To Serve Man: Controlling Humanity's Space Weaponry Through Legal Reviews—The Immediate Limitations and Hidden Strengths

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Abstract

The increase in the number of space-faring nations and the development and proliferation of space-based technology has increased the possibility both for military conflict in outer space and the potential devastation such conflict could cause. The laws of war, formulated over the last century and a half, have acted as a restraint on terrestrial warfare, but now face new challenges as warfare moves into space. This Thesis examines the application of the legal requirement to review the legality of new weapons systems on the likely or prospective weapons systems designed for warfare in and involving outer space. The rules were designed with terrestrial warfare in mind, and are likely to have little direct impact in banning space weapons. However, the more subtle limits governing the weapons actual use must also be considered during weapons reviews. This Thesis argues that the limitations considered in such reviews will be identified, addressed, and built in to state's larger doctrinal practices. These limitations and considerations in turn provide time and space to build and shape norms of restraint even in the absence of more direct rules and treaty agreements.

Résumé

Le nombre croissant de nations conduisant des activités dans l'espace et la prolifération des technologies spatiales augmentent la possibilité de conflit militaire dans l'espace ainsi que la dévastation potentielle qu'un tel conflit pourrait causer. Les lois de la guerre qui ont été formulées au cours du dernier siècle et demi, ont jusqu'à présent agi comme un frein à la guerre terrestre, mais font maintenant face à de nouveaux défis alors que la possibilité de conflit apparait également dans notre espace extra-atmosphérique. Cette thèse examine si l'obligation de réviser la légalité de tous nouveaux systèmes d'armes est applicable pour les armes conçus pour l'environnement spatial. Ces règles ont été créées avec la guerre terrestre à l'esprit et auront probablement peu d'impact direct sur l'interdiction des armes spatiales. Cependant, des limites plus subtiles régissant l'utilisation réelle des armes doivent également être prises en compte lors de l'examen de nouvelles armes. Cette thèse soutient que ces limites doivent être identifiées, abordées et intégrées aux pratiques doctrinales des États. Ces limites et ces considérations fourniront à leur tour du temps et de l'espace pour façonner des normes de restriction propre à l'espace extra-atmosphérique, même en l'absence de règles plus directes ou de traités.

Acronyms and Abbreviations

ABM	Anti-Ballistic Missile Treaty
AMW	Manual on International Law Applicable to Air and Missile Warfare
ASAT	Anti-Satellite
BBC	British Broadcasting Corporation
CCW	Convention on Certain Conventional Weapons
CISA	Cybersecurity & Infrastructure Security Agency
DOD	United States Department of Defense
DoDD	United States Department of Defense Directive
EMP	Electromagnetic Pulse
ENMOD	Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques
ESA	European Space Agency
GEO	Geostationary Orbit
GLONASS	Globalnaya Navigazionnaya Sputnikovaya Sistema, or Global Navigation Satellite System
GNSS	Global Navigation Satellite System
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
GSO	Geosynchronous Orbit
HPM	High-Powered Microwave
ICBM	Intercontinental Ballistic Missile
ICJ	International Court of Justice

ICRC	International Committee of the Red Cross
ISR	Intelligence, Surveillance, and Reconnaissance
LEO	Low Earth Orbit
LOAC	Law of Armed Conflict
MEO	Medium Earth Orbit
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NTM	National Technical Means
OST	Outer Space Treaty
PGM	Precision-guided munition
PPWT	Prevention of Placement of Weapons in Outer Space Treaty
PTBT	Partial Test-Ban Treaty
SC	Security Council
SCA	Space Coordinating Advisor
SDI	Strategic Defense Initiative
SIPRI	Stockholm International Peace Research Institute
UAV	Unmanned Aerial Vehicle
UK	United Kingdom
UN	United Nations
UNIDIR	United Nations Institute for Disarmament Research
US	United States

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Introduction

From its earliest days, human activity in outer space proceeded under conflicting conditions: hope that space would be the one domain that would—finally—remain free of the scourge of war; while those activities have been hopelessly entangled with and driven by the needs of the military and state security.[1]

The earliest objects in space—V2 rockets launched by Nazi Germany in 1945—were weapons of war, designed to evoke terror in England.[2] The first human object placed into orbit—Sputnik, launched by the Soviet Union in 1957—was a military object.[3] The first cosmonauts and astronauts were military.[4] The competition and arms race between Cold War rivals served as the driving force in the early Space Race.[5]

Yet despite this inauspicious beginning, the space domain has also been characterized by continued attempts at creating a peaceful environment. The first major international agreement concerning outer space, the Outer Space Treaty, recognized "the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes."[6] It placed concrete, if limited, prohibitions on the militarization of outer space.[7] The Partial Test-Ban Treaty of 1963 limited nuclear testing in the atmosphere and in outer space for the parties, which included the then-nuclear powers.[8] Despite space becoming increasingly important for terrestrial

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[1] Michel Bourbonnière, "National Security Law in Outer Space: The Interface of Exploration and Security" (2005) 70 J. Air L. & Com. 3 at 3. (Discussing the basic contradiction.).
[2] Duncan Blake & Joseph Imburgia, "'Bloodless Weapons?' The Need to Conduct Legal Reviews of Certain Capabilities and the Implications of Defining Them as 'Weapons'" (2010) 66 A.F. L. Rev. 157 at 191.
[3] Paul B. Larsen, "Outer Space Arms Control: Can the USA, Russia and China Make this Happen" (2018) J Conflict Security Law (2018) 23 (1): 137.
[4] Yuri Gagarin (Soviet) and Alan Shepherd (American) were both in the military and the first two humans in space. Smithsonian Air and Space Institute, "Racing to Space: Gagarin and Shepherd" online <airandspace.si.edu/gagarin-vs-shepard> [perma.cc/Z3RY-4HRN]. In addition, the U.S. Mercury program consisted entirely of military test pilots. Robert Ramey, "Armed Conflict on the Final Frontier: The Law of War in Space" (2000) 48 A.F. L. Rev. 1 at 151 n.640.
[5] Bourbonnière, *supra* note 1 at 3.
[6] Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Jan. 27, 1967, 720 U.N.T.S. 8843, Can. T.S. 1967 No. 19, T.I.A.S. 6347 [OST].
[7] *Ibid.*, Art. IV. (Barring the placement of nuclear weapons in space and restricting use of the Moon and other celestial bodies for exclusively peaceful purposes.).
[8] Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, 5 August 1963, 14 UST 1313, TIAS No 5433, 480 U. N. TS 43 (entered into force 10 October 1963) [Partial Test-Ban Treaty].

activities and increasingly crowded with more satellites launched by more states, warfare has not yet come directly to outer space.[9]

But every day, the possibility for war in space increases. In December 2019, the North Atlantic Treaty Organization (NATO) declared outer space to be an operational domain for its military alliance.[10] The United States, the largest space power, created Space Force as an independent branch of its military in 2019.[11] China and Russia recently re-organized their military space operations, giving them a higher organizational priority.[12] More and more countries are taking to the stars, placing satellites in orbit, and developing civilian and military capabilities based on satellites. There are a number of threats to the peace, and questions as to whether the laws of space or armed conflict are sufficient to deter a true war in space.[13]

Among the greatest challenges to preserving the peace are the limitations of the laws of armed conflict (LOAC). The laws have developed through both customary international law and international agreements, principally the Geneva Conventions.[14] Those Conventions, in turn, had

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[9] *See, e.g.,* Steven Freeland, "'War in Space' Would be a Catastrophe. A Return to Rules-Based Cooperation is the Only Way to Keep Space Peaceful" (Nov. 30, 2020) The Conversation.

[10] London Declaration, Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in London, 3-4 December, 2019, 115 NATO Press Release, online: <www.nato.int/cps/en/natohq/official_texts_171584.htm> [perma.cc/TP53-DG3R].

[11] Section 952 of the National Defense Authorization Act for Fiscal Year 2020, Pub. L. 116-92, 133 Stat. 1198 (Dec. 20, 2019) [NDAA 2020].

[12] Brian Weeden & Victoria Samson, "Global Counterspace Abilities" (Apr. 2021) Secure World Foundation, p. xvi (China) & xviii (Russia), online (pdf): <swfound.org/media/207162/swf_global_counterspace_capabilities_2021.pdf> [perma.cc/8ETJ-G522].

[13] *See, e.g.,* Cort S. Thompson, "Avoiding Pyrrhic Victories in Orbit: A Need for Kinetic Anti-Satellite Arms Control in the Twenty-First Century" (2020) 85 J. Air L. & Com. 105 at 105. (Arguing the regime of regulating anti-satellite weapons is ineffective.). Ross Brown, "Conflict on the Final Frontier: Deficiencies in the Law of Space Conflict, and How to Remedy Them" (2019) 51 Geo. J. Int'l L. 11 at 11. (Arguing that weaknesses in the prohibition on the use of force and the requirement of injury-centric proportionality "render countermeasures ill-equipped to address conflict in outer space".). David A. Koplow, "The Fault is Not in Our Stars: Avoiding an Arms Race in Outer Space" (2018) 59 Harv. Int'l L.J. 331 at 331. [The Fault is Not in Ours Stars]. (Noting the process for formulating new agreements and norms in space has broken down.).

[14] Geneva Convention for the Amelioration of the Condition of the Wounded in Armies in the Field, Aug. 22, 1864, 75 U.N.T.S. 31, 22 Stat. 940 (1865) [1864 Geneva Convention]; Geneva Convention Relative to the Amelioration of the Wounded and Sick in Armed Forces in the Field, Aug. 12, 1949, 6 U.S.T. 3114 (1949) [Geneva Convention I]; Geneva Convention for the Amelioration of the Condition of Wounded, Sick and Shipwrecked Members of the Armed Forces at Sea, Aug. 12, 1949, 6 U.S.T. 3217, 75 U.N.T.S. 85 [Geneva Convention II]; Geneva Convention Relative to the Treatment of Prisoners of War, Aug. 12, 1949, 6 U.S.T. 3316, 75 U.N.T.S. 135 [hereinafter Geneva Convention III]; Geneva Convention Relative to the Protection of Civilian Persons in Time of War, Aug. 12, 1949, 6 U.S.T. 3516, 75 U.N.T.S. 287 [Geneva Convention IV]; Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I), June 8, 1977, 1125 U.N.T.S. 3 [Additional Protocol I]; Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Victims of Non-International Armed Conflicts (Protocol II) of 8 June 1977, 1125 U.N.T.S. 609 [Additional Protocol II].

their genesis in the observations of banker Henry Dunant following the bloody Battle of Solferino in 1859. His work "Un Souvenir de Solferino" (A Memory of Solferino) is widely credited with leading to the foundation of the International Red Cross and the first Geneva Convention in 1864.[15] Over time, international conventions of states crafted rules to limit harm to noncombatants and the pain and suffering of combatants.[16]

As states develop new technologies and weapons to engage in prospective warfare in outer space, they must ensure that these weapons comply with the laws of armed conflict prior to their deployment.[17] This presents an opportunity to limit the development and proliferation of weapons and means and methods of warfare which might cause irretrievable harm to the space environment and the people on Earth who depend upon it. Yet the space domain is largely devoid of humans: the few astronauts present at any time are considered "envoys of mankind" and are likely to be noncombatants—nor in any event is it likely that astronauts will be a principal instrument of war in the foreseeable future.[18] The laws have a weakness: they were crafted with bloody terrestrial warfare in mind, but do not address the likely concerns of warfare in space.

LOAC's primary purpose is to regulate and mitigate the use of violence in warfare, for the benefit and protection of civilians, civilian objects, neutral parties, and combatants.[19] Yet in a largely anarchic international system, states act in accordance with their interests, and in matters of security most of all.[20] Dating back at least to the Peloponnesian War, the principle that the "strong do what they will and the weak suffer what they must" pervades international relations and the conduct of warfare.[21] Even with the emergence of firmer obligations and international

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[15] Francois Bugnion, "Birth of an Idea: The Founding of the International Committee of the Red Cross and of the International Red Cross and Red Crescent Movement" (2012) 94:888 International Review of the Red Cross at 1299-1338.
[16] See *supra* note 14.
[17] Additional Protocol I, *supra* note 14, Art. 36. (Discussed *infra.*).
[18] Ramey, *supra* note 4 at 150-53. (The status of astronauts, though noting they easily could be combatants, concluding that so long as they do not engage in combat activities, they would be regarded as "envoys," essentially enjoying diplomatic status.).
[19] Laurie R. Blank & Geoffrey S. Corn, "Losing the Forest for the Trees: Syria, Law, and the Pragmatics of Conflict Recognition" (2013) 46 Vand. J. Transnat'l L. 693 at 709. *See also* United States Dep't of Defense Law of War Manual, (Dec. 2016) ¶ 1.3.4. [DOD LOAC Manual].
[20] Mohamed S. Helal, "Justifying War and the Limits of Humanitarianism" (2014) 37 Fordham Int'l L.J. 551 at 554. (The traditional international relations view "depict[s] world affairs as an anarchic realm populated by coequal, mutually suspicious, sovereign states). Kenneth Waltz, *Theory of International Politics* (Reading, Ma.; Addison-Wesley Publishing Co., 1979) at 126. ("In anarchy, security is the highest goal").
[21] Thucydides, (Rex Warner, ed.), *History of the Peloponnesian War* (Baltimore, Md: Penguin Books., 1954) Book 5, "The Melian Debate" at 359. S*ee generally* Julian W. Korab-Karpowicz, *Political Realism in International*

institutions that first arose in the late 19th century, the power of the law remains subordinate to the needs of states.[22] The prospect of a new domain for warfare in outer space, in a completely different environment than the rules and systems were created to regulate, create even more opportunity for security-minded states to act aggressively without stepping outside of the law.

This Thesis argues that the requirement to review new weapons for their compliance with the laws of armed conflict provides ample room for states to pursue their self-interested security objectives, but fails to achieve significant limitation on the proliferation of weapons and the means and methods of warfare in space. This is the result not only of the soft legal system pervading international law, but specifically because the legal regime, designed for terrestrial warfare, has not caught up with the new challenges in space. This Thesis concludes that while the law's inability to curb the development of weapons, means, and methods of warfare in the review process, it sees more promise in the review process' consideration of how otherwise legal weapons may—and may not—be used in actual operations. The limitations on individual targets and operations may place more relevant limitations, but because they are highly situational, they will be of modest effect in limiting the proliferation of the means of destruction in space. However, it concludes by finding value in the review process as a whole, in forcing states to assess their weapons early in ensuring such legal limitations or concerns are considered alongside the development of weapons and doctrine concerning their usage. This provides adequate room for states to pursue their security needs while providing means by which legal, practical, and normative limitations on use can develop.

This Thesis first provides an overview of the space environment as it is utilized by humanity in the early 21st century, including the civilian and military uses derived from space. It then examines the developments in military capabilities, both proven and speculative, whose existence creates a threat to the peace in outer space.

The Thesis examines the requirement under Article 36 of the Geneva Conventions, Additional Protocol I, or alternatively under customary international law, to review new weapons, means, and methods of warfare. Next, the Thesis looks at the requirements of the law

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Relations, The Stanford Encyclopedia of Philosophy (Summer 2018 Edition), Edward N. Zalta (ed.) (Summarizing the history of realism in international relations, beginning with the Melian Dialogue.).

[22] *See* Thomas M. Frank, "The Power of Legitimacy and the Legitimacy of Power: International Law in an Age of Power Disequilibrium" (2006) 100 A.J.I.L. 88 at 90-91. (Scholars who question the degree to which the laws on use of force have acted to limit violence, instead of, where successful, simply coinciding with states acting in accordance with their interests.).

of armed conflict which apply to new weapons, and how those will be expected to apply to space weaponry. Finding those rules provide few instances of *per se* illegality, it looks to the portion of the legal review process that identifies potential limitations and issues on how an otherwise legal weapon can be used. Finally, the Thesis examines how the limits on space weaponry fit within the larger picture of operations and doctrine.

Methodologically, the Thesis will start by examining the treaty language where applicable. It will analyze its meaning and application based on the opinions of learned scholars in the field, the opinions of states through their practice and stated legal opinions, and in some instance through court opinions, largely relying on the International Court of Justice. Moving beyond treaty law, the Thesis will rely again on scholarly opinion and court opinions in understanding the state of customary international law. It will look to state practice to help assess the validity of these claims, both what rules are customary and how those rules might apply. The use of sources, particularly on state practice, is strongly weighted by drawing from Western nations, and the United States and its NATO allies in particular. This is largely out of necessity, as those states tend to provide the most commentary and published doctrine and regulatory manuals. However, even without a robust source of commentary from non-United States-aligned sources, such as China, India, and Russia, the Thesis seeks to soften this limitation by assessing the publicly-known practices of those states.

