstrates the capability to target satellites accompanied by the clear and immediate intent to do so. And yet, a state might regard an

184 *See* Helfrich & Rogoway, *supra* note 163 (discussing "destructive anti-satellite weapon testing" by the United States, Russia, and China).

185 *Rule 3: Peaceful Purposes in Outer Space*, *in* WOOMERA MANUAL, *supra* note 17, at 49–51.

186 *See* OST, *supra* note 85, art. IX, 18 U.S.T. at 2416–17, 610 U.N.T.S. at 210.

187 *See* Mosteshar, *supra* note 181.

ASAT weapon—especially when nuclear-armed—as so threatening that it is tempted to ignore the legal limits on the use of force. A state could claim, contrary to the legal limits, that it is entitled to act in anticipatory self-defense given the short timeframe to defend against ASAT weapons and their catastrophic capabilities. States' fear of the unknown may thus prompt them to take the very action that international law seeks to constrain in the face of uncertainty: the use of force in the absence of an armed attack. Doing so would be clearly unlawful.

When ASAT weapons are deployed without the clear and immediate intent to use them, such that the threat does not qualify as imminent, states are limited to responding with lawful measures to lawful actions. The state may use retorsions such as diplomatic measures or withdrawal of cooperation with a state that has launched such a capability—for example, refusing to cooperate in the operation of the International Space Station. A state asserting a right to respond beyond such lawful measures could endanger its own space program. Given that the United States has significant ASAT capacity of its own, engaging in a more expansive response would risk emboldening adversaries such as Russia or China to respond in kind.

2. *ASAT Weapons Deployed or Used in Contravention of International Law—But No Armed Attack*

The launch of non-nuclear ASAT weapons into space does not necessarily contravene international law. However, States Parties to the OST would violate their treaty obligations if they (1) deploy ASAT weapons armed with nuclear weapons or weapons of mass destruction; (2) use ASAT weapons that contaminate outer space, impede its peaceful use, or damage the property of other states; or (3) use an ASAT weapon for jamming, dazzling, or grappling another state's satellite, given that these actions would impede the free use of outer space.[188] Such kinetic and non-kinetic uses of ASAT weapons by one state to interfere with another state's use of space would also violate a customary principle of international law, the norm of non-intervention, which "involves the right of every sovereign State to conduct its affairs without outside interference."[189]

States may prepare for such threats by hardening satellites to make them resistant to—and more likely to survive—nuclear radiation or by ensuring

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188 *See* OST, *supra* note 85, art. I, 18 U.S.T. at 2412–13, 610 U.N.T.S. at 207–08. ("Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.").

189 Military and Paramilitary Activities in and Against Nicaragua (Nicar. v. U.S.), Judgment, 1986 I.C.J. 14, ¶ 202 (June 27); *see also Rule 20: Non-Intervention Principle*, *in* WOOMERA MANUAL, *supra* note 17, at 191–92.

alternatives for communications and sensors are in place.[190] In addition, because using ASAT weapons in the manner outlined above would constitute internationally wrongful acts, States Parties to the relevant treaties may respond with countermeasures. Countermeasures must aim to induce compliance by the offending state and may not be merely retaliatory.[191] They must not constitute a "use of force" under UN Charter Article 2(4).[192] The physical destruction of an ASAT weapon through kinetic force would almost certainly constitute a use of force and be unlawful.[193] While lawful countermeasures might include non-kinetic actions to disable the ASAT weapons, such as dazzling or jamming, these actions must remain proportionate to the initial wrongful act.[194]

A violation of the prohibition on the use of force requires some form of violence—generally understood to mean a kinetic destructive force.[195] The UN General Assembly's 1970 General Declaration on Principles of International Law Concerning Friendly Relations rejected a proposal to define "force" as encompassing "all forms of pressure, including those of a political or economic character, which have the effect of threatening the territorial integrity or political independence of any State."[196] It is widely accepted that economic coercion is *not* a use of force.[197] As discussed in greater detail under Scenario 3, only the small subset of cyber-attacks that produce kinetic effects sufficient to constitute an armed attack if carried out

190 Starling-Daniels & Massa, *supra* note 2.

191 Draft Articles, *supra* note 118, art. 49, Commentary ¶ 7 ("Countermeasures are taken as a form of inducement, not punishment."); Hathaway et al., *War Reparations*, *supra* note 118, at 977, 1020.