I. Chapter 1 - Background

A. The Space Environment

In terms of human activity, satellites provide the vast majority of the commercial and technological benefits to humanity derived from outer space. While space may appear vast and limitless, there are a limited number of standard orbital planes which satellites occupy, each with a finite number of positions. Satellites in Low Earth Orbit (LEO) occupied an orbital plane between 160 to 1000 kilometers above Earth's surface.[23] Because this type of orbit is the closest to Earth's surface, it is the most common location for satellites used for remote imaging, both commercially and for intelligence-gathering.[24] Additionally, some telecommunications

[23] "Types of Orbits" (Mar. 30, 2020), European Space Agency, online: <www.esa.int/Enabling_Support/Space_Transportation/Types_of_orbits> [perma.cc/PK9Y-ELQN].
[24] *Ibid.* Michel Bourbonnière, "Law of Armed Conflict (LOAC) and the Neutralisation of Satellites or *Jus In Bello Satellitis*" (2004) 9 C&S Law 43 at 55. [*Jus In Bello Satellitis*].

companies place their satellite constellations in LEO, such as Iridium, which provides satellite phone and transceiver communications.[25]

Satellites in Geosynchronous Orbit (GSO) possess the unique ability to orbit the Earth at the same speed as Earth's rotation—taking 23 hours, 56 minutes, and 4 seconds to complete a single orbit.[26] Those satellites aligned along the equator are said to be in Geostationary Orbit (GEO), traveling in a circular orbit about 35,786 kilometers from Earth, which allows them to remain in the same position relative to a location on Earth's surface.[27] All satellites at this altitude are aligned along the equator.[28] This orbital location is particularly useful for telecommunications satellites—as it provides the receiver on Earth a fixed location to target—and for weather satellites.[29] However, this orbital location is a poor fit for remote sensing satellites due to the distance from Earth, as well as telecommunications requiring back-and-forth communication, due to the .25 second delay in signal travelling from Earth to the satellite and back again.[30]

Satellites in Medium Earth Orbit (MEO) travel between LEO and GEO.[31]`This plane hosts constellations of satellites used for navigation such as the Global Positioning System (Navstar), GLONASS, and Galileo.[32] It is also home to a series of communications satellites.[33] There are additional specific orbital paths, such as polar, sun synchronous, and Molniya orbits, which are utilized for different tasks.[34]

The sky may seem limitless, but it is rapidly growing crowded. As of 2021, approximately 3,300 satellites orbit the Earth.[35] Entities from approximately 70 states operate at

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[25] Iridium Communications Network, online: <www.roadpost.com/iridium-satellite-network> [perma.cc/T2LT-B4WY]. A satellite constellation is "number of similar satellites, of a similar type and function, designed to be in similar, complementary, orbits for a shared purpose, under shared control." International Astronomical Union, "Satellite Constellations" online: <www.iau.org/public/themes/satellite-constellations/> [perma.cc/8USA-3RRP].
[26] Thompson, *supra* note 13 at 109 n.13.
[27] *Ibid.*; ESA, "Types of Orbits" *supra* note 23.
[28] *Ibid.*
[29] *Ibid.*
[30] *Ibid.*; Roscoe M. Moore, III, "Business-Driven Negotiations for Satellite System Coordination: Reforming the International Telecommunication Union to Increase Commercially Oriented Negotiations Over Scarce Frequency Spectrum" (1999) 65 J. Air L. & Com. 51 at 57. (citing the delay in relaying a signal at that distance and its negative implications for certain telecommunications applications)
[31] ESA, "Types of Orbits" *supra* note 23.
[32] *Ibid.*; "What's In Space?" (May 17, 2006), online: *Union of Concerned Scientists* <www.ucsusa.org/resources/whats-space> [perma.cc/7ZH6-9253].
[33] Thompson, *supra* note 13 at 109 n.12.
[34] *Ibid.*; ESA, "Types of Orbits" *supra* note 23.
[35] "UCS Satellite Database" (Jan. 1, 2021) online: *Union of Concerned Scientists* <www.ucsusa.org/resources/satellite-database> [perma.cc/E3UJ-YJN6].

least one active satellite.[36] At least 13 nations have demonstrated independent launch capability.[37] The commercial satellite industry reported $271 billion in revenue in 2019, up from $189 billion in 2012, an increase of 50% in only 7 years.[38]

All of these numbers—satellites, launching states, and operator states—are only likely to increase in the coming years. As technology improves, more smallsats—satellites less than 600 kg—will be launched, perhaps as many as 800 per year by the end of the decade.[39] SpaceX plans to launch as many as 12,000 satellites for its Starlink mega constellation by the end of the decade, with other entities such as OneWeb and Amazon launching thousands of their own.[40] States such as Argentina, Brazil, and the Philippines are making concerted efforts to develop independent launch capabilities.[41]

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[36] *Ibid.* The number includes 70 unique states alone or in conjunction, as well as satellites that are multinational or operated by the E.S.A. This includes both satellites directly controlled by the government of the state, or a corporation or entity subject to the jurisdiction of that state, as under the Outer Space Treaty, a state is responsible for the activities of any entity operating. OST, *supra* note 6, Article VI.

[37] Ram S. Jakhu, Kuan-Wei Chen & Bayar Goswami, "Threats to Peaceful Purposes of Outer Space: Politics and Law, Astropolitics" (2020) 18:1 The International Journal of Space and Space Politics 22 at 26. (noting there are 13 states with launch capability); Deborah Housen-Couriel, "Cybersecurity and Anti-Satellite Capabilities (ASAT): New Threats and New Legal Responses" (2015) 4 J.L. & Cyber Warfare 116 at 123 n.19. (Listing 13 states of the United States, Russia, China, India, Iran, Israel, North Korea, Japan, France, U.K., the Soviet Union, Ukraine, and South Korea. Of these, the U.K. and France each had launch capability but now operate under the E.S.A.). "Member States & Cooperating States", European Space Agency, online: <www.esa.int/About_Us/Corporate_news/Member_States_Cooperating_States> [perma.cc/4UM5-KNDE]. The Soviet Union ceased to exist in 1991, succeeded by several states Ukraine and Russia among them. Finally, South Korea has successfully launched 1 satellite into orbit as of 2021. "(Naro) Naro-1 Space Rocket Carries Future of S. Korean Satellites" (Jan. 30, 2013) Yonhap News Agency, online: <en.yna.co.kr/view/AEN20130129005400320> [perma.cc/AH7M-Y6UT]. Ukraine had such capability but has no present operational launching facility. For a further discussion of present launch capabilities, *see* Thompson, *supra* note 13 at 116 n.45.

[38] "State of the Satellite Industry Report (SSIR)" (2020) Satellite Industry Association, online: <satellitemarkets.com/market-trends/satellite-industry-grows-record-setting-pace-according-sia-annual-report> [perma.cc/J5HV-UQXX] (2019 numbers).; Bhupenda Jasani & Ram Jakhu, "Overview of Commercialisation in Space" (2014) *Commercialisation of Space: Opportunities and Challenges,* at 5. (2012 numbers); note that both exclude remote sensing, but includes manufacturing, launch, and operational value.

[39] "Global Prospects for the Small Satellite Market, 2018-2022" Globe Newswire, online: <www.globenewswire.com/news-release/2019/03/27/1774017/0/en/Global-Prospects-for-the-Small-Satellite-Market-2018-2022.html?culture=en-us> [perma.cc/827M-JPSX].

[40] Jonathan O'Callaghan, "The Risky Rush for Mega Constellations" (Oct. 31, 2019) Scientific American, online: <www.scientificamerican.com/article/the-risky-rush-for-mega-constellations> [perma.cc/LD9D-X36E].

[41] Argentina's TRONODOR rocket program, *see* "Argentina's Space Program Sets Its Sights on Indigenous Launch Capabilities" (Jul. 20, 2016) World Politics Review, online: <www.worldpoliticsreview.com/trend-lines/19423/argentina-s-space-program-sets-its-sights-on-indigenous-launch-capabilities> [perma.cc/XH48-JYQ8]. Brazil signed an agreement with Virgin Orbit to develop the capability to launch satellites into orbit in April 2021. Virgin Orbit, Press Release, "Virgin Orbit Selected to Bring Orbital Launch Capabilities to Brazil" (Apr. 28, 2021), online: <spaceref.com/news/viewpr.html?pid=57345> [perma.cc/G2DX-JDZR]. The Philippines working with Orbital Exploration Technologies to develop suborbital launch vehicles by the middle of the 2020's. Joe Devanesan, "Philippines Wants to be a Leader in Green Space" (Nov. 6, 2020) Tech Wire Asia, online: <techwireasia.com/2020/11/philippines-wants-to-be-a-leader-in-green-space-tech> [perma.cc/N233-DV8E].

Aside from increasing the number of states that rely directly upon and have a direct stake in outer space assets, the massive increase in satellites occupying limited orbital paths contributes to the problem known as Kessler's Syndrome. First described by the syndrome's namesake in 1978, it posits that a collision in orbitals paths between space objects—whether between two satellites, or between a satellite and another space object such as a meteor—will lead to more debris. This additional debris in turn increases the probability of further collisions, further collisions will create more debris, leading to an increased risk of collision, until an orbital path becomes unusable.[42] Given the tremendous speeds debris in such orbital pathways can move—between 7 to 10 km/s[43]–and how long it may remain there before its orbit decays—up to a century or more at higher orbits[44]—the risk of rendering key orbits such as LEO unusable is a very real concern.[45]

B. Applications

As space traffic grows in size and complexity, and carries with it the potential for an orbital apocalypse, the degree to which those back on Earth depend on the utilization of those space assets is also increasing rapidly.

The Global Positioning System consists of a constellation of satellites owned by the U.S. government.[46] The system is designed such that there are at least 4 satellites within line-of-sight of any location on Earth at a given time.[47] A person on Earth with a receiver that communicates with the satellites can determine their exact position.[48] While originally intended for military use, the U.S. opened it to public use in 1983, with the system becoming fully functional in 1995 upon

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[42] For the initial work, *see* Donald J. Kessler & Burton G. Cour-Palais, "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt" (1978) 83 J. Geophysical Res. 2637 at 2637. For a concise summary of the problem, *see* Paul B. Larsen, "Solving the Space Debris Crisis" (2018) 83 J. Air L. & Com. 475 at 476-78.
[43] NASA Orbital Debris Program Office, Frequently Asked Questions, online: <orbitaldebris.jsc.nasa.gov/faq> [perma.cc/58KV-CJM2].
[44] Larsen, "Solving the Space Debris Crisis" *supra* note 42 at 478. (discussing the Inter-Agency Space Debris Coordination Committee (IADC) Space Debris Mitigation Guidelines developed as an attempt to limit the debris).
[45] David A. Koplow. "Asat-isfaction: Customary International Law and the Regulation of Anti-Satellite Weapons" (2009) 30 Mich. J. Int'l L. 1187 at 1206. [Asat-isfaction]. Jeffrey A. Murphy, "The Cold Vacuum of Arms Control in Outer Space: Can Existing Law Make Some Anti-Satellite Weapons Illegal?" (2019) 68 Clev. St. L. 125 at 138. Jesse Oppenheim, "Danger at 700,000 Feet: Why the United States Needs to Develop a Kinetic Anti-Satellite Missile Technology Test Ban" (2013) 38 Brooklyn J. Int'l L. 761 at 780.
[46] "Space Segment" GPS, online: <www.gps.gov/systems/gps/space> [perma.cc/F8B4-AK4N].
[47] *Ibid.*; "How GPS Works" GPS, online: <www.gps.gov/multimedia/poster/poster.txt> [perma.cc/C84F-QP2J]. (explaining the process of how location is determined by sending signals between a device and four satellites, then using the satellites' positions and accounting for the time the signals took to travel to determine the device's location on earth).
[48] *Ibid.*

the launching of the 24th satellite to complete the constellation and ensure full coverage.[49] Similar services are provided by Galileo (European Space Agency), BeiDou (China), and GLONASS (Russia).[50] Collectively, they form the basis of the Global Navigation Satellite System (GNSS).[51]

The civilian applications of satellite navigation touch most major sectors of the economy. Airplanes rely on the system as a critical navigation component.[52] Marine shipping utilizes the system for navigation, safety, and security.[53] Adoption of the system in agriculture has made effective land management more efficient and precise.[54] Individuals employ the technology for day-to-day navigation.[55] GPS has fueled the rise of ride-sharing services such as Uber and Lyft, and is integrated into new driverless automobile technology that may define the future of ground transportation.[56] In total, the cost of the loss of use of the system has been estimated at as much as $1 billion per day in 2019.[57]

Satellites serve a critical role in telecommunications. Both satellite and cable television rely on satellites: the former to directly send signals to the consumer, the latter to relay broadcast to "headends," from which the proverbial cable carries the signal to consumers.[58] Satellite radio operates similarly, by sending signal to satellites, then to ground stations and out to receivers.

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[49] *Ibid.*; Nathan J. Buchok, "Plotting a Course for GPS Evidence" (2010) 28 Quinnipiac L. Rev. 1019 at 1021 n.7 & n.12. (regarding the order in 1983 to make GPS available to civilians and the launch of the 24th satellite in 1995). As of January 2021, there were 31 operational satellites, not counting on-orbit backups. "Space Segment" GPS, *supra* note 46.

[50] Paul B. Larsen, "International Regulation of Global Navigation Satellite Systems" (2015) 80 J. Air L. & Com. 365 at 366-71. (summarizing the systems as of 2015, as well as noting prospective systems by Japan and India).

[51] *Ibid.*

[52] "Applications" GPS, online: <www.gps.gov/applications> [perma.cc/QM82-7NBT]. ("Reliance on GPS as the foundation for today and tomorrow's air traffic management system is a major part of many national plans.").

[53] *Ibid.*

[54] Johnathan Coppess, "A Return to the Crossroads: Farming, Nutrient Loss, and Conservation" (2017) 39 U. Ark. Little Rock L. Rev. 351 at 379. (discussing Uber and Lyft).

[55] "Applications" GPS, *supra* note 52.

[56] Joseph W. McHugh, "Looking Through the (Mis)Classifieds: Why Taskrabbit is Better Suited Than Uber and Lyft to Succeed Against a Worker Misclassification Claim" (2018) 66 Clev. St. L. Rev. 694 at 653. (discussing Uber and Lyft). Harry Surden & Mary-Anne Williams, "Technological Opacity, Predictability, and Self-Driving Cars" (2016) 38 Cardozo L. Rev. 121 at 142-43. (discussing the use of GPS in self-driving cars, noting it is necessary but not sufficient).

[57] "Economic Benefits of the Global Positioning System (GPS)" (2019) National Institute of Standards and Technology at 14.2, online (pdf): <www.rti.org/sites/default/files/gps_finalreport.pdf> [perma.cc/KL5C-T9SX] (in estimating the costs of a 30-day outage).

[58] Reporter, "Allocating Copyright Liability to Telecommunications Common Carriers Supplying Cable Systems" (1983) 67 Minn. L. Rev. 963 at 967. (describing the process for cable television transmission).

and nearly 35 million subscribe to Sirius/XM, the largest such provider.[59] Ordinary commerce also depends on satellites, as credit card transactions utilize satellites to transmit information.[60]

Satellites also provide communication to areas too remote or underdeveloped for land-based infrastructure. Satellite phones, for example, allow for communication in even the most remote areas.[61] Internet is increasingly becoming viable via satellite as well. SpaceX's Starlink proposes to provide internet and telecommunication services via satellite to consumers in remote or underdeveloped locations at competitive prices, with some 900 satellites in orbit already, and thousands more proposed.[62] Other entities, such as Amazon, Facebook, and Google, also aim to get into the field.[63]

Remote sensing, or using satellites to take images of earth's surface, is increasingly valuable. The remote sensing market is expected to grow to $22 billion by 2022, though only a portion of that comes from satellites.[64] Satellite imaging is commercialized by selling high-resolution images to news and media organizations, mapping and navigation projects such as Google Earth, locating natural resources, watching for natural disasters, measuring climate change, and even monitoring compliance with environmental regulations.[65]

Meteorological satellites provide critical data on Earth's changing weather systems.[66] In 1960, the United States launched TIROS, the first weather satellite.[67] Sixty years later, several

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[59] Andrea Zarczynski, "Record High 34.9 Million Paid Subscribers Marks SiriusXM Milestone Year" (Jan. 7, 2020) Forbes. (34.9 million subscribers utilizing satellite radio in 2020).
[60] 3 Jeffrey J. Wong & Barry A. Dubin, Equipment Leasing ¶ 30.01 n.2, n.4 (LexisNexis).
[61] *Ibid.* n.5.
[62] Ram Jakhu, Upsana Dasgupta, & Steven Freeland, "Back to the Future: Space Law in a Networked World" (2020) 71st International Astronautical Congress, IAC at 4-5.
[63] *Ibid.*
[64] "Report Remote Sensing Services Market Will Worth $ 21.62 Billion by 2022" (Oct. 31, 2017) Geospatial World, online: <www.geospatialworld.net/news/remote-sensing-services-market-will-worth-21-62-billion-2022-report> [perma.cc/7822-7X6Y]. (Citing the $22 billion number, but note that it includes imagery from air rather than solely space). "Commercial Satellite Imaging Market Outlook – 2026" (Aug. 2019) Allied Market Research. (The 2018 value of the commercial satellite imaging market was $2.24 billion, with anticipation of it growing to over $5.25 billion by 2026, more than doubling in 8 years).
[65] Anne Toomey McKenna, Amy C. Gaudion, & Jenni L. Evans, "The Role of Satellites and Smart Devices: Data Surprises and Security, Privacy, and Regulatory Challenge" (2019) 123 Penn. St. L. Rev. 591 at 612-15 & 630 n.199. Allison F. Gardner, "Environmental Monitoring's Undiscovered Country: Developing a Satellite Remote Monitoring System to Implement the Kyoto Protocol's Global Emissions-Trading Program" (2000) 9 N.Y.U. Envtl. L.J. 152 at 193. (Discussing LANDSAT, the first resource-monitoring satellite, as well as climate change and environmental compliance satellites.).
[66] Meteorological satellites are sometimes grouped with remote sensing satellites, and sometimes divided into a distinct class. *See, e.g., Ibid.* (Discussing the meteorological value of remote sensing satellites.). Bourbonnière, "*Jus in Bello Satellitis*" *supra* note 24 at 52-53. (Listing meteorological satellites as one distinct group, separate from remote sensing.).
[67] Gardner, *supra* note 65 at 193.

nations possess constellations of such satellites, such as the United States' GOES-EAST and GOES-WEST, Japan's Himiwari, and Europe's Meteosat.[68] These satellites provide not only data on daily weather, but also track hurricanes, forest fires, volcanic eruptions, and monitor climate change and oceanographic data.[69]

For as much as terrestrial society has become dependent upon outer space, militaries have become even more reliant upon it. GPS was developed for military purposes, so it should come as no surprise that the United States has utilized it heavily for that very purpose. During the Gulf War, GPS "enabled military units in the vast desert to pinpoint and report their location, thus clearing some of the 'fog of war.'"[70] Hand-held units may be utilized by soldiers in remote locations and difficult-to-navigate terrain, as well as in search-and-rescue missions requiring a precise location.[71] Satellites have enabled the proliferation of unmanned aerial vehicles (UAVs), aircraft which are able to be piloted remotely using satellite guidance from halfway around the world.[72]

Utilization of satellites for communication is a critical component for militaries as well. Satellite communications constitute the primary means of communication for United States naval vessels, even for hospital ships; a critical capacity given its worldwide deployment of ships.[73] Special forces in remote regions of Afghanistan maintained communication and called in air strikes from satellite phones.[74] Satellite communications have become so ubiquitous that they have expanded beyond mission-specific uses: the Indian military has provided soldiers in remote locations satellite phones for the purpose of communicating with family at home.[75]

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[68] Bourbonnière, "*Jus in Bello Satellitis*" *supra* note 24 at 52-53.
[69] "GOES-R" NASA, online: <www.nasa.gov/content/goes-r/index.html> [perma.cc/FM7P-S4JP].
[70] Jonathan M. Epstein, "Global Positioning System (GPS): Defining the Legal Issues of its Expanding Civil Use" (1995) 61 J. Air L. & Com. 243 at 245.
[71] Rajat Baijal & Manoj K. Arora, "GPS: A Military Perspective" (Sep. 1, 2009) Geospatial World, online: <www.geospatialworld.net/article/gps-a-military-perspective> [perma.cc/W7D4-DWJM].
[72] Markus Wanger, "The Dehumanization of Humanitarian Law: Legal, Ethical, and Political Implications of Autonomous Weapons Systems" (2014) 47 Vand. J. Transnat'l L. 1371 at 1373.
[73] DOD LOAC Manual, *supra* note 19 ¶ 7.12.2 n.322. (U.S. hospital ships use satellite communication exclusively.). Elizabeth Seebode Waldrop, "Integration of Military and Civilian Space Assets: Legal and National Security Implications" (2004) 55 A.F. L. Rev. 157 at 166. [Integration of Military and Civilian Space Assets]. (The U.S. Navy purchased data usage from commercial satellites in 1995 and continues to be a major mode of communication.).
[74] Ricky J. Lee & Sarah L. Steele, "Military Use of Satellite Communications, Remote Sensing, and Global Positioning Systems in the War on Terror" (2014) 79 J. Air L. & Com. 69 at 71.
[75] "Soldiers Posted in Remote Locations Can Now Use Satellite Phone to Connect with Families" (Dec. 22, 2019) Economic Times, online: < economictimes.indiatimes.com/news/defence/soldiers-posted-in-remote-locations-can-now-use-satellite-phone-to-connect-with-families/articleshow/72907736.cms?from=mdr> [perma.cc/5FUL-E5GW].

Space assets have proven vital for intelligence-gathering. "Spy satellites," or Intelligence, Surveillance, and Reconnaissance (ISR) satellites, serve as early missile attack warning systems, gather signal intelligence, and observe enemy movements.[76] Satellites are legally allowed to release images with a resolution of 30cm per pixel in the United States, and it is believed that government satellites in the United States and elsewhere possess even better capabilities.[77] This level of precision allows for precise monitoring of enemy positions and movements. It also allows observation of an adversary's capabilities: spy satellites detected and measured North Korea's nuclear tests.[78]

Perhaps most significantly for warfare, the latest generation of warfare has undergone a revolution in precision. Gone are the days of World War II, where the United States reported that 16% of its aerial bombs fell within 1,000 feet of where they were intended.[79] Even with the assistance of radar, these numbers only improved to 31%.[80]

The Persian Gulf War in 1991, fought between Iraq and Coalition forces led by the United States, has been called "the first space war" due to the first widespread use of satellite technology, principally for surveillance and navigation but also for targeting.[81] While precision-guided munitions (PGM) using GPS was in its infancy, and only a small proportion of the bombs used were so guided, those that were proved remarkably accurate: 85% of PGMs landed within 10 feet of their targets.[82] Now, the vast majority of aerial munitions used by the United States are precision-guided: even "dumb" bombs are fitted with relatively inexpensive kits to render them accurate to within a few meters when dropped as many as fifteen miles from the target.[83]

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[76] Elizabeth Seebode Waldrop, "Challenges to Security in Space" (2019) Defense Intelligence Agency, at 8. [Challenges to Security in Space]. (Discussing ISR concepts). online (pdf): <www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Space_Threat_V14_020119_sm.pdf> [perma.cc/NW4L-LHFF].

[77] Phillip Bump, "Here's Why the Resolution of Satellite Images Never Seems to Improve" (Apr. 21, 2017) Washington Post

[78] Charles J. Moxley, Jr., "The Sword in the Mirror – the Lawfulness of North Korea's Use and Threat of Use of Nuclear Weapons Based on the United States' Legitimization of Nuclear Weapons" (2004) 27 Fordham Int'l L.J. 1379 at 1389-90 n.42. (Discussing spy satellites observations regarding North Korea's nuclear program.).

[79] John T. Correll, "Daylight Precision Bombing" (Oct. 1, 2008) Air Force Magazine. Christopher B. Puckett, "In This Era of 'Smart Weapons,' Is a State Under an International Legal Obligation to use Precision-Guided Technology in Armed Conflict" (2004) 18 Emory Int'l L. Rev. 645 at 649. (Further discussing circular error probable during the war.).

[80] *Ibid.*

[81] Larry Greenmeier, "GPS and the World's First 'Space War'" (Feb. 8, 2016) Scientific America. John Yoo, "Rules for the Heavens: The Coming Revolution in Space and the Laws of War" (2020) 20 U. Ill. L. Rev. 123 at 175.

[82] Nathan A. Canestaro, "Legal and Policy Constraints on the Conduct of Aerial Precision Warfare" (2004) 37 Vand. J. Transnat'l L. 431 at 451.

[83] *Ibid.* at 451-52. (Discussing Joint Direct Attack Munitions (JDAM).).

II. Chapter 2 - Space Weapons, Means, and Methods

For powerful states, the value and utility of satellites render them a "center of gravity": "the hub of all power and movement, on which everything depends."[84] In military theory, the political, military, or economic might of a state rests on these certain key centers, the destruction of which is sufficient to deprive the state of power and compels their defeat in conflict.[85] This creates a weakness, a point at which "the concentrated blow of all the forces must be directed."[86] Satellites have become both a vital target to attack, and one that is of the utmost importance to defend.[87] In response to the growing importance of space assets, nations have developed a wide array of military capabilities.

Assessing proven, potential, and theoretical space weapons, means, and methods of warfare runs into the reality that most such capabilities, both extant and in development, are highly secretive.[88] Literature discussing space capabilities is often limited to discussion of those which are openly announced, informed speculation based on known tests, research, and

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[84] Carl von Clausewitz, "On War" Michael Howard and Peter Paret, *ed.* (1984) Princeton Univ. Press, at 595-96. Thompson, *supra* note 13 at 157. (The reliance on guidance and surveillance satellites for the United States renders those satellites networks as a center of gravity.). Arnold H. Streland, "Clausewitz on Space: Developing Military Space Theory Through a Comparative Analysis" (1999) Air Command and Staff College at 35-36. (Arguing that the commercial space sector has become a national center of gravity for the United States.). online(pdf): < apps.dtic.mil/sti/pdfs/ADA399136.pdf > [perma.cc/B3NB-RNGF]. Eric Talbot Jensen, "Computer Attacks on Critical National Infrastructure: A Use of Force Invoking the Right of Self-Defense" (2002) 38 Stan. J. Int'l L. 207 at 227.

[85] *Ibid.* at 596-97.

[86] Clausewitz, *supra* note 84 at 596.

[87] A 1996 Executive Order established the President's Commission on Critical Infrastructure Protection, tasked with identifying areas of critical infrastructure, vulnerabilities, and plans to protect them. Exec. Order no. 13,010, (1996) 61 Fed. Reg. 37347. While the space sector was not specifically identified, the Communications Sector-Specific Plan includes communications satellites as a Key Sector Component within the larger framework of that critical infrastructure. "Communications Sector-Specific Plan, An Annex to the NIPP 2013" (2015) CISA, at 6. Online (pdf): <www.cisa.gov/sites/default/files/publications/nipp-ssp-communications-2015-508.pdf> [perma.cc/BT4L-98AS]. As of May 2021, a Space Systems Critical Infrastructure Working Group was launched to "identify and develop strategies to minimize risks to space systems that support the nation's critical infrastructure." CISA, Press Release, "CISA Launces a Space Systems Critical Infrastructure Working Group" (May 13, 2021) online: <www.cisa.gov/news/2021/05/13/cisa-launches-space-systems-critical-infrastructure-working-group> [perma.cc/GKW2-8J8M].

[88] *See* Weeden & Samson, *supra* note 12 at xxxii. (Much of the information in space counterspace abilities is classified.). Justin McClelland, "The Review of Weapons in Accordance with Article 36 of Additional Protocol I" (2003) 850 ICRC 397 at 414.

intelligence, and inferences based on physics and established technology.[89] Since this Thesis does not seek to determine a full analysis of the legality of all weapons in every situation, but rather the general efficacy and application of existing laws to the likely types of weapons with which a space war will be fought, this does not present a major limitation. However, it is noteworthy to keep in mind the limitations of knowledge in all public assessments of these capabilities. At best, these are known unknowns, and perhaps unknown unknowns, regarding what is possible or likely in space warfare.[90]

Space weapons and capabilities defy easy characterization. One view is to compare them according to their mission: do they target satellites, or defend against missile attack?[91] Another method is to distinguish between kinetic attacks—when the desired effects are generated by a physical transfer of energy—and non-kinetic attacks, such as using malicious code to infect or disable an asset.[92] Grouping like technologies together does not have particular legal significance—independent weapons have to be reviewed separately, whether they are part of a family of weapons or not—but does make it easier to conceptualize how each type of weapon is likely to be viewed and what legal issues each raises.

This Thesis will divide space capabilities into three categories. First, kinetic abilities—those that destroy a satellite physically through direct contact or explosives—such as missiles, co-orbital interceptors, or smallsats designed to collide with other satellites. Second, other direct energy abilities not designed at physically destroying a satellite, but otherwise targeting it with a form of physical energy, either to temporarily or permanently disable it.[93] Third, all non-kinetic effects, such as jamming, spoofing, and other forms of "cyber" warfare directed at space assets.[94]

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[89] *See* David A. Koplow, "Deterrence as the MacGuffin: The Case for Arms Control in Outer Space" (2019) 10 Nat'l Security L. & Pol'y 293 at 301-02. (Some of the secretive measures taken by the U.S. and Russia on weapons technology.).

[90] C-SPAN, "U.S. Sec. of Defense Donald Rumsfeld, DOD Press Briefing" (Feb. 12, 2002) at 00h:38m:00s, online (video): <www.c-span.org/video/?168646-1/defense-department-briefing> [perma.cc/8CH3-53MX].

[91] Ramey, *supra* note 4 at 19.

[92] *See* DOD LOAC Manual, *supra* note 19 p. 1021 n.52. (Defining non-kinetic attacks as those *not* involving the physical transfer of energy. While this definition would appear to include direct energy weapons, such as lasers and microwave beams, most commenters treat those as distinct from kinetic energy weapons. For the purposes of this Thesis, "kinetic" will exclude directed energy weapons, focusing solely on capabilities used to physically destroy objects.).

[93] This two-part division is utilized by Koplow, "Asat-isfaction" *supra* note 45 at 1201. (Calling the former "kinetic energy interceptors" and the latter "directed energy." Part of the reason for group temporary and permanent destruction in this way is because many of the capabilities can do either, and it may not be certain what effect will occur when it is used, creating considerable uncertainty for weapons reviews and targeting.).

[94] Koplow, "The Fault is Not in Our Stars" *supra* note 13 at 339. (Dividing capabilities into kinetic interceptors, directed energy weapons, and cyber mechanisms.).

A. Physically Destructive Kinetic Capabilities

First, and perhaps most dramatically, states have developed physically-destructive kinetic antisatellite weapons (ASATs) that physically destroy satellites in orbit. There are multiple varieties of kinetic ASATs, at least two of which have been successfully demonstrated. A direct-ascent ASAT is a type of weapon—a missile—launched from earth, a ship, or a plane in flight, upward to a targeted satellite, without the weapon entering into orbit itself.[95] Co-orbital ASATs, by contrast, are not launched directly at a target, but rather placed into an orbit.[96] From there, the weapon may "chase" a target satellite in orbit, until approaching and detonating or colliding with it, destroying both.[97] It is also potentially feasible to place such an object into orbit well in advance of intended use.[98] Space-based co-orbital ASATs could "trail" a potential target satellite, following it in orbit until an attack is desired, at which point it would be maneuvered closer and exploded.[99] Alternative options exist, such as weapons travelling in an orbit designed to intersect the targeted satellite at a given point, or to travel in a different orbit and transfer to target a given satellite only when needed.[100] Such options may be more difficult and cost-intensive to execute, but come with the advantage of obscuring the intent of the user.[101]

While conventional missiles may have difficulty reaching higher orbits, a long duration co-orbital ASAT may be more effective. The primary drawback of such weapons is timing: a direct-ascent missile can be launched and hit a target within minutes, but the planning, launching, and utilization of a deeper co-orbital weapon would take considerably longer. These weapons also have other weaknesses: they could be detected in advance, since they must be placed in orbit well before use, allowing time for countermeasures to be considered. Leaving an

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[95] Brian D. Green, "Space Situational Awareness Data Sharing: Safety Tool or Security Threat?" (2016) 75 A.F. L. Rev. 39 at 63.
[96] *Ibid.*
[97] *Ibid.*
[98] *Ibid.*; *see also* David Wright, Laura Grego, & Lisbeth Gronlund, "The Physics of Space Security: A Reference Manual" American Academy of Arts & Sciences (2005) at 152. (Discussing space-based ASATs.).
[99] *Ibid.* While no state has openly declared placing such devices in orbit to trail adversary's satellites, in 2020 it was reported that a Russian satellite was "trailing" a U.S. spy satellite. Joel Gehrke, "Russia is Stalking US Satellites in Orbit, a NATO General Warns" (Feb. 7, 2020) Business Insider (Though the article speculates that the satellites could be used to interfere with the satellites in a time of conflict, without specifying whether it is expected that it would be kinetic or merely electronic.).
[100] Wright *et al*, *supra* note 98 at 152-54.
[101] *Ibid.*

object in orbit for an indefinite period of time can also degrade performance and reliability, as well as requiring periodic boosts to remain in that orbit, increasing costs.[102]

The United States began developing ASAT technology in 1958, almost immediately after the Soviets launched Sputnik.[103] In 1985, the United States successfully destroyed one of its satellites at a height of 530 kilometers utilizing a direct-ascent ASAT.[104] An F-15 fighter plane fired the missile while the fighter flew at 38,000 feet.[105] Some of the debris from the test remained in orbit for approximately 17 years.[106] In 2008, the United States shot down one of its malfunctioning satellites by firing a missile from a naval vessel just before re-entry, leading to trackable debris remaining in orbit for less than a year.[107]

The Soviet Union developed a form of kinetic ASAT technology as early as the 1960's. Early Soviet attempts involved co-orbital devices.[108] The Soviets tested a number of such weapons from the 1960's through the early 1980's, achieving a few successes.[109] Russia, as the primary successor to the Soviet Union, has fired several direct-ascent weapons tests, though none destroyed satellites.[110]

In 2007, China joined the Cold War rivals by destroying one of its weather satellites in LEO.[111] China reportedly used a two-stage, solid fuel ballistic missile to destroy a satellite orbiting at 530 kilometers.[112] The test resulted in approximately 35,000 pieces of debris of at

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[102] *Ibid.*
[103] Green, *supra* note 95 at 65.
[104] *Ibid.*; Gregory Karambelas & Sven Grahn, "The F-15 ASAT Story" Space History Notes, online: <www.svengrahn.pp.se/histind/ASAT/F15ASAT.html> [perma.cc/X5KC-S4RT].
[105] *Ibid.*
[106] Green, *supra* note 95 at 65.
[107] Anna Mulrine, "The Satellite Shootdown: Behind the Scenes" (Feb. 25, 2008) U.S. News and World Report, online: <www.usnews.com/news/world/articles/2008/02/25/the-satellite-shootdown-behind-the-scenes>. Jim Wolf, "U.S. Satellite Shootdown Debris Said Gone from Space" (Feb. 27, 2009) Reuters, online: <www.reuters.com/article/us-space-usa-china/u-s-satellite-shootdown-debris-said-gone-from-space-idUSTRE51Q2Q220090227> [perma.cc/F6CG-HTSX]. (The debris from the 2008 incident had likely all burned up in Earth's atmosphere in less than a year.).
[108] Weeden & Samson, *supra* note 12 at Table O-3.
[109] *Ibid.*
[110] Apparently as intended. Abhijan Rej, "Russia Tests Anti-Satellite Missile: US" (Dec. 18, 2020) The Diplomat, online: <thediplomat.com/2020/12/russia-tests-anti-satellite-missile-us> [perma.cc/G6BH-5NCW].
[111] Shirley Kan, "China's Anti-Satellite Weapon Test," Cong. Research Serv., RS22652, (2007).
[112] *Ibid.*

least 1 cm in size.[113] The debris affected multiple space objects, including the International Space Station, which had to maneuver to avoid some of the debris in 2011.[114]

In 2019, India successfully destroyed a satellite in LEO at 285 kilometers with a direct-assent, ground-based missile.[115] However, as with other successful ASAT tests, it left some debris in orbit, as many as 400 trackable pieces, the long-term consequences of which are still unknown.[116]

As of 2021, these are the only states with the proven ability to physically destroy a satellite in orbit. It is unknown how many other nations intend to pursue such weapons in the near future. Japan and Israel may be developing such capabilities.[117]

With the proliferation of smallsats and microsatellites in civilian use, so too can they be used as weapons.[118] As with other co-orbital weapons, they could be placed in orbit and then used to attack target satellites either immediately or at an advantageous time in the future. The distinction between these weapons and those described above is that, unlike being equipped with explosives or other destructive materials, the satellite would be steered directly into the target, destroying it in a collision.[119] This is significant because it not only allows for purpose-built weapons, but also the use of ordinary satellites that otherwise serve a different purpose and are not built as a weapon *per se*.[120]

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[113] T.S. Kelso, "Analysis of the 2007 Chinese ASAT Test and the Impact of Its Debris on the Space Environment 321" (2007) Center for Space Standards and Innovation, online (pdf): <amostech.com/TechnicalPapers/2007/Orbital Debris/Kelso.pdf> [perma.cc/5USE-8L6Q].

[114] Robert David Olney, "Death From Above? The Weaponization of Space and the Threat to International Humanitarian Law" (2013) 78 J. Air L. & Com. 739 at 749.