192 Draft Articles, *supra* note 118, art. 50 ("Countermeasures shall not affect . . . the obligation to refrain from the threat or use of force as embodied in the Charter of the United Nations.").

193 *See* Koplow, *supra* note 5, at 1202 (noting the violent nature of a kinetic action by explaining that the difference "between the kinetic and directed energy ASATs is the creation of space debris. When the interceptor rams into or detonates against its target, both spacecraft fragment into thousands of pieces; in contrast, a laser or particle beam weapon would usually not compromise the gross physical integrity of its target . . . .").

194 *See* Draft Articles, *supra* note 118, art. 51 ("Proportionality. . . . Countermeasures must be commensurate with the injury suffered, taking into account the gravity of the internationally wrongful act and the rights in question.").

195 Whether property destruction, on its own, is sufficient to constitute an armed attack remains a matter of some debate.

196 TALLINN MANUAL 2.0 ON THE INTERNATIONAL LAW APPLICABLE TO CYBER OPERATIONS 331 (Michael Schmitt & Liis Vihul eds., 2017) [hereinafter TALLINN MANUAL 2.0] (quoting U.N. General Assembly Special Committee on Principles of International Law Concerning Friendly Relations and Co-Operation Among States, U.N. Doc. A/AC.125/SR.110-14 (Sept. 1, 1970)).

197 At the 1945 UN Charter drafting conference in San Francisco, states considered and rejected a proposal to include economic coercion as a use of force prohibited under Article 2(4). 6 DOCUMENTS OF THE UNITED NATIONS CONFERENCE ON INTERNATIONAL ORGANIZATION 334–35(1945), https://digitallibrary.un.org/record/1300969?ln=en [https://perma.cc/U6FW-RUVU]; 3 DOCUMENTS OF THE UNITED NATIONS CONFERENCE ON INTERNATIONAL ORGANIZATION 252–53 (1945), https://digitallibrary.un.org/record/1300969?ln=en [https://perma.cc/C7T7-UV93].

through conventional means qualify as an armed attack triggering a right of self-defense.[198] Given these parameters, a cyber-attack on an ASAT weapon that does not reach the required level of kinetic damage would amount to a violation of international law warranting a proportional countermeasure. For instance, an in-kind cyber-attack may constitute a lawful countermeasure so long as it does not result in kinetic destructive force amounting to an armed attack. Other available countermeasures include economic sanctions. Lawful retorsions also always remain an available option—including withdrawing cooperation from the International Space Station.

Under the Liability Convention, the state conducting the attack would be liable for any damage caused to another state's space objects, but it is unclear whether liability for compensation would be abrogated by countermeasures doctrine. Under Article XII, compensation "shall be determined in accordance with international law and the principles of justice and equity."[199] Where lawful countermeasures are taken to disable ASAT weapons, a claims commission might reasonably refrain from imposing damages relief on the state taking countermeasures on the grounds that the state that committed an internationally wrongful act (which justified the countermeasures) is not entitled to compensation. The Articles on Responsibility of States for Internationally Wrongful Acts seem to support this outcome: "The wrongfulness of an act of a State not in conformity with an international obligation towards another State is precluded if and to the extent that the act constitutes a [lawful] countermeasure taken against the latter State."[200] Therefore, the disabling of an ASAT weapon as a lawful countermeasure should not give rise to financial liability under the Liability Convention.[201]

3. ASAT Weapons Used in an Armed Attack

While the possession of ASAT weapon capabilities on Earth or in space does not violate the OST nor does it warrant self-defense measures under international law, the use of force through a kinetic ASAT weapon—whether conventional or nuclear—that meets the "most grave" threshold of harm

198 *See* Oona A. Hathaway, Rebecca Crootof, Philip Levitz, Haley Nix, Aileen Nowlan, William Perdue & Julia Spiegel, *The Law of Cyber-Attack*, 100 CALIF. L. REV. 817, 841, 847 (2012); *cf.* TALLINN MANUAL 2.0, *supra* note 196, at 342 ("The case of cyber operations that do not result in injury, death, damage, or destruction, but that otherwise have extensive negative effects, remains unsettled.").