[115] Marco Langbroek, "Why India's ASAT Test was Reckless" (Apr. 30, 2019) The Diplomat, online: <thediplomat.com/2019/05/why-indias-asat-test-was-reckless> [perma.cc/5N4K-M9JL].

[116] David Dickinson, "What India's Anti-Satellite Test Means for Space Debris" (Apr. 5, 2019) Sky & Telescope, online: <skyandtelescope.org/astronomy-news/what-indias-anti-satellite-test-means-for-space-debris> [perma.cc/L5B6-JPWE].

[117] Jack M. Beard, "Soft Law's Failure on the Horizon: The International Code of Conduct for Outer Space Activities" (2017) 38 U. Pa. J. Int'l L. 335 at 420. (noting that, as of 2017, India, Japan, and Israel were pursuing such technology, India having since successfully achieved it). Daniel Darling, "Japanese Government Considering Launching a Satellite Interceptor" (Aug. 26, 2019) Defense & Security Monitor, online: <dsm.forecastinternational.com/wordpress/2019/08/26/japanese-government-considers-launching-a-satellite-interceptor> [perma.cc/YV87-M9HF]. Barbara Opall-Rome, "Israeli Experts: Arrow-3 Could Be Adapted for Anti-Satellite Role" (Nov. 9, 2009) Space News (*citing* to Maj. Gen. Yitzhik Ben-Israel) online: <spacenews.com/israeli-experts-arrow-3-could-be-adapted-anti-satellite%E2%80%82role> [perma.cc/59E9-EZCE].

[118] Blake & Imburgia, *supra* note 2 at 176.

[119] *See Ibid.*

[120] This is relevant to the discussion of "weapons" and what capabilities need to be reviewed, *see* Section III.A. *infra*.

There is no proven example of this capability being utilized. However, in 2009, a non-functioning Russian military satellite collided with a satellite belonging to Iridium, a U.S. company.[121] Some American sources have speculated that it was an intentional crash by the Russians.[122] Russian officials, however, contended that it was the United States that was responsible.[123] The collision created 2,000 pieces of debris larger than 10 centimeters, and thousands of smaller pieces.[124] It is important to note that there does not appear to be any evidence to actually demonstrate intent on the part of either nation, and absent any, it should not be regarded as an attack. Rather, the incident demonstrates both the fact that collisions, even accidental, are possible, the potential debris and damage that can be done, and the ambiguity in assigning fault or blame.

Another potential technique utilizing small or nanosatellites is the so-called parasitic satellite. A small satellite is launched, maneuvers to the target satellite, and attaches to it.[125] Then, at an advantageous time in the future, it can be detonated or otherwise activated to inhibit or destroy the target satellite.[126] There was speculation that China had developed such technology, though little proof.[127] However, in 2020, a commercial satellite by Northrup Grumman successful docked onto a failing satellite and provided assistance.[128] A weaponized parasitic satellite would have to approach covertly and to attach without cooperation from the host satellite, creating new difficulties, but this provides proof of concept in space.

A final destructive method worth mentioning in passing are nuclear weapons. In 1962, the United States conducted "Starfish Prime," a high-altitude nuclear test.[129] The 1.4-megaton blast, occurring 400 kilometers above Earth's surface, had the unintended and undesired effect of

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[121] *Ibid.*; "Russian and U.S. Satellites Collide" (Feb. 12, 2009) BBC, online: <news.bbc.co.uk/2/hi/science/nature/7885051.stm> [perma.cc/97W6-YJXB].
[122] Blake & Imburgia, *supra* note 2 at 176. (*citing* "Editorial: Strike From Space?" (Mar. 6, 2009) Washington Times, online: <www.washingtontimes.com/news/2009/mar/06/strike-from-space> [perma.cc/23S6-RJPE]).
[123] *Ibid.*
[124] Brian Weeden, "2009 Iridium-Cosmos Collision Fact Sheet" (Nov. 10, 2010) Secure World Foundation, online (pdf): <swfound.org/media/6575/swf_iridium_cosmos_collision_fact_sheet_updated_2012.pdf> [perma.cc/G7XP-9SGD].
[125] Richard J. Adams & Martin E. France, "The Chinese Threat to U.S. Space Superiority" (2005) High Frontier, at 17-22.
[126] *Ibid.*
[127] *Ibid.* at 20 (The speculation ultimately came from unnamed Chinese sources.).
[128] Dan Robitzski, "Parasitic Spacecraft Docks with Dead Satellite, Brings it Back to Life" (Apr. 17, 2020) The Byte, online: <futurism.com/the-byte/parasitic-spacecraft-docks-dead-satellite-back-life> [perma.cc/9C7G-GEB9].
[129] Green, *supra* note 95 at 65. Richard Hollingham, "The Cold War Nuke that Fried Satellites" (Sep. 11, 2015) BBC, online: <www.bbc.com/future/article/20150910-the-nuke-that-fried-satellites-with-terrifying-results> [perma.cc/BLU2-W2SL].

damaging satellites, including British satellite Ariel-1 and the U.S. satellite Telstar, the first telecommunications satellite, degrading their orbits and damaging sensors.[130] The damage was caused both by a large electromagnetic pulse (EMP) and by creating a new belt of radiation.[131] The EMP also damaged streetlights in Hawaii, over a thousand kilometers away.[132]

B. Direct Energy Weapons

There are a variety of capabilities that, while not necessarily likely to physically destroy a satellite and cause a great deal of space debris, involve a targeted use of energy to disable or destroy a satellite or some of its functions. The U.S. Department of Defense defined a "directed energy weapon" as "an umbrella term covering technologies that produce concentrated EM [electromagnetic] energy and atomic or subatomic particles. A DE weapon is a system using DE primarily as a means to incapacitate, damage, disable, or destroy enemy equipment, facilities, and/or personnel."[133] A number of such capabilities exist or are believed to be under development in the space domain.

"Dazzlers" are energy beams used to "blind" or disable—temporarily or permanently—remote sensing satellites.[134] It involves beaming a laser—a concentrated energetic beam of light—to a sensing a satellite. If sufficiently bright, it can obscure the satellite's image of a given area.[135] In addition, it can potentially permanently damage some of the satellite's sensors, partially blinding it.[136] China,[137] Russia,[138] and the United States[139] at least appear to have such capabilities.

Alternatively, high-powered lasers could instead be used to attack a satellite directly, rather than just its sensors. Instead of attack the sensors, it could damage the solar panels (used for power), or compromise the hull or other portions of the satellite.[140] Similarly, use of high-

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[130] *Ibid.*
[131] *Ibid.*
[132] *Ibid.*
[133] U.S. Dep't of Defense Joint Publication 3-13.1, Electronic Warfare (2012) p. ix
[134] Wright *et al*, *supra* note 98 at 125-30. (for a full explanation).
[135] *Ibid.*
[136] *Ibid.* at 128-30.
[137] Koplow, "The Fault is Not in Our Stars" *supra* note 13 at 340 n.14. (China has developed and potentially tested such capabilities on a U.S. satellite in 2006).
[138] Weeden & Samson, *supra* note 12 at 2-30. (Russia has developed and tested a mobile dazzler).
[139] "In Test, Military Hits Satellite Using a Laser" (Oct. 21, 1997) New York Times, online: <www.nytimes.com/1997/10/21/us/in-test-military-hits-satellite-using-a-laser.html> [perma.cc/QY38-Q53W].
[140] Wright *et al*, *supra* note 98 at 134-35. (noting that the time of writing, in 2006, that technology was not sufficient for ground-based lasers).

powered microwave (HPM) waves could instead accomplish the same effects.[141] The United States has the only open test of such weapons, using the MIRACL laser system in 1997 to attempt to damage one of its own satellites.[142] It is believed the test failed, but results were not publicly released.[143] China and Russia may be developing such capabilities with lasers.[144] Further, the United Sates has successfully tested laser weapons as an anti-missile weapon, leading to speculation that it may also have such capabilities towards satellites.[145]

Another potential usage would be space-based energy weapons directed not towards satellites, but missiles. The United States explored this possibility in the 1980's under the auspices of the Strategic Defense Initiative (SDI), popularly known as "Star Wars."[146] This brought the United States into conflict with the Anti-Ballistic Missile Treaty (ABM) with the Soviet Union, which among other things limited development of missile defense regimes and testing.[147] The U.S. ultimately moved in a different direction, finding those unfeasible at that time. It later mooted any issues regarding conflict with the ABM Treaty by withdrawing in 2002.[148]

One present limitation on the feasibility, if not legality, of such weapons is that the distance from Earth to space, including distorting effects of the atmosphere and vulnerability to convention attack.[149] Another possibility is mounting such weapons on other satellites.[150] This has been proposed, though not yet utilized, for "space broom" devices, lasers designed to target small pieces of space debris, causing them to change orbit and ultimately re-enter Earth's

[141] *Ibid.* at 130-33. S*ee also* Blake & Imburgia, *supra* note 2 at 179. (noting the U.S. Air Force developed a plan to study their employment in 2009).
[142] *Ibid.* at 178-79. Wright *et al*, *supra* note 98 at 124. (describing the physical and chemical characteristics of the weapon).
[143] David A. Koplow, "An Inference About Interference: A Surprising Application of Existing International Law to Inhibit Anti-Satellite Weapons" (2014) 35 U. Pa. J. Int'l L. 737 at 799. [An Inference About Interference]. (A subsequent laser may have blinded the satellite).
[144] Waldrop, "Challenges to Security in Space" *supra* note 76 at 20, 29.
[145] Blake & Imburgia, *supra* note 2 at 177.
[146] Emily K. Penney, "Is that Legal?: The United States' Unilateral Withdrawal from the Anti-Ballistic Missile Treaty" (2002) 51 Cath. U.L. Rev. 1287 at 1293-94.
[147] *Ibid.*
[148] *Ibid.*
[149] Ramey, *supra* note 4 at 25.
[150] *Ibid.*

atmosphere.[151] The United States is researching the possibility of such a system.[152] Such systems could potentially be dual-use, either as a weapon or to clear space debris, or a weapons system could be launched under the guise of being for debris use, obscuring its purpose.

C. Non-Kinetic Abilities

Finally, there are a number of capabilities which are entirely non-kinetic, but may interfere with, or outright disable, satellites or their signals on Earth. To operate, satellites receive information from an Earth station ("uplink"), and then send information back to receivers on Earth ("downlink"), all in the form of electromagnetic radiation, specifically, radio waves.[153] Some satellites also communicate directly with each other rather than an Earth station in between, which is called a "crosslink."[154] Interfering with those signals can inhibit the utility of the satellite.

A variety of different interference techniques exist. "Jamming" is the practice of "disrupting communication with a satellite by overpowering the signals being sent to or from the satellite by using a signal at the same frequency and higher power."[155] Jamming may be attempted either against those signals being sent up from the ground station to the satellite ("uplink jamming") or being sent from the satellite to the ground ("downlink jamming").[156]

In downlink jamming, an attack may attempt to disrupt a GPS receiver on the ground or a radio receiving a signal by sending additional signals at the same frequency to the receiver.[157] The jammer will typically be based on the ground, though they can be carried in planes as well, and in the general proximity of the receiver.[158] A variety of countermeasures and response to the

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[151] Lisa Grossman, "NASA Considers Shooting Space Junk With Lasers" (Mar. 15, 2011) Wired, online: <www.wired.com/2011/03/lasering-space-junk> [perma.cc/9UU5-TQ62]. (talking about the concept in general). Shen Shuangyan, Jin Xing, & Chang Hao, "Cleaning Space Debris With a Space-Based Laser" (2014) 27 Chinese J. of Aeronautics 805. (Noting the issues with ground-based lasers and considering space-based ones.).
[152] Patrick Tucker, "Pentagon Wants to Test A Space-Based Weapon in 2023" (Mar. 14, 2019) Defense One, online: <www.defenseone.com/technology/2019/03/pentagon-wants-test-space-based-weapon-2023/155581> [perma.cc/U53A-4WS5].
[153] *See* "Spacepower: Doctrine for Space Force" (Jun. 20, 2020) United States Space Force, Chapter 1, Space System Architecture at 5. Online(pdf): <www.spaceforce.mil/Portals/1/Space%20Capstone%20Publication_10%20Aug%202020.pdf> [perma.cc/NKH3-PJA2].
[154] *Ibid.*
[155] Wright *et al*, *supra* note 98 at 118.
[156] Sarah H. Mountin, "The Legality and Implications of Intentional Interference with Commercial Communication Satellite Signals" (2014) 90 Int'l L. Stud. 103 at 128.
[157] Wright *et al*, *supra* note 98 at 118-19.
[158] *Ibid.*

countermeasure may be utilized, though with increasing cost and complexity to the satellite system or jammer, respectively.[159] While affecting space-related operations, this is not "space warfare" in the strictest sense, since the jammer is not likely to be space-based and the downlink facilities are also terrestrially-based.

Uplink jamming involves interfering with the signal received by the satellite in space.[160] Critically, one of the key functions of the uplink is to provide command and control communications, for instance, maneuvering the satellite or running various on-board systems.[161] Uplink signals are also critical in communications, as signals are sent from Earth to the satellite and back to Earth.[162] Uplink jamming typically comes from signals sent from Earth: it requires more energy, since a signal has to be sent from Earth to the satellite in space, but because a satellite will typically be in line-of-sight from a much wider area on Earth, such jamming can be done from a wide array of locations.[163] Commercial satellites are more at-risk of jamming due to minimal encryption compared to military satellites.[164]

"Spoofing" involves using a false signal to fool the receiver, either the satellite or ground station, into believing the false signal is the correct one.[165] While jamming simply tries to block out the signal, spoofing attempts to replace it with a false one. This is considered much more difficult. However, among the advantages of spoofing is that it may not be readily clear to the satellite operators that the signal has been spoofed, whereas signal interference is likely to be obvious.[166] A spoofed downlink for GPS could, for instance, give false directions or times to the recipient, but without proper countermeasures might be believed to be real.[167]

Several states possess or are believed to possess significant capabilities in these areas.[168] While attribution to a particular state can often be difficult to demonstrate, there are numerous

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[159] *See ibid.* at 118-21 for a more detailed discussion. Notably, basic jamming technology is cheap and available commercially.
[160] *Ibid.* at 121.
[161] *Ibid.*
[162] *Ibid.*
[163] *Ibid.*
[164] *Ibid.*
[165] *Ibid.*
[166] *Ibid.* at 167-68.
[167] For a greater discussion of spoofing GPS specifically, *see* Mark L. Psiaki & Todd E. Humphreys, "GNSS Spoofing and Detection" (2016) Proceedings of the IEEE, oniline(pdf): <radionavlab.ae.utexas.edu/images/stories/files/papers/gnss_spoofing_detection.pdf> [perma.cc/5X2M-BRGQ].
[168] Mountin, *supra* note 156 at 107 n.28.

examples of commercial satellites experiencing intentional interference.[169] In 2011, a U.S. military drone operating in or near Iran was lost to American operators, only to show up more or less intact in the possession of Iran.[170] Iran claimed to have successfully spoofed the signals the drone was using and induced it to land in Iran.[171] North Korea is believed to have initiated mass interference with signals in South Korea at times, including in 2012 for a period of two weeks, causing considerable disruption to civilian services as well as military.[172]

III. Chapter 3 - Weapons Reviews

With all these emerging weapons technologies and the possibility of using those weapons in a new domain with untold effects, states face the challenge of ensuring these capabilities are consistent with their international legal obligations. Additional Protocol I of the Geneva Convention (hereinafter "Additional Protocol I"), adopted in 1977, enshrined a number of new rules, regulations, and prohibitions in international law regarding the conduct of warfare. Regarding the implantation of new weapons, Article 36 states:

> In the study, development, acquisition or adoption of a new weapon, means or method of warfare, a High Contracting Party is under an obligation to determine whether its employment would, in some or all circumstances, be prohibited by this Protocol or by any other rule of international law applicable to the High Contracting Party.[173]

Additional Protocol I was ratified by 174 states, and signed but not ratified by an additional three: the United States, Pakistan, and Iran.[174]

While the obligations imposed by Additional Protocol I are binding upon ratifying states, authorities are divided as to whether the requirements are also required by customary international law. A rule may become binding under customary international law—and therefore binding upon all states, whether or not they are party to a treaty or agreement regarding the

[169] *Ibid.* at 118-19. (providing examples and *citing* Wright *et al*, *supra* note 98 at 121-22).
[170] Adam Rawnsley, "Iran's Alleged Drone Hack: Tough, but Possible" (Dec. 16, 2011) Wired, online: <www.wired.com/2011/12/iran-drone-hack-gps> [perma.cc/8MXD-PQ3J].
[171] *Ibid.* (It is worth noting that the claims of what occurred are not necessarily reliable, given that both the U.S. and Iran have reason to conceal or exaggerate the truth, as the case may be, and because there is little independent information to verify their claims.).
[172] Tegg Westbrook, "The Global Positioning System and Military Jamming: The Geographies of Electronic Warfare" (2019) 2:12 Journal of Strategic Studies at 6-7.
[173] Additional Protocol I, *supra* note 14, Art. 36.
[174] *Ibid.*

rule—if there is "a general and consistent practice of states followed by them from a sense of legal obligation."[175]

In some views, the requirement to review new weapons for compliance with international law is a "truism" which flows from the nature of requirements.[176] Because states are obliged to follow the underlying rules regarding the use of their weapons—discussed below—it follows that they must review their new weapons and methods of warfare to ensure faithful compliance with the rules.[177] In its Commentary on the Additional Protocol, the International Committee of the Red Cross (ICRC) argues that Article 36 was intended to be linked to the obligations of Article 35, which declares that the means and methods of warfare are not unlimited and that it is prohibited to employ weapons which cause superfluous injury, unnecessary suffering, or long-term damage to the natural environment.[178]

Other commenters believe that, rather than being a truism, the rule has become a staple of customary international law through state practice.[179] They note, for instance, that several states have developed practices and procedures to review their weapons and means and methods of warfare, including the United States, which are not bound by Additional Protocol I.[180] Numbers

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[175] Restatement (Third) of the Foreign Relations Law of the United States (Am. Law Inst. 1987) § 102(2). North Sea Continental Shelf (F.R.G. v. Den., F.R.G. v. Neth.), Judgment, 1969 I.C.J. Rep. 3, PP 76-77 (Feb. 20) (for the source of the basis of customary international law as consistent state practice).

[176] Vincent Bernard, "A Guide to the Legal Review of New Weapons, Means and Methods of Warfare: Measures to Implement Article 36 of Additional Protocol I of 1977" (2006) 88 I.R.R.C. 931 at 933.

[177] *Ibid.*

[178] Jean de Preux *et al*., "ICRC Commentary on the Additional Protocols of 8 June 1977 to the Geneva Conventions of 12 August 1949" (Yves Sandoz, Christophe Swinarski, & Bruno Zimmerman *eds*., 1987) [ICRC Commentary] ¶¶ 1463-66. Additional Protocol I, *supra* note 14, Art. 35.

[179] *See* Blake & Imburgia, *supra* note 2 at 163. (Stating that such an obligation exists under customary international law, citing the United States' acceptance of it, the history of acceptance of restrictions on weapons use under other conventions, and the *Nuclear Weapons* opinion from the International Court of Justice.). Michael N. Schmitt, "'Out of the Loop': Autonomous Weapons Systems and the Law of Armed Conflict" (2013) 4 Harv. Nat'l Sec. J. 231 at 271. [Out of the Loop]. (Some believe that Article 36 "restates customary international law" a review of a new means of warfare is "generally considered, and correctly so, reflective of customary international law." However, he acknowledges that a review of new methods of warfare is more uncertain.). (*citing* "Tallinn Manual on the International Law Applicable to Cyber Warfare" (Michael N. Schmitt, gen. ed. 2013) [Tallinn Manual] Rule 48(a) ("All States are required to ensure that cyber means of warfare that they acquire or use comply with the rules of armed conflict that bind the State."). (In Tallinn Manual 2.0, it is the same, but under Rule 110). "Tallinn Manual 2.0 on the International Law Applicable to Cyber Operations" (Michael N. Schmitt & Liis Vihul eds., 2017) [Tallinn Manual 2.0]. Kenneth Anderson, Daniel Reisner, & Matthew Waxman, "Adapting the Law of Armed Conflict to Autonomous Weapons Systems" (2014) 90 Int'l L. Stud. 386 at 398 n.27. ("Article 36 is widely regarded among scholars as expressing customary law with respect to 'legal reviews of new means of warfare before their use is generally considered,' but such consensus is 'lacking as to whether an analogous requirement exists to perform legal reviews of new methods of warfare.'").

[180] Blake & Imburgia, *supra* note 2 at 160 n.2. (Arguing that the United States has undertaken weapons review as a matter of practice across its services and citing to the opinion of Michael J. Matheson, indirectly opining that the United States regards it as such.). Michael J. Matheson, "The United States Position on the Relation of Customary

vary, but accounts may include between 15-20 states with acknowledged practices of weapons reviews, with further states not objecting, so much as remaining silent.[181]

However, others contend that these practices fall short of establishing a legally binding rule under customary international law. That states are under obligation to use their weapons and means and methods of warfare in accordance with binding international law is not the same as a requirement that they conduct a review in advance, or even at all.[182] Further, commenters note that the state practice of reviewing weapons out of a sense of legal obligation falls well short of what is required to establish a principle of customary international law.[183] The number of states openly adopting the requirements of Article 36 is limited.[184] A majority of the states who ratified Additional Protocol I have not indicated whether they are in fact following its requirements, among them major powers such as China and Russia.[185] Even of those states which are party to the agreement and appear to be faithfully discharging their obligation, the fact that they are complying with their treaty obligation does not necessarily mean that the obligation exists

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International law to the 1977 Protocols Additional to the 1949 Geneva Conventions" (1987) 2 Am. U. J. Int'l L. & Pol'y 419 at 420. (Discussing the Articles with the United States objected to, omitting discussion of Article 36 and thereby implicating its acceptance.). For present U.S. policy, *see* U.S. Dep't of Defense Directive (DODD) 5000.01 (Sep. 9, 2020) at 1.2(v). (The "acquisition and procurement of all weapons and information systems must be consistent with all applicable domestic laws, and the resulting systems must comply with applicable treaties and international agreements …, customary international law, and the law of armed conflict (also known as the laws and customs of war.). An attorney authorized to conduct such legal reviews in the DoD must conduct the legal review of the intended acquisition of weapons or weapons systems."). *See also* DOD LOAC Manual, *supra* note 19, ¶ 6.2. (Discussing the obligation to review new weapons.).

[181] Vincent Boulanin & Maaike Verbruggen, "SIPRI Compendium on Article 36 Reviews" (2017) Stockholm International Peace Research Institute (SIPRI) Background Paper. [SIPRI Compendium]. (Showing practices of Belgium, Germany, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the U.K., and the United States.). Natalia Jevglevskaja, "Weapons Review Obligation Under Customary International Law" (2018) 94 Int'l L. Stud. 186 at 208-09. (Adding Austria, Canada, France, Australia, and Israel as states with review processes, though in the case of Israel disputing that it is out of a sense of legal obligation and concluding that no obligation exists.). Editors, "Legal Review of New Weapons: Scope of the Obligation and Best Practices" (2016) Humanitarian Law & Pol'y. online: <blogs.icrc.org/law-and-policy/2016/10/06/legal-review-new-weapons> [perma.cc/RQ6N-7YW3]. (*Quoting* Dr. Gilles Giacca, Legal Advisor, ICRC, and suggesting that "15-20 states" have adopted a review in practice.).

[182] *See* Jevglevskaja, *supra* note 181 at 188. (Criticizing those finding the existence of CIL to conduct a weapons review for basing it on the "general duty of compliance with the law of armed conflict."). Darren M. Stewart, "New Technology and the Law of Armed Conflict" (2011) 87 International Law Series 271 at 283. (The requirements of Article 36 have been adopted by many states as "either reflective of best practice or as an obligation flowing from the customary law norm articulated Article 35(2)" [banning weapons causing superfluous injury] but that "although it is by no means clear that Article 36 has the status of customary law.").

[183] *Ibid.*

[184] *See* notes 180 & 181, *supra*. (Other than Israel and the United States, the other parties included are already parties to Additional Protocol I, and bound by the treaty.).

[185] *Ibid.*

outside of that treaty obligation.[186] Of those non-party states applying weapons reviews, contrary to some opinions, the United States has not made a definitive statement regarding its views on Article 36 as a legal requirement.[187]

The status of the requirement is not a trivial matter. Eight states and the European Union have independent launch capability as of 2021.[188] Of those, Israel and India are neither signatories nor parties to the Protocol, and Iran and the United States signed but did not ratify.[189] In addition to those states, non-party states Azerbaijan, Indonesia, Malaysia, Nepal, Pakistan, Singapore, Sri Lanka, Thailand, and Turkey operate at least one satellite.[190] The number of space-faring nations can only be anticipated to grow in the coming years.

Moreover, the weapons review requirement serves an important function in limiting the scope and damage of warfare. Applying the laws of armed conflict involve determinations that need to be made on an operational and tactical basis—states engaged in air strikes have to review them to ensure they comport with the rules of distinction, necessity, and proportionality. Limitations on certain weapons or weapons systems imposed at the developmental stage, to include cancelling an entire weapon because it would violate the state's obligations, present an earlier opportunity to shape the options available later, when the decision is made when and how to use such weapons.[191] Put another way, a weapon which is never developed or deployed cannot be used in violation of the law. Even for weapons which are allowed to go forward, reviews

[186] John B. Bellinger III & William J. Haynes II, "A U.S. Government Response to the International Committee of the Red Cross Study Customary International Humanitarian Law" (2007) 89 IRRC 443 at 446-47. (objecting to the Committee's focus on military manuals when the manuals often reflect existing policy obligations; states bound by Additional Protocol I as ratifying parties must do so due to their having ratified it, and thus it would not serve to prove the existence of an obligation greater than or beyond the treaty obligation, such as customary international law.).

[187] *Ibid.* at 213. (Arguing that U.S. weapons review is based on "good policy," rather than legal obligation.). S*ee also* "Memorandum for Mr. John H. McNeill, Assistant General Counsel (International), OSD, "1977 Protocols Additional to the Geneva Conventions: Customary International Law Implications" (May 9, 1986) Library of Congress, online: <www.loc.gov/rr/frd/Military_Law/pdf/LOAC-Documentary-Supp-2015_Ch26.pdf> [perma.cc/6HKW-F9MU]. (Stating which portions of Additional Protocol I the United States views as part of customary international law, omitting Article 36.).

[188] The others are Russia, the EU, China, Japan, and North Korea.

[189] Additional Protocol I, *supra* note 14, Parties.

[190] Jevglevskaja, *supra* note 181 at 191 n.20. (listing non-party states).

[191] Schmitt, "Out of the Loop" *supra* note 179 at 272. ("Early legal reviews can shape the development stage of a weapon system and resultantly avoid the unnecessary effort and cost associated with components and capabilities that may not pass legal muster.").

provide "significant potential when it comes to effectively implementing the laws of armed conflict as well as arms control and disarmament law."[192]

Determining the true legal status of the weapons review requirement is beyond the scope of this Thesis. It is enough to note that it is binding on a vast majority of states, and is utilized by at least two other major space powers. Even if its application is not truly universal, it influences the behavior of most states, and most key space states, that its significance, or lack thereof, is of value to examine.

That said, some caution is warranted. It is unclear several space-faring states utilize it, or consider themselves bound by it, even those that are parties to Additional Protocol I.[193] Further, because reviews themselves are generally not publicly disseminated, there is little ability to assess *how* states are applying the rules, except in their ultimate deployment and use of weapons and means and methods of warfare.

However, as will be discussed below, states are ultimately bound by the laws of armed conflict in the use of their weapons. States adhering to those rules thus likely find it "reflective of best practice" to review them in advance, to avoid spending time and resources developing weapons it cannot use and to incorporate any limitations on usage into its operational plans prior to conflict breaking out.[194] Particularly as new frontiers of warfare are breached, states will likely want to assess their legal obligations in advance of investing in, developing, and deploying new weapons systems.[195] Therefore, although the legal requirement to review new weapons may not be universal, it nevertheless provides a mechanism for most states to adhere to the laws of armed conflict.

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[192] Anne Dienelt, "The Shadowy Existence of Weapons Review and its Impact on Disarmament" (June 4, 2018) S+F Sicherheit und Frieden / Security and Peace (2018), Nomos (Forthcoming), at 10. Online: <ssrn.com/abstract=3190285> [perma.cc/3CSV-KX5F].

[193] *Ibid.* at 213. (Listing the absence of established institutional weapons review in party states such as China and North Korea, as well as non-party states such as India, Indonesia, Iran, Malaysia, Pakistan, Singapore, Thailand, and Turkey.).

[194] Stewart, *supra* note 182 at 284. (Arguing it would appear to be best practice to review in advance.). Brian Rappert *et al*., "The Roles of Civil Society in the Development of Standards Around New Weapons and Other Technologies of Warfare" (2012) 94 IRRC 765 at 779 n. 52. (States may undertake a review either out of legal obligation or best practice.). Maura Riley, "Killer Instinct: Lethal Autonomous Weapons in the Modern Battle Landscape" (2017) 95 Tex. L. Rev. Online 19 at 28 n. 46. (same).

[195] Stewart, *supra* note 182 at 284. (A preemptive assessment is likely in states' interests and is evidenced by the United States' practice in doing so as a major military power, despite not being party to Additional Protocol I.).

A. Weapon

Unfortunately for clarity in the law, "weapon" lacks a clear definition. Additional Protocol I does not provide one.[196] There is no clearly-accepted international legal definition of the term elsewhere.[197] Kinetic capabilities, including direct energy devices, are certainly weapons under any reasonable definition of the word—they are a device designed for military use to destroy materiel and personnel to obtain a military advantage in armed conflict. It is less clear whether electronic means of interference fall within the definition of "weapon."

In its commentary on the Additional Protocol, the ICRC asserts "the experts [drafting Article 36] were concerned with…geophysical, ecological, electronic and radiological warfare as well as with devices generating radiation, microwaves, infrasonic waves light flashes and laser beams."[198] Far from remaining fixated on weapons such as the bombs and bullets of the past, the law was understood to incorporate future technology and how it would be applied to warfare.[199] Therefore, there is good reason to give "weapon" an expansive, rather than restrictive, meaning.

The United Nations Institute for Disarmament Research (UNIDIR), when specifically considering ASAT weapons, as "ways and means that can be used, with malicious intent, for the purpose of damaging, destroying, or seizing a satellite, or making it unusable by its owner."[200] It then subdivided the categories into weapons designed specifically to destroy satellites, and those developed for other purposes that could be utilized to destroy satellites, such as nuclear weapons.[201] The report noted the particular concern in defining weapons in this sense, because it included such a wide range of capabilities, from interceptor missiles to electronic devices for jamming.[202] Fundamentally, the report looks to the intent of the potential use of the system: whether kinetic or not, whether built with satellites in mind or some other purpose, for any system that *could* be used for antisatellite reasons is a weapon. The breadth of the types of weapons and systems that could be included under this definition, however, creates a problem, in

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[196] *See generally* Additional Protocol I, *supra* note 14; Blake & Imburgia, *supra* note 2 at 169.
[197] *Ibid.*; Thompson Chengeta, "Are Autonomous Weapon Systems the Subject of Article 36 of Additional Protocol I to the Geneva Conventions?" (2016) 23 U.C. Davis J. Int'l L. & Pol'y 65 at 72. (Noting the definition is unclear internationally, "as states often have their own definitions.").
[198] ICRC Commentary, *supra* note 178, ¶ 1476.
[199] *Ibid.*, ¶ 1477. (Focusing on the concerns of technological advances causing an arms race.).
[200] UNIDIR, "Satellite Warfare: A Challenge for the International Community" (United Nations Publications: 1987) at 20.
[201] *Id.*
[202] *Id.* at 25.

that by combining so many disparate systems under one umbrella, it makes it "impossible to formulate a single, exhaustive system of weapons for the purposes of banning them."[203]

The United States has several different definitions between its various armed services. Relevant to space capabilities, the Air Force, as the predecessor to the Space Force, defines a weapon as:

> A device designed to kill, injure, disable or temporarily incapacitate people or destroy, damage, disable or temporarily incapacitate property or materiel. The term "weapon" does not include a device developed and used for training, or launch platforms to include aircraft and intercontinental ballistic missiles.[204]

Notably, the previous definition utilized by the Air Force explicitly excluded "electronic warfare devices," focusing instead on "devices designed to kill, injure, or disable people, or to damage or destroy property."[205] The Air Force separately defines cyber capabilities as being distinct from a weapon, though subject to review nonetheless.[206] Taken with Department of Defense Directive (DoDD) 5000.01's requirement to review all weapons and "information systems," the definition of "weapon" is best understood as excluding objects which do not intend to cause kinetic effects.[207]

Other nations maintain definitions which focus on kinetic weaponry. Norway defines a weapon as "any means of warfare, weapons system/-project, substance etc. which is particularly suited for use in combat."[208] Similar definitions are utilized by Denmark and Canada.[209] Australia previously identified weapons in a similarly traditional manner, but also included a note that a "computer expressly designed as a new weapon to offensively target enemy computer systems for destruction is covered."[210] A new definition, in 2018, gave "weapon" a broader

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[203] *Id.*
[204] Air Force Instruction ("AFI") 51-401, "The Law of War" (Aug. 3, 2018) at 13-14. As of this publication, the Space Force has not issued new publications in this regard, and so the Air Force Instruction still controls.
[205] *See* Todd Graham, "Armed Attack in Cyberspace: Deterring Asymmetric Warfare with an Asymmetric Definition" (2009) 64 A.F. L. Rev. 65at 80. (*citing* to AFI 51-402, dated May 13, 1994. The present version of AFI 51-401, effective as of Aug. 3, 2018, combined AFI 51-401 and 402, and updated the definition of "weapons," among other changes. *See* AFI 51-401, at 2.).
[206] *Ibid.* (See discussion *infra*).
[207] *See* Jeffrey T. Biller & Michael N. Schmitt, "Classification of Cyber Capabilities and Operations as Weapons, Means, or Methods of Warfare" (2014) 95 Int'l L. Stud. 179 at 187. (Sharing that understanding of the U.S. position.).
[208] "Directive on the Legal Review of Weapons, Methods and Means of Warfare" (Jun. 18, 2003) Norwegian Dep't of Defense, ¶ 1.4. [Norwegian Directive].
[209] Biller & Schmitt, *supra* note 207 at 196-99. (Surveying state definitions.).
[210] *Ibid.* at 197. (*citing* Department of Defence, DI(G) OPS 44-1, Legal Review of New Weapons ¶ 3 n.2 (2005) (Austl.)).

definition, including "a device, whether tangible or intangible, designed or intended to be used in warfare to cause…damage, or destruction of, objects."[211] Even this appears to limit those effects to kinetic, rather than simple interference.