199 Liability Convention, *supra* note 86, art. XII, 24 U.S.T. at 2397, 961 U.N.T.S. at 192.

200 Draft Articles, *supra* note 118, art. 22.

201 The *Air Services Agreement* arbitration also supports the proposition that lawful countermeasures do not incur financial liability. There, the Tribunal determined that the United States' countermeasures against France were lawful and did not order the United States to compensate France for the financial impact of suspending Air France flights to Los Angeles. *See* Air Servs. Agreement (U.S. v. Fr.), 18 R.I.A.A. 416, 443–44 (1978).

would constitute an armed attack and trigger a state's right of self-defense. As earlier noted, there is some debate as to whether destruction of property alone is sufficient to meet this threshold or whether physical injury to a person is required.[202] Under the Registration Convention, the state of registry maintains jurisdiction and control over the satellite as its property.[203]

Scholars debate what actions constitute an armed attack. Though kinetic destruction caused by a projectile would qualify as an armed attack,[204] disagreement remains in non-kinetic contexts (e.g., in the context of cyber operations) about whether physical destruction of property alone can constitute a "most grave form[]" of the use of force required under international law to amount to an armed attack justifying a forceful response under Article 51.[205] This is particularly relevant with regard to dazzling, jamming, or similar non-kinetic disabling attacks on satellites.

Here, the developing law of cyber-attacks is instructive. The rise in cyber-attacks, which may not result in any discernible physical effects yet can inflict severe harm to a state's national security, has demonstrated the challenge of determining what constitutes an armed attack. A small subset of cyber-attacks—those that produce kinetic effects—amount to a use of force and perhaps even an armed attack. By resulting in physical destruction, the cyber-attack rises to the level of a use of force. However, the challenge remains to determine the level of physical destruction necessary to qualify as a "most grave form" of the use of force amounting to an armed attack.[206]

Under one test, a cyber-attack that foreseeably causes physical injury, loss of life, or property damage is one that inflicts harm severe enough to constitute an armed attack, thereby justifying self-defense in response.[207] However, other inquiries seeking to determine the severity of the harm caused by the cyber-attack may focus on different factors, such as the degree to which the attack infiltrated the victim state's territory.[208] The "Stuxnet" incident, in which malware introduced into air-gapped computers running nuclear centrifuges at Natanz nuclear facilities in Iran caused a change in the centrifuges' rotor speed with the goal of causing them to effectively self-destruct, has been the subject of significant analysis in the cyber context. The cyber-attack physically destroyed 900–1000 centrifuges worth hundreds of millions of dollars. The attack has been called "the launch of the world's first

202 *See supra* notes 125–27.

203 *Rule 7: Jurisdiction*, *in* WOOMERA MANUAL, *supra* note 17, at 85–87.

204 *See* Koplow, *supra* note 5, at 1200–02.

205 TALLINN MANUAL 2.0, *supra* note 196, at 341 (quoting Military and Paramilitary Activities in and Against Nicaragua (Nicar. v. U.S.), Judgment, 1986 I.C.J. 14, ¶ 191 (June 27)); Hathaway et al., *supra* note 198, at 844–45.

206 *See* Hathaway et al., *supra* note 198, at 841, 847. *See generally* THOMAS RID, CYBER WAR WILL NOT TAKE PLACE (2013).