New Zealand affirms that LOAC principles apply to "all potential technology available for military use."[212] It includes examples such as "electromagnetic and radiation weapons," "laser weapons," "particle beam weapons," and "weapons with artificial intelligence."[213] Purely cyber operations are not listed here. Instead, it addresses cyber capabilities separately, noting those that occur in the context of armed conflict or have comparable effects must comply with LOAC.[214]

Other commenters have given similar definitions. William Boothby defines a weapon as "a device, system, munition, implement, substance, object or piece of equipment that is used, intended or designed to cause injury or damage to an adverse party in an armed conflict."[215] Justin McClelland defined a weapon as "an offensive capability that can be applied to a military object or enemy combatant."[216] He later uses the example of an electronic communications systems which analyzes and provides a target as something that must be reviewed, but, critically, as a means or method, not as a weapon.[217] Blake and Imburgia give it an almost identical definition, though concluding it applies to both offensive and defensive capabilities, as well as regarding it as clearly applying to more than kinetic weapons.[218] Notably, they state that it should be understood to include "non-kinetic, space and cyberspace capabilities."[219]

The Manual on International Law Applicable to Air and Missile Warfare (AMW) defines a "weapon" as "a means of warfare used in combat operations, including a gun, missile, bomb or other munitions, that is capable of causing either (i) injury to, or death of, persons; or (ii) damage

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[211] *Ibid.* (*citing* Department of Defence, Interim Defence Instruction, DI Admin 44-1, Legal Review of New Weapons ¶ 3 (2018) (Austl.) (referring to Directorate of Operations and Security Law, Defence Legal Division, Australian Defence Force, Defence Legal Review of New Weapons Guide (n.d.)).
[212] New Zealand Defence Force, "Manual of Armed Forces Law, Vol. 4: Law of Armed Conflict" DM 69 (2ed) (2017) p 7.4.6. [New Zealand LOAC Manual], online: <www.nzdf.mil.nz/assets/Publications/DM-69-2ed-vol4.pdf> [perma.cc/4H5D-VRVP].
[213] *Ibid.*
[214] *Ibid.* ¶ 5.2.23.
[215] William Boothby, "Space Weapons and the Law" (2017) 93 Int'l L. Stud. 179 at 182.
[216] McClelland, *supra* note 88 at 404.
[217] *Ibid.* at 405-06.
[218] Blake & Imburgia, *supra* note 2 at 172.
[219] However, they hedge and note that, even if not weapons, such capabilities would clearly be means and methods of warfare and still subject to review. *Ibid.*

to, or destruction of, objects."[220] In other words, it takes a strictly kinetic, traditional view of weapons. The nature of the manual is to discuss air and missile warfare, so it is not clear if the definition provided was even intended to define "weapon" in a universal sense, as opposed to providing a workable definition within the specific focus of the manual.[221]

In assessing newer non-kinetic abilities, it is helpful to look at developments in cyber warfare, which shares many characteristics with the types of non-kinetic operations directed at satellites and satellite signals.[222] In both, the capabilities do not necessarily cause physical damage as their primary intended effect, but may target assets with civilian and military uses (dual use objects) and give rise to both a significant military advantage and disruption to civilian life.[223] While not directly defining a weapon, the Tallinn Manual, which applies the law of war to the cyber domain, describes a cyber-attack as "cyber operation, whether offensive or defensive, that is reasonably expected to cause injury or death to persons or damage or destruction to objects."[224] It argues for an effects test: a cyber-attack that leads to fires on an electrical grid would qualify as an attack, even if the means used were not kinetic.[225] Applied to space, this would mean that non-kinetic capabilities which cause physical damage would constitute an armed attack, and, by analogy, likely be a weapon.[226]

Considering all of this, the best understanding of a weapon is to examine whether it is intended to be utilized as a military capability, and whether it is likely or intended to produce kinetic effects, that is, death or physical destruction. This is line with state definitions and practice and the majority of commenters.

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[220] Program on Humanitarian Policy and Conflict Research, "Manual on International Law Applicable to Air and Missile Warfare" (2009) Section A, Definitions. [AMW], online(pdf): <reliefweb.int/sites/reliefweb.int/files/resources/8B2E79FC145BFB3D492576E00021ED34-HPCR-may2009.pdf > [perma.cc/VK4P-P95Y].

[221] *Cf.* Jordan J. Paust, "The 2009 Air and Missile Warfare Manual: A Critical Analysis" (2012) 47 Tex. Int'l L.J. 277 at 278-79. (Discussing shortcomings of the definition of "weapon" in the context of the use of chemical or biological weapons, suggesting it is too narrow to match international law, as well as similar shortcoming on its definition of "attack".).

[222] *See, e.g.*, Scott J. Shackelford, "The Law of Cyber Peace" (2017) 18 Chi. J. Int'l L. 1 at 11. (Comparing the cyber and space domains.). Arie J. Schaap, "Cyberlaw Edition: Cyber Warfare Operations: Development and Use Under International Law" (2009) 61 A.F. Law Rev. 121 at 163. (Noting that if a space asset is used in conflict, it can be targeted by cyber warfare, that is, non-kinetic techniques to disable it, indicating the overlap between the two.).

[223] *Cf.* Yoo, *supra* note 81 at 179-80.

[224] Tallinn Manual 2.0, *supra* note 179, r.95.

[225] *Ibid.* r.30(3).

[226] Caution should be utilized here. The principles regarding an "armed attack" stem from the *jus ad bellum*, when a state can go to war, as opposed to the issues addressed here, the *jus in bello*, how armed conflict is conducted. Brown, *supra* note 13 at 69 n. 250. (Discussing the dangers of overlap between the two areas of law.).

B. Means or Methods

While the above view has the effect of excluding purely electronic and cyber capabilities that are not intended to cause kinetic effects from the definition of "weapons," it does not exempt them from review; there is still "means and methods" to consider. Unfortunately, the definition of a "means" or "method" of warfare is less certain still. Many commenters consider this to encompass broader aspects of warfare that do not squarely fit with traditional weaponry, such as cyber capabilities.[227] The United States Air Force, separately from its requirement to review weapons, also requires a review of "cyber capabilities," which it defines as "any device, computer program or computer script, including any combination of software, firmware or hardware intended to deny, disrupt, degrade, destroy or manipulate adversarial target information, information systems, or networks."[228] While the United States position on Article 36 denies it is a matter of customary international law, because the U.S. requires a legal review of these capabilities distinct from "weapons," it is reasonable to view them as "means and methods."

As discussed above, McClelland views electronic communications systems utilized in targeting as a clear example of a means or method of warfare.[229] Blake and Imburgia take the view that electronic warfare, if not a weapon, certainly would be a means or method of warfare.[230] Boothby refers to a means of warfare as "weapons and weapon systems," and a "method of warfare" as "an activity designed to adversely affect the enemy's military operations or military capacity."[231] In a more general sense, Michael Schmitt argues that, if occurring within the context of an armed conflict, interference with satellites leading to non-kinetic effects would trigger the provisions and protections of humanitarian law, while those same capabilities used outside of a conflict would not.[232] While this final appraisal does not place certain interference systems definitively as weapons, means, or methods for all purposes, it indicates such

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[227] Gary D. Brown & Aaron O. Metcalf, "Easier Said Than Done: Legal Reviews of Cyber Weapons" (2014) 7 Nat'l Security L. & Pol'y 115 at 130. (Looking at the requirements of Article 36 and concluding that cyber capabilities are most properly a "means or method" of warfare.).
[228] AFI 51-401, *supra* note 204, Attachment 1, *Terms.* (Note that the Air Force categorizes electronic means "intended to provide access to an adversarial computer system for data exploitation," that is, espionage and intelligence, separately, and does not require a legal review.).
[229] McClelland, *supra* note 88 at 405-06.
[230] Blake & Imburgia, *supra* note 2 at 172.
[231] Boothby, "Space Weapons and the Law" *supra* note 215 at 182.
[232] Michael N. Schmitt, "International Law and Military Operations in Space" (2006) 10 Max Planck Y.B. U.N. L. 89 at 116.

capabilities ordinary or expected use *could* be during warfare and therefore would constitute a means or method of warfare.

The AMW defines a "means of warfare" as "weapons, weapon systems or platforms employed for the purposes of attack," placing it as a larger grouping of weapons, rather than something distinct.[233] It defines a "method of warfare" as "designed to adversely affect the enemy's military operations or military capacity, as distinct from the means of warfare used during military operations, such as weapons. In military terms, methods of warfare consist of the various general categories of operations, such as bombing, as well as the specific tactics used for attack, such as high-altitude bombing."[234]

The Tallinn Manual 2.0, looking specifically to cyber warfare, finds that a means of warfare includes "cyber weapons and their associated cyber systems."[235] Methods of cyber warfare, meanwhile, are "cyber tactics, techniques, and procedures by which hostilities are conducted."[236]

Arriving at a precise definition for means or method of warfare for all purposes is not necessary here. Generally, "means" includes weapons, but also weapons systems and the integrated parts that are needed to make them work.[237] For instance, a missile is a weapon, while a launch platform and computer system designed for targeting would be part of the weapons system and a "means" of warfare. A method of warfare is conceptual, including techniques such as high-altitude bombing or interfering with electromagnetic signals.[238]

More importantly, the term as utilized by states and as viewed by commenters almost certainly includes non-kinetic electronic warfare, of the type that states are developing for warfare in outer space. Therefore, those capabilities, no less than missiles targeting outer space assets, are subject to review by states for compliance with the laws of armed conflict.

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[233] AMW, *supra* note 220, Part 1, Definitions, (t). (*But see* the definition of "electronic warfare," (p), which is defined as "electromagnetic or directed energy to control the electromagnetic spectrum or attack." It later defines "electronic warfare" "or computer network attacks" against military objectives as taking part in hostilities. Sec F(29). In other words, activities such as jamming and spoofing would qualify as electronic warfare, and almost certainly a means or method of warfare.).
[234] *Ibid.* (v).
[235] Tallinn Manual 2.0, *supra* note 179, r.103.
[236] *Ibid.*
[237] *E.g.,* Blake & Imburgia, *supra* note 2 at 172.; Boothby, "Space Weapons and the Law" *supra* note 215 at 182. AMW, *supra* note 220, Part 1, Definitions, (t). Schmitt, "Out of the Loop" *supra* note 179 at 271. (same).
[238] *Cf.* Boothby, "Space Weapons and the Law" *supra* note 215 at 182. AMW, *supra* note 220, Part 1, Definitions, (v). Schmitt, "Out of the Loop" *supra* note 179 at 271. (same).

C. New

One additional feature of the requirement under Article 36 is that it applies to "new" weapons.[239] For space warfare, weapons, means, and methods existing before the Protocol was adopted in 1977 are not particularly concerning.[240] Rather, the primary concern is at what point a change or modification renders it a "new" weapon, means, or method of warfare such that it requires a new legal review.

The United States requires reviews for new weapons that include changes that are greater than "a minor modification." A "minor modification" in turn includes "Software, firmware or hardware changes to previously reviewed cyber capabilities (to include updates and upgrades) that are necessary to deploy, employ, command and control or recover a device or software payload, but do not change the intended effects of the capability."[241] The U.K. requires a new review if there is a change to a weapon's "use or capability."[242]

This view is shared by a number of commenters. McClelland argues that one would look to whether an upgrade affected the weapon's capabilities to determine if a new review was required: a change to the mobility of a weapon, for example, would not render it "new."[243] The Tallinn Manual 2.0, when looking at cyber warfare, concludes the same, finding that "significant changes" require a new review, but changes that "do not affect [the weapon's] operational effects" do not.[244] Boothby concludes a new review is required for an already-reviewed weapon if the relevant law has changed or it if "has been the subject of an upgrade or other amendment that changes its combat performance."[245]

The prevailing view, then, is based on intent and effects. When there is an alteration in that aspect of a device—a previously-reviewed missile is now utilized to attack satellites, for example, or a cyber capability used to disable a computer network is now designed to disable a

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[239] Additional Protocol I, *supra* note 14, Art. 36.
[240] With the exception of the Russian co-orbital interceptors and the use of nuclear weapons to accidentally destroy satellites, all other destructive ASAT capabilities were acquired, or at least demonstrated, after 1977.
[241] AFI 51-401, *supra* note 204, at 13. This definition is used with regard to cyber capabilities specifically, not weapons in general.
[242] U.K. Ministry of Defense, "U.K. Weapons Review" Development, Concepts and Doctrine Centre, p. 4. Online(pdf): <assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/507319/20160308-UK_weapon_reviews.pdf> [perma.cc/RUC5-YZSU]. (In addition, the U.K. states that weapons being altered or developed quickly in response to battlefield conditions are also reviewed, albeit orally.).
[243] McClelland, *supra* note 88 at 404.
[244] Tallinn Manual 2.0, *supra* note 179, r. 103, ¶ 9-10.
[245] William Boothby, *Weapons and the Law of Armed Conflict* (Oxford: Oxford University Press, 2016) at 355.

satellite—a new review will be required. This approach harmonizes the Article 36 review requirement with the intended end-state: ensuring compliance with the laws of armed conflict. Because the laws of armed conflict focus on the intent and the potential effects, tying the requirement for a new review to those ends accomplishes that goal.

Further, the review obligation applies to a state which acquires a capability by, for example, purchasing a new weapon or weapon system, or entering into a shared agreement to gain intelligence or knowledge.[246] While it might be assumed that the state providing the capability has already reviewed it, that nevertheless does not relieve the gaining state of the responsibility. This is significant for a number of reasons: if the selling state has not honored its obligation (or does not believe it has one); the gaining state is party to different agreements and has different responsibilities; or because the states come to different conclusions about the legality of the weapon or weapon system.[247]

IV. Chapter 4 - The Laws of Armed Conflict

Article 36 does not specify how a review is to be conducted, only requiring states to determine if the employment of the weapons[248] "would, in some or all circumstances, be prohibited by this Protocol or by any other rule of international law applicable to the" state.[249] What rules of that Protocol or international law apply?

There is no universally agreed-upon method of review. For some particular rules or specific treaties, individual states either have different obligations—a state may not be party a treaty limiting a kind of weapon—or different views of what obligation applies. However, there are a few core principles which are largely accepted by all states as customary, and generally applied in weapons reviews.

As a foundational matter, Article 35(1) of Additional Protocol I declares that in an "armed conflict, the right of the Parties to the conflict to choose methods or means of warfare is

[246] ICRC Commentary, *supra* note 178, ¶ 1473. McClelland, *supra* note 88 at 404. Isabelle Daoust, Robin Coupland, & Rikki Ishoey, "New Wars, New Weapons? The Obligation of States to Assess the Legality of the Means and Methods of Warfare" (2002) 84 IRCC 345 at 348.
[247] *See* "U.K. Weapons Review" *supra* note 242 at 4. (Stating that the U.K. reviews all weapons and systems it acquires, even from other states, and stating the reasons.).
[248] For simplicity, this Thesis will generally refer to "weapons" rather than "weapons, means, and methods" except where it is specifically relevant.
[249] Additional Protocol I, *supra* note 14, Art. 36.

not unlimited."[250] While the Protocol itself lays down a number of more specific limitations, discussed *infra*, the principle that warfare's means are not unlimited draws from a long history. It can trace its earliest foundation to the St. Petersburg Declaration of 1868, which limited certain kinds of small-arms ammunition as causing superfluous injury and stating in its preamble that "the employment of [arms which uselessly aggravate the sufferings of disabled men] would, therefore, be contrary to the laws of humanity."[251] Numerous agreements since that time placed limitations on the means and methods of warfare, such as the Hague Conventions of 1899 and 1907.[252] That states are limited in their means and methods of warfare is widely-accepted as customary international law.[253]

That merely establishes that limits do apply, not what they may be or where they may be found. There is no fixed understanding of precisely how to review the weapons or indeed what specific rules apply. There are a few key rules that appear to be universally agreed-upon as applicable to weapons reviews, and others which are hotly contested.

In its *Nuclear Weapons* opinion, the International Court of Justice (ICJ) examined whether the use of nuclear weapons would be "considered as illegal in the light of the principles and rules of international humanitarian law applicable in armed conflict and of the law of neutrality."[254] Recounting the history of agreements barring the use of certain weapons, the ICJ found that "the right of belligerents to adopt means of injuring the enemy is not unlimited."[255] The ICJ held that while it could not conclude that nuclear weapons were illegal to use in all circumstances, the use of such weapons were "subject to the requirements of the international

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[250] *Ibid.*, Art. 35(1).
[251] Declaration Renouncing the Use, in Time of War, of Explosive Projectiles Under 400 Grammes Weight [St. Petersburg Declaration], Nov. 29/Dec. 11, 1868, 138 Consol. T.S. 297.
[252] *E.g.*, The Hague Convention (II) with Respect to the Laws and Customs of War on Land and its annex: Regulations concerning the Laws and Customs of War on Land. The Hague, 29 July 1899, Art. 23. [Hague II]. (Discussing the means which are "especially forbidden".). Declaration Concerning the Prohibition, for the Term of Five Years, of the Launching of Projectiles and Explosions from Balloons or Other New Methods of a Similar Nature, 29 July 1899, 32 Stat. 1839. (Hague IV, 1) (Barring certain projectiles launched from balloons.). The Hague Convention No. IV Respecting the Laws and Customs of War on Land, Oct. 18, 1907, Art. 23, 36 Stat. 2277. [Hague IV] (Placing particular limits on the "means of injuring the enemy".).
[253] Blake & Imburgia, *supra* note 2 at 166. ("Customary international law governs a weapon's legal use".). Thomas Michael McDowell, "Cluster Bombs Over Kosovo: A Violation of International Law?" (2002) 44 Ariz. L. Rev. 31 at 105-06. (The U.S. acceptance of that a number of provisions of Additional Protocol I, including Article 35(1) and (2), are customary international law.).
[254] International Court of Justice, "Advisory Opinion on the Legality of the Threat or Use of Nuclear Weapons" 1996 I.C.J. 226 at 256. [Nuclear Weapons Opinion]. (Earlier in the opinion, the ICJ examined the use or threat of use of nuclear weapons with regard to the prohibition on the use of force generally.).
[255] *Ibid.*

law applicable in armed conflict, particularly those of the principles and rules of international humanitarian law, as well as with specific obligations under treaties and other undertakings which expressly deal with nuclear weapons."[256]

With respect to those "principles and rules of international humanitarian law," the ICJ laid out the cardinal rules of humanitarian law which applied to weapons. First, weapons that cannot distinguish between civilian and military targets or that target civilians are prohibited.[257] Second, weapons which cause unnecessary suffering or useless injuries are prohibited.[258] Third, it stated that "civilians and combatants remain under the protection and authority of the principles of international law derived from established custom, from the principles of humanity and from the dictates of public conscience," a formulation of the Martens Clause.[259] While not explicitly stated as a test, the ICJ considered whether the use of the weapons were barred (1) by a specific rule or custom, or (2) by principles of customary international law. The second question looked at whether the weapon was indiscriminate, caused unnecessary suffering or superfluous injury, or violated the dictates of humanity and conscience.

Turning to state practice, Australia cites to the ICJ opinion as the basis for its test.[260] First, when reviewing the legality of a weapon, it inquires whether "international customary or treaty law applicable to Australia that contains a specific prohibition against the threat or use of a weapon in general or in certain circumstances."[261] Second, in the absence of a specific prohibition, it asks if there is "a general prohibition against the threat or use of a weapon in general or in certain circumstances, such that it is: of a nature to cause superfluous injury or unnecessary suffering; capable of being used discriminately; capable of being used

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[256] *Ibid.* at 266.
[257] *Ibid.* at 256.
[258] *Ibid.*
[259] *Ibid.* (quoting Additional Protocol I, *supra* note 14, Art. 1(2)) (Originating in Hague II, Preamble – "Until a more complete code of the laws of war is issued, the High Contracting Parties think it right to declare that in cases not included in the Regulations adopted by them, populations and belligerents remain under the protection and empire of the principles of international law, as they result from the usages established between civilized nations, from the laws of humanity, and the requirements of the public conscience".). S*ee also* ICRC Commentary, *supra* note 178, ¶ 52-56, for more discussion.
[260] Group of Governmental Experts of the High Contracting Parties to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects, "The Australian Article 36 Review Process" U.N. Doc. CCW/GGE.2/2018/WP.6 (Aug. 30, 2018), 15(d). [The Australian Article 36 Review Process]. online: <docs-library.unoda.org/Convention_on_Certain_Conventional_Weapons_-_Group_of_Governmental_Experts_(2018)/2018_GGE%2BLAWS_August_Working%2Bpaper_Australia.pdf> [perma.cc/WF4W-65PG].
[261] *Ibid.* at 15(d)(i).

proportionately; expected to cause widespread, long term and severe damage to the natural environment; and likely to be affected by current and possible future trends in the development of international humanitarian law."[262] Third, it asks whether the use of the weapon violates the "dictates of public conscience."[263]

The International Red Cross proposes the same essential framework. First, is the employment of the weapons barred by a treaty or specific international law?[264] Second, if not, would the employment of the weapons under normal or expected usage comply with the general rules applicable to all weapons, means and methods of warfare found in Additional Protocol I?[265] This is divided into several individual rules, but they can be summed up as the rules against causing superfluous injury, long-term environmental damage, being inherently indiscriminate, and attacks where damage to civilians outweighs the military advantage to be achieved.[266] Third, would its use violate the principles of humanity and the dictates of public conscience?[267]

The United States undertakes a three-part review: (1) whether the weapon's intended use is calculated to cause superfluous injury; (2) whether the weapon is inherently indiscriminate; and (3) whether the weapon falls within a class of weapons that has been specifically prohibited.[268] Additionally, it also undertakes review to determine if: the type of weapon has additional restrictions on use specific to that type of weapon and "whether other measures should be taken that would assist in ensuring compliance with law of war obligations related to the type of weapon being acquired or procured."[269] This is not viewed as a legal requirement imposed by international law as much as an expedient attempt to identify issues and problems well in advance of deployment.

Boothby believes there are five considerations: is the weapon of a nature to cause superfluous injury; is the weapon intended or will it cause widespread environmental damage, if the state is party to Additional Protocol I; is the weapon inherently indiscriminate; is it prohibited by a specific treaty or rule; and whether future developments in the law may be expected to

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[262] *Ibid.* at 15(d)(ii).
[263] *Ibid.* at 15(e) and n.20. (Noting that Australia applies the Martens Clause in the most limited way, merely acknowledging that it "prevents the assumption that anything which is not explicitly prohibited by the relevant treaties is therefore permitted".) (*quoting* ICRC Commentary, *supra* note 178, ¶ 55).
[264] Bernard, *supra* note 176 at 939-42.
[265] *Ibid.* at 942-44.
[266] *Ibid.*
[267] *Ibid.* at 945.
[268] DOD LOAC Manual, *supra* note 19 ¶ 6.2.2.
[269] *Ibid.*

affect that weapon?[270] However, the final criterion is not required by law, and the environmental question only applicable to countries party to Additional Protocol I; he does not view it as a matter of customary international law. He also suggests that other inquiries may be necessary depending on the weapon: in the case of an autonomous weapon, whether it would comply with targeting rules in actual operations?[271]

Some states include a provision for reviewing weapons based on the law "not only as it stands" but to consider "likely future developments."[272] However, this should not be viewed as a legal requirement, but a precautionary measure to avoid approval of a weapons system that is likely to be prohibited in the near-future, and thus the whole enterprise wasted.[273]

What is demonstrated by these varying approaches are three common questions: 1) are there specific treaty or rules-based weapons restrictions; 2) is the weapon designed or likely to cause superfluous injury; and 3) is the weapon inherently indiscriminate? The first is inherent to the question: a state which has signed a treaty barring a particular type of weapon cannot legally utilize that weapon in a manner inconsistent with the agreement, both by its own terms and under Article 36. The latter two, as discussed below, are both found in Additional Protocol I, but also universally-agreed upon LOAC principles constituting customary international law.

It is not clearly-established, however, whether long-term environmental damage, the balance of proportionality and necessity, and dictates of humanity and conscience are required rules for all states under international law, as will be discussed, *infra*.

A. Specific Treaty Obligations or Bans

Unfortunately for hopes of limiting military weaponry in outer space, the number of arms agreements or multistate treaties restricting weapons in space have been few and far between. One of the few success stories was the Partial Test-Ban Treaty.[274] The United States, Soviet Union, and United Kingdom—all the nuclear powers at that time—concluded the treaty in

[270] Boothby, *Weapons and the Law of Armed Conflict*, *supra* note 245 at 342-43.
[271] *Ibid.* at 343.
[272] United Kingdom, "Joint Service Manual of the Law of Armed Conflict" (2004) JSP 383 at 119, online: <assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/27874/JSP3832004Edition.pdf> [perma.cc/24LG-ZY69]. *See also* New Zealand LOAC Manual, *supra* note 212, ¶ 7.4.2.
[273] It should be self-evident that there cannot be a strict legal requirement to determine the legality of a weapon based on legal rules that do not exist at the time of the review.
[274] Partial Test-Ban Treaty, *supra* note 8.

1963.[275] Subsequently, 126 nations have ratified, though not subsequent nuclear powers China, France, or North Korea.[276] It barred nuclear weapons testing underwater, in the atmosphere, and in outer space.[277] It is recognized as the first major space treaty and "arguably the most successful."[278]

1967 saw the adoption of the Outer Space Treaty.[279] In general terms, it laid out the hopeful aspiration that, in "the common interest of all mankind in the progress of the exploration and use of outer space" would be reserved for "peaceful purposes."[280] More directly, Article IV placed certain limitations on weapons. Parties agreed "not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner."[281] There is some controversy as the final phrase regarding stationing "such" weapons in outer space, as the "such" is missing from UN General Assembly Resolution 2222, to which the treaty is annexed, as reading the final phrase to include all weapons, instead of "such" weapons, that is, the weapons of mass destruction referenced previously, would lead to a radically different legal regime.[282] The Treaty also restricted use of celestial bodies, including the Moon, to exclusively "peaceful purposes."[283] While not forbidding the presence of military members or assets, the creation of bases, testing of weapons, or military maneuvers on celestial bodies was restricted.[284]

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[275] Ram Jakhu, "Sixty Years of Development of International Space Law" (2016) in Stephan Hobe (ed.) *Air Law, Space Law, Cyber Law - the Institute of Air and Space Law at Age 90* (Carl Heymanns Verlag 2016) at 84. [Sixty Years].
[276] *Ibid.* at 84-85. UN Office for Disarmament Affairs, "Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water" Status of Treaty, online: <treaties.unoda.org/t/test_ban> [perma.cc/GS26-ABD4].
[277] Jakhu, "Sixty Years" *supra* note 275 at 85.
[278] *Ibid.* U.S. State Dep't, "The Limited Test Ban Treaty" online: <history.state.gov/milestones/1961-1968/limited-ban> [perma.cc/KD2L-G3HR]. ("Because it stopped the spread of radioactive nuclear material through atmospheric testing and set the precedent for a new wave of arms control agreements, the Treaty was hailed as a success".).
[279] OST, *supra* note 6.
[280] *Ibid.*, Preamble.
[281] *Ibid.*, Art. IV.
[282] United Nations General Assembly in its Resolution 2222 (XXI) of 19 December 1966).
[283] *Ibid.*
[284] *Ibid.* Of possible interest, this section omits "the Moon." The phrase "celestial bodies" in its use is likely inclusive of "the Moon," rendering it applicable to the Moon as well. Ramey, *supra* note 4 at 84. S*ee also* Alexis and Jessica Ramsey, "Space Force and the Outer Space Treaty: One Small Step Forward for a Man, One Giant Leap Backward for Mankind" (2020) 54 U.S.F.L. Rev. F. 4 at 17. (Considering no base could be built *on* the Moon, but one could be placed in orbit around it.).

The Treaty enjoys broad support, especially among space-faring nations, with 111 states having ratified it.[285]

These restrictions, however, leave many gaps.[286] Military activity in space as such is not barred. Nuclear weapons may traverse space, so long as they are not stationed there or placed into orbit, allowing for Intercontinental Ballistic Missiles (ICBMs).[287] There are no restrictions on the placement or use of weapons which are not "weapons of mass destructions," excepting on celestial bodies.[288] Satellites have no restrictions on their use in war-fighting, nor do any provisions protect them against attack, kinetic or otherwise.[289]

However, there are no further explicit agreements banning space weapons with any wide recognition. The so-called Moon Agreement largely reiterated the prohibitions in the Outer Space Treaty, but received only a handful of ratifications, none from an established space power.[290] The ABM Treaty, mentioned previously, placed some limitations on space weaponry, but the United States "creatively reinterpreted" the Treaty to allow for such experimentation, and the agreement ended in 2002 with the United States' withdrawal.[291] In 2008, the Prevention of Placement of Weapons in Outer Space Treaty (PPWT) was put forward by Russia and China as a means to limit all weapons in space, but has not been advanced towards any meaningful agreement.[292] Even this agreement would have been quite limited. It proposed barring placement of all weapons in space, and barred the use or threat of force against space objects, but, critically, did not limit states' inherent right to self or collective self-defense.[293]

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[285] UN Office for Disarmament Affairs, Outer Space Treaty, Status of Treaty, online: <treaties.unoda.org/t/outer_space> [perma.cc/R8DE-XY2U].
[286] "Gaps" may be misleading, as it implies that there is a need or intent to restrict weapons. That may not be the case.
[287] DOD LOAC Manual, *supra* note 19 ¶ 14.10.3.1.
[288] *Ibid.* Koplow, "Asat-isfaction" *supra* note 45 at 1198.
[289] OST, *supra* note 6, Art. IV. *see also* Jakhu, "Sixty Years" *supra* note 275 at 100. (Discussing gaps in the treaty.).
[290] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 5 December 1979, 1363 U.N.T.S. 3. [Moon Agreement].
[291] *See supra* notes 146 & 147.
[292] Ram Jakhu, Cassandra Steer, & Kuan-Wei Chen, "Conflicts in Space and the Rule of Law" (2017) 66 ZLW 657 at 672-73. Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects (Draft), Jun. 16, 2014 [PPWT]. Online: <www.fmprc.gov.cn/mfa_eng/wjb_663304/zzjg_663340/jks_665232/kjfywj_665252/t1165762.shtml> [perma.cc/H5Y6-QVAT].
[293] *Ibid.* Effectively, threats of force and the use of force are already barred by the UN Charter, and the inherent right of self or collective defense allows for force to be used in self-defense, meaning that the treaty would be restating law already applicable and, in any event, such law would allow warfare in space if in "self-defense." *See* Bret Austin White, "Recording the Law for a China World Order: China's Legal Warfare Strategy in Outer Space and

None of these treaties have the effect of limiting the weapons systems discussed above. That should not be surprising: the treaties were in place over half a century ago, so it would be unexpected for nations to undertake new weapons or systems in violation of such agreements.

There are a number of other limitations on weapons, largely centered on terrestrial concerns, which could have an impact on the development of space weapons, but because they were designed with terrestrial warfare in mind, are unlikely to apply to space weapons as presently envisaged.[294]

The Protocol on Blinding Laser Weapons banned the design and use of lasers as weapons used solely to blind personnel.[295] However, no limitations were placed on other uses of lasers, such as for targeting or as a direct-energy weapon when not targeting personnel.[296] Weapons which produce undetectable fragmentation in personnel are barred, but fragmentation weapons themselves are not, thus leaving open fragmentation anti-satellite weapons.[297] The other provisions and agreements provide no further limitations on the present set of space weapons.[298]

More abstract limitations have been suggested. David Koplow suggests that interference with the national technical means (NTM) of verification for various arms control agreements could provide a basis for regulating anti-satellite weapons.[299] Various arms control agreements come with prescribed methods of ensuring the parties are complying, for instance, satellite reconnaissance to observe nuclear tests in the atmosphere in violation of the Partial Test-Ban

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Cyberspace" (2021) 11 J. Nat'l Security L. & Pol'y 435 at 461-62. (Noting the applicability of Article 51 of the UN Charter in space and how it would allow warfare in self-defense against space objects.).

[294] Principally, those in Additional Protocol I itself. Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons which May be Deemed to be Excessively Injurious or to Have Indiscriminate Effects, Oct. 10, 1980, 1342 U.N.T.S. 7 (entered into force Dec. 2, 1983) [Convention on Conventional Weapons, or CCW], as well as its Protocols; Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and Their Destruction, 36 I.L.M. 1507 (1997) [Ottawa Treaty]; and Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction, Jan. 13, 1993, 32 I.L.M. 800 (1993) [Chemical Weapons Convention].

[295] Protocol [to the CCW] on Blinding Laser Weapons (Protocol IV), Oct. 13, 1995, 35 I.L.M. 1218 (1996) (entered into force on July 30, 1998) Art. I. ("It is prohibited to employ laser weapons specifically designed, as their sole combat function or as one of their combat functions, to cause permanent blindness…").

[296] *Ibid.*, Art. III. Ramey, *supra* note 4 at 58-59. DOD LOAC Manual, *supra* note 19 ¶ 6.15.1.1. (Lasers used for purposes other than blinding were legal.).

[297] Protocol [to the CCW] on Non-Detectable Fragments (Protocol I) Apr. 10, 1981, 1342 U.N.T.S. 7 (entered into force Dec. 2, 1983) ("It is prohibited to use any weapon the primary effect of which is to injure by fragments which in the human body escape detection by X-rays".). Wright *et al*, *supra* note 98 at 159-60. (Discussing the possibility of a pellet ASAT which fills a satellite's path with debris.).

[298] Boothby, "Space Weapons and the Law" *supra* note 215 at 192-99. (Examining various *ad hoc* rules as applied to space weapons.). Ramey, *supra* note 4 at 58-59. (Noting the unlikelihood of present weapons conventions applying to space weapons.).

[299] Koplow, "An Inference About Interference" *supra* note 143 at 808-09.

Treaty. The treaties include rules barring interference with those means of verification. He reasons that kinetic ASAT weapons, by creating debris, could damage satellites that are used for NTM, or force them to alter their movements, or use energy to avoid the debris, limiting their lifespan, all thereby interfering with NTMs.[300] However, no state appears to have raised such concerns, and even he notes that there are likely too few treaties with such rules to provide a basis for a rule, even assuming the mere possibility of interference with NTMs would be sufficient to render kinetic ASATs illegal.[301]

While such creative or unorthodox interpretations of existing law are worth considering, they highlight the degree to which the weapons, means, and methods of warfare in outer space remain free of meaningful regulation by treaty. Rules certainly apply to weapons in space as much as they do on Earth, but because the nature of warfare is so different from the agreements developed for traditional, terrestrial warfare, there are few practical limits. Just as the law, in its "majestic equality…forbids rich and poor alike to sleep under the bridges, to beg in the streets, and to steal their bread," so too does the law forbid use on Earth and in space of poison gas, blinding lasers, and biological agents.[302]

B. Superfluous Injury or Unnecessary Suffering

Aside from rules found in specific agreements and treaties which bind states, two broad principles of weapon law regulate weapons. The first is found in Article 35(2) of Additional Protocol I, which states it "is prohibited to employ weapons, projectiles and material and methods of warfare of a nature to cause superfluous injury or unnecessary suffering."[303] The 2nd Hague Convention, arising out of the first Hague Conference, first laid this principle out explicitly in 1899.[304] The ICJ declared this to be a well-established rule of customary international law in the *Nuclear Weapons* opinion, when it was one of the "cardinal principles contained in the texts constituting the fabric of humanitarian law."[305] Scholars and states

[300] *Ibid.*
[301] *Ibid.* at 815.
[302] Anatole France, *Le Lys Rouge* [The Red Lily] (USA: Dodd, Mead, and Co., 8th ed. 1923, orig. 1894) at 91. [translated by Winifred Stephens].
[303] Additional Protocol I, *supra* note 14, Art. 35(2).
[304] Hague II, *supra* note 252, Art. 23(e). Hague IV, supra note 252, Art. 23(e).
[305] *Nuclear Weapons Opinion*, *supra* note 254 at 256. *Ibid.* at 395. (Shahabuddeen, J., dissenting) (Agreeing the principle is enshrined in customary international law.). For a summary of the history leading to this conclusion, *see* Yves Sandoz, "Unlawful Damage in Armed Conflicts and Redress Under International Humanitarian Law" (1982) 228 I.R.R.C. 131 at 144

overwhelmingly express agreement with this principle being binding as a matter of customary international law.[306]

The relevance of this rule to space warfare depends on the meaning of "superfluous injury and unnecessary suffering." Warfare, of course, has always involved both injury and suffering. The origins of international humanitarian law draw from a tradition of attempting to minimize the consequences of kinetic warfare on human beings above all else.[307] In its *Nuclear Weapons* opinion, the ICJ defined the phrase as "a harm [to combatants] greater than that unavoidable to achieve legitimate military objectives."[308] The prohibition, then, focuses on causing harm to combatants that either serves no legitimate military objective or is clearly disproportionate to the military advantage to be gained. [309]

However, the application of this rule in space warfare as it is likely to exist in the foreseeable future is limited. First and foremost, this rule applies strictly to combatants, not civilians.[310] While there is a dissenting argument the rule also applies to civilians as well, [311] this is not supported by the authorities,[312] nor is it clear what this reading of the rule would accomplish. Civilians cannot be targeted directly.[313] If civilians are put at risk through the indirect effects of an attack targeted at a military objective, it is more likely to violate the