207 Hathaway et al., *supra* note 198, at 848.

208 *Id.* at 847; TALLINN MANUAL 2.0, *supra* note 196, at 342, 346.

digital weapon."[209] The *Tallinn Manual*, an academic study on how international law applies to cyber operations, indicates that the experts consulted agreed that the incident was a "use of force" but disagreed over whether it amounted to an "armed attack."[210] In short, disagreement remains about whether mere property damage—even substantial property damage—is sufficient to trigger the right of self-defense.

Measures taken as an exercise of a state's right of self-defense in response to an armed attack must be necessary and proportionate and must comply with international humanitarian law. The DoD *Law of War Manual* affirms the importance of proportionality: "Force may be used in self-defense, but only to the extent that it is required to repel the armed attack and to restore the security of the party attacked."[211] Similarly, it states that the necessity condition requires that all peaceful pathways have first been exhausted so that they "provide no reasonable prospect of stopping the armed attack or threat thereof."[212] In embracing necessity and proportionality requirements for the use of force in self-defense, the Manual reflects the widely held understanding of international law.

C. Lawful Responses to Nuclear ASAT Threats

Nuclear-armed ASAT weaponry poses unique threats. The mere placement of a nuclear-armed ASAT weapon in space constitutes a clear violation of the OST and allows for retorsions[213] and countermeasures.[214] However, the devastating degree of harm that nuclear-armed ASAT weaponry can generate may heighten states' fears and make the limited remedies available under the OST seem weak. States may be tempted to take more forceful actions in anticipatory self-defense. The question, then, is in what contexts the deployment of a nuclear-armed ASAT would warrant self-defensive measures, allowing for an armed attack in response.

While the precise question of whether the deployment of a nuclear-armed ASAT weapon is an unlawful "threat or use of force" in violation of the UN Charter or justifies a response under Article 51 has not been authoritatively resolved, the lawfulness of the possession of nuclear weapons *has* been considered by the International Court of Justice (ICJ). The ICJ considered whether "possession of nuclear weapons is itself an unlawful

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209 KIM ZETTER, COUNTDOWN TO ZERO DAY: STUXNET AND THE LAUNCH OF THE WORLD'S FIRST DIGITAL WEAPON (2014).

210 TALLINN MANUAL 2.0, *supra* note 196, at 342; *see also* Kim Zetter, *Legal Experts: Stuxnet Attack on Iran Was Illegal 'Act of Force'*, WIRED (Mar. 25, 2013), https://www.wired.com/2013/03/stuxnet-act-of-force [https://perma.cc/3KX9-JQ5H].

211 LAW OF WAR MANUAL, *supra* note 97, at 41.

212 *Id.* at 42.

213 *Rule 24: Retorsion*, *in* WOOMERA MANUAL, *supra* note 17, at 241–42.

214 *Rule 25: Countermeasures*, *in* WOOMERA MANUAL, *supra* note 17, at 243–45.

threat to use force" in the *Nuclear Weapons Advisory Opinion*.[215] The ICJ concluded that possession of such weapons was not itself an unlawful threat to use force. It explained:

> Possession of nuclear weapons may indeed justify an inference of preparedness to use them. . . . Whether this is a "threat" contrary to Article 2, paragraph 4, depends upon whether the particular use of force envisaged would be directed against the territorial integrity or political independence of a State, or against the Purposes of the United Nations or whether, in the event that it were intended as a means of defence, it would necessarily violate the principles of necessity and proportionality. In any of these circumstances the use of force, and the threat to use it, would be unlawful under the law of the Charter.[216]

The court's opinion does not provide further details clarifying which nuclear armament scenarios would constitute violations of international law. However, given the many hundreds of warheads states maintained then—and maintain now—in their arsenals, it is clear that possession alone, without an intent to use nuclear weapons in a way that violates the Charter, does not constitute an unlawful threat of force.[217] Though many existing warheads are positioned for quick deployment against particular targets, that fact is not a threat to use force that justifies the use of force in self-defense. Rather, states must have clear and convincing evidence that there is an imminent threat—both the capability and the clear intent to attack on a timescale and in a manner that forecloses the use of non-forceful avenues of prevention—in order to lawfully employ force in self-defense.

Still, as discussed in Section I.B, some nuclear-armed ASAT weapons pose unique threats compared to conventional ballistic missiles because they can travel through low Earth orbit, evade traditional anti-ballistic missile defenses, and reduce cruise time before impact. A space-based ASAT weapon targeting another space object "could carry out an attack almost instantaneously from the time a decision was made to attack," unlike a ground-based kinetic ASAT weapon that could take several hours to reach its target in space.[218]

Above and beyond the threat posed to satellites, space-based weapons in low Earth orbit would enable a state to have global reach to carry out "prompt, on demand attacks" on the ground.[219] This prompt attack capacity

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215 *See* Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, ¶ 48 (July 8).

216 *Id.*

217 *Id.*

218 DAVID WRIGHT, LAURA GREGO & LISBETH GRONLUND, THE PHYSICS OF SPACE SECURITY: A REFERENCE MANUAL 8–9 (2005), https://aerospace.csis.org/wp-content/uploads/2019/06/physics-space-security.pdf [https://perma.cc/344P-ZKNW].

219 *Id.* at 15.

would shorten the warning window ahead of a strike.[220] While it would take a land-based missile approximately thirty minutes to reach the United States from Russia,[221] it could take a space-based weapon as little as ten to fifteen minutes to de-orbit and strike, if the satellite is in the optimal position.[222] This timeframe is similar to a submarine-based nuclear missile, which can strike in as little as fifteen minutes after launch.[223]

The legal analysis is the same for any space-based nuclear threat: For a threat to constitute an imminent attack warranting self-defense, an adversary must have both the capability and the intent to attack on a timescale and in a manner that forecloses non-forceful avenues of prevention.[224] Drawing on the imminence framework examined in Section II.C, a state may consider the nature, gravity, and immediacy of the threat. Weapons of mass destruction pose the gravest dangers, and the characteristics of nuclear-armed ASAT weapons make them particularly challenging to intercept. In addition, if these weapons are launched into space, they could pose a threat that exceeds that posed by ballistic missiles on Earth that have not been launched, given the shorter timeframe from orbit to impact.

ASAT weapons also present distinct threats compared to ballistic missiles by virtue of how difficult it is to determine the purpose of a space object as opposed to detecting its launch. Whereas missile launches leave unique heat and noise signatures that ground- and space-based sensors can detect, verifying the function of a space object is much more difficult.[225]

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220 *Id.* at 6; MICHAEL P. GLEASON & PETER L. HAYS, CTR. FOR SPACE POL'Y & STRATEGY, A ROADMAP FOR ASSESSING SPACE WEAPONS 3 (2020), https://aerospace.org/sites/default/files/2020-10/Gleason-Hays_SpaceWeapons_20201005_1.pdf [https://perma.cc/C8ZE-MPTB] ("[S]pace-to-space and space-to-Earth kinetic weapons would be difficult to defend against because their very high speeds and very brief flight times provide only an extremely limited window for warning and potential response options.").

221 UNION OF CONCERNED SCIENTISTS, FACT SHEET: FREQUENTLY ASKED QUESTIONS ABOUT TAKING NUCLEAR WEAPONS OFF HAIR-TRIGGER ALERT 1 (2015), https://www.ucsusa.org/sites/default/files/attach/2015/01/Hair-Trigger%2520FAQ.pdf [https://perma.cc/KTW7-GLAY]; *see also* OFF. OF THE DEPUTY ASSISTANT SEC'Y OF DEF. FOR NUCLEAR MATTERS, *Nuclear Delivery Systems*, *in* THE NUCLEAR MATTERS HANDBOOK (Rev. 2020), 1, 4, https://www.acq.osd.mil/ncbdp/nm/NMHB2020rev/docs/NMHB2020rev_Ch3.pdf [https://perma.cc/NBX6-B5H8] ("Intercontinental ballistic missiles . . . can strike their intended targets within 30 minutes or less of launch.").

222 WRIGHT, GREGO & GRONLUND, *supra* note 218, at 59, 91–92.

223 Bruce G. Blair, *The U.S. Nuclear Launch Decision Process*, GLOBAL ZERO (Oct. 2019), https://www.globalzero.org/wp-content/uploads/2020/11/Full-LOWTimeline.pdf [https://perma.cc/RW7U-BCZ7] (describing the time from launch to impact on Russia of U.S. sea-launched ballistic missiles).

224 *See supra* Section II.C.

225 Satellites can detect space launches using infrared and infrasound sensors to pick up on heat and noise signatures. Space situational awareness systems (SSAS) can observe midcourse adjustments and predict de-orbit and re-entry by detecting and predicting positions of space objects and potential impacts. But "[v]erifying the function of a particular space object already in orbit is significantly more difficult than detecting launch or re-entry." Ben Baseley-Walker & Brian

"Drones, ballistic missiles, and explosives detonated near satellites [could] all function as [kinetic]-ASAT[]" weapons.[226] To determine whether a space launch contains a conventional or nuclear weapon, states might look to the object's launch trajectory and orbit, payload characteristics, technology on board, spectral and radiological analysis, or other sources of intelligence and surveillance.[227] Though Russia claimed Cosmos 2553's purpose was electronics testing, the satellite's particular orbit belied its stated function.[228] Yet, the world did not learn of the dummy nuclear warhead in Cosmos 2553 until close to two years after it was launched, underscoring the difficulty in assessing a satellite's true function.[229]

If a nuclear-armed ASAT weapon is deployed to space, and assuming it is possible to discern that it *is* a weapon, the question then becomes whether it is possible to assess the intent to use the weapon in an attack and the immediacy of the threat. In the absence of clear and convincing evidence of those two elements, the threat would almost certainly not cross the threshold for lawful self-defense. Assuming, for example, the United States knew for certain that Russia had launched a nuclear-armed ASAT weapon into space, it would likely have to rely on intelligence collection to determine whether Russia intended to use that weapon for deterrence or whether it instead intended to use it in an attack. The gravity and nature of a nuclear-armed ASAT weapon certainly heightens the threat. Yet in the absence of

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Weeden, *Verification in Space: Theories, Realities and Possibilities*, 3 DISARMAMENT F. 39, 39–42 (2010), https://www.ipndv.org/wp-content/uploads/2017/11/UNIDIR_pdf-art3001-2.pdf [https://perma.cc/M883-S9EX]; *see also* Talia M. Blatt, *Anti-Satellite Weapons and the Emerging Space Arms Race*, HARV. INT'L REV. (May 26, 2020), https://hir.harvard.edu/anti-satellite-weapons-and-the-emerging-space-arms-race [https://perma.cc/GC8H-P8Z7] ("The dual-use nature of space infrastructure makes differentiating between weapon and non-weapon nearly impossible.").

226 Blatt, *supra* note 225.

227 Chemical, nuclear, electromagnetic, optical, thermal, infrared, and microwave sensors might help determine a space object's function based on the theory that "form follows function," and, given these tools, "a close examination of a satellite's design should reveal its function." Baseley-Walker & Weeden, *supra* note 225, at 42; *see also Defense Support Program Satellites*, U.S. SPACE FORCE (Oct. 2020), https://www.spaceforce.mil/About-Us/Fact-Sheets/Fact-Sheet-Display/Article/2197774/defense-support-program-satellites [https://perma.cc/VKB4-WVZG] (describing how U.S. Space Force satellites detect missile launches, space launches, and nuclear detonations via infrared sensors).

228 Theresa Hitchens, *New Details Emerge of Russia's Potential Nuclear Space Weapon*, BREAKING DEF. (May 3, 2024, 3:41 PM), https://breakingdefense.com/2024/05/new-details-emerge-of-russias-potential-nuclear-space-weapon [https://perma.cc/TL99-R5QF] (describing how the orbit of Cosmos 2553 through a region with a particular level of radiation contradicted Russia's claim that the satellite's purpose was to test electronics); Rebecca Connolly & Saadia M. Pekkanen, *Nuclear Threats in Space Demand New Diplomacy*, INTERPRETER (May 30, 2025), https://www.lowyinstitute.org/the-interpreter/nuclear-threats-space-demand-new-diplomacy [https://perma.cc/Z6RW-BQDZ] (discussing how Cosmos 2553 "entered an unusual, high-radiation 'graveyard' orbit at the outer edge of Low Earth Orbit").

229 Barnes et al., *supra* note 2.

clear intent to use the weapon with an immediacy that forecloses the possibility of a non-forceful response, a use of force in self-defense would not comply with Article 51 or customary international law. Although the deployment of a nuclear-armed space weapon is unlawful, the only lawful responses in this situation would be countermeasures, retorsions, or a request for compensation, as provided for in the OST and the Liability Convention.

CONCLUSION

This Essay has examined the ways in which states might lawfully respond to the deployment of ASAT weapons. It concludes that the deployment or use of such weapons in violation of the OST or Liability Convention may trigger non-forceful countermeasures. However, the placement of such weapons, including nuclear-armed ASAT weapons, in space does not by itself justify the use of force in self-defense without clear evidence of an intent to carry out an imminent attack. Asserting such a right would risk eroding constraints on the use of force and creating threats to states' space programs, which form an increasingly integral component of the functions of everyday life.

The conclusion that deployment of ASAT weaponry, including nuclear-armed ASAT weapons, does not justify defensive uses of force might be, we acknowledge, unsatisfying. International law cautions restraint to minimize the chance of catastrophic escalation—and with good reason. But the modest lawful responses available to states facing the potential deployment of a weapon whose use would be catastrophic might seem deeply problematic. If states are prohibited from deploying nuclear-armed ASAT weapons, but there is little a state can do when another state does just that, it would seem to render the prohibition ineffectual. Once the weapon is in place, a mere push of a button could wipe out the entire low Earth satellite network and, with it, global communications networks and all the other civilian services that rely on them. Because that would blind the military as well, such an act could precipitate a military conflict—an attack on the network may be interpreted as a precursor to something far worse. The inability to enforce the law regarding deployment of such weapons may itself become escalatory—encouraging states to match one another tit-for-tat in their deployment of unlawful ASAT weapons, increasing the chance that they may be used—with all the catastrophic effects that would have for life on Earth.

Existing international law, it is clear, is not sufficient to answer these questions. But it does not require states to remain utterly unresponsive to threats. As detailed above, there are many lawful responses available to states—including countermeasures and retorsions. Still, these can feel like weak tea in the face of such catastrophic threats.

The unfortunate truth, however, is that the extension of the nuclear weapons race from Earth to space is the extension of an existing existential threat rather than the creation of a new one. The world has lived with the reality of the nuclear threat now for over eight decades. Today, the United States has deployed 1,419 strategic warheads and Russia has deployed 1,549.[230] China, India, North Korea, the United Kingdom, France, Israel, and Pakistan all possess nuclear weapons, and many are actively working on developing their nuclear delivery systems.[231] In this context, pressing against international law's boundaries constraining the use of force may seem attractive for those who find inaction dissatisfying. But doing so is unlikely to solve the real problems we face. Picture the result: States blow up each other's rockets and satellites for fear they contain nuclear warheads, scattering debris on Earth and throughout space, and setting off a chain of destruction of the very space-based systems upon which the world relies. Attacking suspicious satellites would effectuate the very catastrophe states hope most to avoid.

Instead, the only real solution will come from government officials, diplomats, and experts working together to create new, enforceable, and effective arms control agreements. As difficult, perhaps even as impossible, as that may seem at this moment of a breakdown in global cooperation and diplomacy, it nonetheless remains our best hope at avoiding catastrophe.

230 *Nuclear Weapons: Who Has What at a Glance*, ARMS CONTROL ASS'N (Jan. 2025), https://www.armscontrol.org/factsheets/nuclear-weapons-who-has-what-glance [https://perma.cc/ESW6-G8U6].

231 *Id*.