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[306] *See*, *e.g.*, Jean-Marie Henckaerts & Louise Doswald-Beck, eds., *Customary International Humanitarian Law*, Vol. 1: Rules (Cambridge University Press, Cambridge, 2005) Rule 70. [CIHL]. (Finding that the principle against causing superfluous suffering has achieved customary status.). Schmitt, "Out of the Loop" *supra* note 179 at 242-43. (Article 35(2) "irrefutably" reflects customary international law binding on all states, parties or not.). Matheson, *supra* note 180 at 424. (Acknowledging U.S. support for Article 35(1) and (2) as binding).
[307] *See* Bugnion, *supra* note 15 at 1306.
[308] *Nuclear Weapons Opinion*, *supra* note 254 at 257.
[309] ICRC Commentary, *supra* note 178, ¶ 1429. (Discussing the terminology chosen by the committee when drafting, focusing exclusively on issues of injury, wounding, and bodily pain.). DOD LOAC Manual, *supra* note 19 ¶ 6.6.3. (Citing both.). Australian Law of Armed Conflict, (May 11, 2006) ADDP 06.4, ¶ 2.7. [Australian LOAC Manual] (Either "excessive in the circumstances" or "not actually necessary" to achieve military objectives.).
[310] *See Ibid.* (Specifying "combatants" as the subject of that rule, and noting the protections to civilians under other rules.). Tallinn Manual 2.0, *supra* note 179, r.104(2). (The rule on superfluous injury or unnecessary suffering therein "applies only to injury or suffering caused to combatants, members of organised armed groups, and civilians directly participating in hostilities" as civilians are protected by other rules.). Chengeta, *supra* note 197 at 84. (Same, citing the above.). Customary International Humanitarian Law Database, ICRC, "Practice Relating to Rule 70. Weapons of a Nature to Cause Superfluous Injury or Unnecessary Suffering" [CIHL Database], online: <ihl-databases.icrc.org/customary-ihl/eng/docs/v1_rul> [perma.cc/Q2QL-CB68]. (The rule "refers to the effect of a weapon on combatants".). Luke A. Whitmore, "Proportionality Decision Making in Targeting: Heuristics, Cognitive Biases, and the Law" (2016) 7 Harv. Nat'l Sec. J. 577 at 598. (Same.).
[311] *E.g.,* ICRC Commentary, *supra* note 178, ¶ 1434. Henri Meyrowtiz, "The Principle of Superfluous Injury or Unnecessary Suffering" (1994) 34 IRCR 98 at 105. ("[N]either the text" of Article 35 or 36 "refer solely to methods and means of warfare directed against combatants".).
[312] *See supra* note 310.
[313] *See* Section IV.C & V.B., *infra.*

principle of distinction.[314] A weapon *designed* (of a nature) to inflict injury to civilians would be unlawful not because such damage would inherently be superfluous and unnecessary, but because civilians cannot be targeted without violating the more applicable principle of law.

Historically, the concept served to limit weapons such as poison gas, shells with broken glass, blinding lasers, or dum dum bullets, which may be used upon combatants but would cause considerable pain and suffering, judged to be beyond what is necessary to achieve a military objective.[315] Many such weapons were barred by specific agreement, as discussed *supra*, but that does not even establish a consensus that the weapon in question causes superfluous injury.[316] The concerns states had about weapons causing superfluous suffering and unnecessary injury may have motivated them to enter into the specific agreements, but the weapons barred by those agreements are illegal because of the agreement, not *necessarily* under customary international law for violating the principle herein discussed.

Many such weapons also raise concerns about whether they may be used with proper distinction or discrimination, that is, whether their usage can be properly targeted at military objectives only.[317] However, as will be discussed, those concerns are covered by the question of whether the weapons are "inherently indiscriminate," or other principles of humanity.

Unlike the panoply of weapons that are subject to this rule which target military personnel but cause excessive suffering to those individuals, the space weapons do not figure to cause such consequences. None of the weapons discussed above are designed to be used on humans at all. States need consider the weapons under their normal or expected use, not all possible uses.[318]

Kinetic ASAT weapons could, in theory, target a space station or spacecraft in flight. However, this is not the normal or expected usage for such weapons; they are, as noted in their

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[314] *Ibid.*

[315] *E.g.,* French Ministry of Defense, "Manuel de Droit des Conflits Armes" (2012) at 44-45. [French LOAC Manual] (listing weapons banned because of their "inhumane nature or excessive traumatic effects" such as chemical or biological weapons or poison gas.). (French; *see* CIHL Database, "Rule 70", *supra* note 310 for translation.). Australian LOAC Manual, *supra* note 309, ¶ 4.7. (Listing examples such as broken glass or dum dum bullets.).

[316] *E.g.,* DOD LOAC Manual, *supra* note 19 ¶ 19.21.5. (Agreeing that lasers used to blind are barred by the Blinding Laser Protocol, but that such weapons have *not* been held to cause unnecessary suffering or superfluous injury. In other words, the weapon is barred by agreement only, not customary international law.).

[317] *Ibid.* (Noting that such weapons are also banned because they cannot be used with discrimination.).

[318] Bernard, *supra* note 176 at 939-42. Michael Bothe, Karl Josef Partsch, & Waldemar A. Solf, *New Rules of Armed Conflict for Victims: Commentary on the Two 1977 Protocols Additional to the Geneva Conventions of 1949* (The Hague/Boston/London: Martinus Nijhoff, 1982) at 231.

very name, built to destroy satellites. In the event a state *did* find such a target to be lawful and worthwhile, it is unlikely the weapon's effects would be deemed unnecessary or superfluous. The effects of destroying a spacecraft in flight would not appear to be substantially different, in terms of human suffering or injury, from destruction of a plane carrying combatants. Targeting and destruction of enemy aircraft has been a part of warfare since aircraft became a tool of war.[319]

This analysis applies to the usage of other weapons described as well. Targeting humans or human-based vehicles with other weapons listed above would not be the normal or expected use of any such weapon. Targeting a human with a direct energy weapon otherwise designed for satellites, were it feasible, *could* raise issues about the amount of suffering or injury incurred. However, in all likelihood, any such weapons system would be designed and reviewed separately, and not of the same type that would be used to target satellites.[320] Weapons or systems that jam or otherwise interfere with signals are similarly unlikely to cause such issues. They are certainly not *designed* to cause any injury, let alone superfluous ones.[321]

A second issue arises concerning second-order effects. The weapons may not primarily target human combatants, but need a state consider if the weapon's normal and intended use would cause superfluous injury or unnecessary suffering among combatants via second-order effects? While most sources consider second- and the third-order effects worthy and perhaps necessary of consideration in determining the legality or weapons, in this context, the vast majority look to whether the effects render the weapon inherently indiscriminate, rather than producing superfluous injury.[322] This is sensible since the principal question around the legality of such weapons turns on what they are designed or intended to do. It is difficult to conceive of scenarios where the second-order effects of an attack on a satellite involve superfluous injury to

[319] "Civil War Ballooning" American Battlefield Trust, online: <www.battlefields.org/learn/articles/civil-war-ballooning> [perma.cc/PFJ9-AWUY]. (Union troops used balloons in the American Civil War, while Confederate soldiers attempted to destroy them with artillery.).
[320] *See* DOD LOAC Manual, *supra* note 19 ¶ 6.14.1 n.356-57. (Noting certain non-lethal capabilities including blinding lasers and an active denial system consisting of direct energy waves directed at people, but that such systems are also and separately subject to review.).
[321] Boothby, "Space Weapons and the Law" *supra* note 215 at 112. ("[t]he superfluous injury/unnecessary suffering test is likely to be of little or no relevance".).
[322] *See, e.g.,* Thompson, *supra* note 13 at 146-47. (Discussing second-order effects of orbital destruction of satellites with regard to weapons being indiscriminate.). Koplow, "Asat-isfaction" *supra* note 45 at 1245. ("[T]he indirect, or 'second-order,' effects of a weapon must also be considered in evaluating its discrimination ability".).

combatants *and* that such effects are part of the overall design or intent of the use of the weapon.[323]

At best, an individual attack or operation might raise legal issues. Suppose a country could spoof a satellite signal to then cause the release of toxic chemicals on a military base. The chemicals might be contained within that base and so not inherently indiscriminate, but the chemicals might cause considerable suffering of the type states were concerned about when they banned chemical weapons. Such a specific operation might very well raise concerns about legality due to superfluous injury or unnecessary suffering, as well as prohibitions on the use of chemical weapons. However, there is little to suggest any capabilities *in general* would be *of a nature* to cause such injuries.

This view is echoed by William Boothby, who notes that, when looking at cyber weapons, ordinarily one will look at the generic effects of usage when deciding the legality of a weapon, but if a capability is designed with a specific target in mind, then the "ad hoc circumstances" of that attack will be closely considered when evaluating the weapon for superfluous injury or being indiscriminate.[324] It is not so much that second- and third-order effects do not apply in the analysis, but when evaluating the legality of a weapon at procurement, one is only looking at its general characteristics unless it has a very specific intended usage.[325]

Accordingly, none of the space weapons described above are likely to violate the law on this account. For instance, if a state is evaluating means of destroying or incapacitating communications satellites and what effects that might have on military planes using those satellites for communication or for weapons guidance, it is certainly possibly that inhibiting those communications could lead to injury: a plane crash or a misguided weapon causing unintended casualties. But when reviewing the legality of a weapon or methods or means of warfare, one is not considering any and all situations that could conceivably occur, since doing so would be virtually impossible. Instead, if a weapon passes legal muster, its particular use in a particular operation may be reviewed later as part of the legality of that particular military

[323] Contrast this with second-order effects on in discrimination, where causing harm or damage to civilian infrastructure may well be understood as a likely or inevitable consequence of destruction of a satellite.
[324] William Boothby, "Methods and Means of Cyber Warfare" (2013) 89 Int'l L. Stud. 387 at 392.
[325] For example, Stuxnet was a cyber capability directed at Iranian nuclear facilities that had the apparently intended effect of physically destroying centrifuges. It appears to have been engineered very specifically for this goal. The legality of such a capability would be reviewed based on the specific targets and effects intended, rather than under the guise of general cyber capabilities. Jeremy Richmond, "Evolving Battlefields: Does Stuxnet Demonstrate a Need for Modifications to the Law of Armed Conflict?" (2012) 35 Fordham Int'l L.J. 842 at 849-60.

operation.[326] Almost certainly, the mere possibility of unplanned events occurring which could lead to suffering which would be incidental to the weapon's use is not going to render the weapon illegal.[327]

It is quite possible a capability or series of capabilities—a means of warfare—could be developed to target a specific set of satellites: for example, to disable the GPS constellation, or a nation's military reconnaissance satellites. It is foreseeable that such capabilities may be uniquely developed to address the particular patterns of the satellites in question. The GPS constellation has redundancies and planned routes over particular areas, so a capability would have to target specific satellites at specific times to be effective.[328] Satellite systems have different types of defenses, such as encryption of signals, so a capability to target a particular set of satellites may be customized to address it specifically.[329]

Under these circumstances, a state would have to review the capability in light of the likely or intended effects on the particular target the capability is designed for. In these circumstances, it is easier to evaluate whether there would be unnecessary suffering, since one would look at what effects the weapon is likely to generate upon being used on the particular target. If a capability is designed to spoof GPS signals such that it will create false location information upon anyone using it in a given area and time, then it is possible to estimate the harm caused.

Even this is likely to be largely irrelevant for purposes of a weapons review regarding unnecessary suffering to combatants. At its most damaging, a series of false signals from GPS satellites, if accepted and relied upon by the combatants using them, might lead planes and munitions astray, or troops to move into areas they are not intending. But causing the death, destruction, or disabling of military personnel and equipment in wartime are perfectly permissible military actions. While use of such a weapon may raise issues with distinction,

[326] Brown & Metcalf, *supra* note 227 at 138. (Looking at cyber operations.).
[327] *Cf* Boothby, "Space Weapons and the Law" *supra* note 215 at 186. (Unless designed or likely to cause superfluous injury, weapons will not be illegal *per se.*).
[328] "Space Segment" GPS, *supra* note 46.
[329] *See generally* Psiaki & Humphreys, *supra* note 167. (Discussing the characteristics of the GPS system and issues with a spoofing attack.).

discussed *infra*, it is unlikely to result in a scenario where the capability's use is likely to cause *unnecessary* suffering or *superfluous* injury to combatants.[330]

There is not a great deal of specific commentary on this issue from scholars, most likely because of the limited applicability in practice of this principle. Boothby believes that space weapons, as they are currently conceived, do not violate this principle.[331] Some have taken the other approach, suggesting that space weapons, particular kinetic ASAT weapons, may cause unnecessary suffering by destroying civilian infrastructure.[332] For the reasons discussed, however, an attack or even effects on civilian infrastructure are not "superfluous injury" and, if anything, violate the principle of distinction. State practice is hard to discern. While many concerns have been raised regarding the possibility of space debris and the general proliferation of weapons in space, there has been silence regarding the specific issue of unnecessary suffering.[333]

The present outer space environment is largely devoid of humans. Despite warfare in space having substantial effects on Earth and upon humans, the law against weapons causing superfluous injury or unnecessary suffering is unlikely to do any work in limiting the development of the weapons, means, and methods of warfare in space.

C. Inherently Indiscriminate

The second pillar of weapons law forbids weapons that are "inherently indiscriminate." In Additional Protocol I, this is codified in Article 51(4), which prohibits indiscriminate attacks.[334] These are defined as: "(a) those which are not directed at a specific military objective; (b) those which employ a method or means of combat which cannot be directed at a specific military objective; or (c) those which employ a method or means of combat the effects of which

[330] One could conceive of an action that is intended to or likely to mislead a munition to destroy a chemical plant, releasing toxic chemicals and causing suffering and harm to nearby people, combatant or civilian. This far-fetched scenario seems the only type of action of this type that might trigger a major legal issue.
[331] Boothby, "Space Weapons and the Law" *supra* note 215 at 186. ("[T]he principle is concerned with the effects of a weapon on personnel and is therefore unlikely, for the foreseeable future, to be relevant to outer space weapons if their effects only occur in outer space".).
[332] Ryan Esparza, "Event Horizon: Examining Military and Weaponization Issues in Space By Utilizing the Outer Space Treaty and the Law of Armed Conflict" (2018) 83 J. Air L. & Com. 334 at 343. (Suggesting the "immediate degradation of technological infrastructure" could have a severe impact on civilians.).
[333] Koplow, "Asat-isfaction" *supra* note 45 at 1239-41. (Several states protested China's ASAT test, but only Japan referred to it as unlawful, and not related to suffering.).
[334] Additional Protocol I, *supra* note 14, Art. 51(4).

cannot be limited as required by this Protocol; and consequently, in each such case, are of a nature to strike military objectives and civilians or civilian objects without distinction."[335]

For the purposes of legal reviews of weapons, subsections (b) and (c) are most relevant.[336] Subsection (b) refers to weapons that cannot be *targeted* with distinction. An example might refer to early V2 rockets, which were only able to be launched with limited targeting accuracy, or the laying of sea mines, which remain in place until they collide with a ship, and are unable to distinguish between friend, foe, or civilian.[337] Subsection (c) refers to weapons whose *effects* cannot be discriminating, such as the poisoning of a well, or fire or water used as a weapon.[338] Such an attack could be initially directed at a proper military objective with proper precision—for example, starting a forest fire in a military-occupied area—but there would be no ability to control the effects, which depending on the particular circumstances could easily spread to affect civilians. As a consequence, weapons which cannot be used in accordance with those principles are forbidden.[339]

In a broader sense, this speaks to the principle of distinction or discrimination. Militaries may use force against military objectives.[340] Military objectives are "those objects which by their nature, location, purpose or use make an effective contribution to military action and whose total or partial destruction, capture or neutralization, in the circumstances ruling at the time, offers a definite military advantage."[341] A military may not target civilians or civilian objects.[342] A civilian object is anything that is not a military object.[343] According to Article 49, these rules apply to "land, air, and sea warfare," leaving open the possibility the rules may not apply in outer space.[344] However, the targeting rules and requires are broadly understood to be part of the

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[335] *Ibid.*
[336] Subsection (a) is directed at individual operations, rather than a weapon as a whole, for not being directed at a proper objective.
[337] ICRC Commentary, *supra* note 178, ¶ 1958.
[338] *Ibid.*, ¶ 1963. On both points, *see also* Stephen Townley, "Indiscriminate Attacks and the Past, Present, and Future of the Rules/Standards and Objective/Subjective Debates in International Humanitarian Law" (2017) 50 Vand. J. Transnat'l L. 1223 at 1226. Boothby, *Weapons and the Law of Armed Conflict*, *supra* note 245 at 71. (Also noting the principles of (b) and (c) are the relevant inquiries in a weapons review.).
[339] CIHL, *supra* note 306, Vol. 1: Rules, at 244.
[340] Additional Protocol I, *supra* note 14, Art. 48. ("In order to ensure respect for and protection of the civilian population and civilian objects, the Parties to the conflict shall at all times distinguish between the civilian population and combatants and between civilian objects and military objectives and accordingly shall direct their operations only against military objectives".).
[341] *Ibid.*, Art. 52(2).
[342] *Ibid.*, Art. 48.
[343] *Ibid.*, Art. 52(1).
[344] *Ibid.*, Art. 49(3).

fundamental laws of war as customary international law and almost certainly apply in all domains, even if not explicitly included in Additional Protocol I.[345]

Some objects may have dual uses, both civilian and military: a power station used by a military base and civilians; a bridge necessary for both civilian and military traffic; a factory manufacturing ball bearings needed for both civilian and military uses; or satellites used for communication by both civilian and military users. No mere abstract or hypothetical problem, this issue has long been present in warfare. Regarding dual-use satellites, the U.S. has heavily utilized commercial satellites for communications in the Gulf War, Kosovo, and its 2003 invasion of Iraq.[346]

The term "dual-use object," however, is something of a misnomer. A thing must be a military objective or civilian object: as with Schrödinger's cat, it cannot exist in an indeterminate state.[347] Instead, if a target is a military objective, but also has civilian uses, an attacker is required to consider the concept of proportionality in its attack. The attacker must ask, do the military advantages expected to be conferred by the action outweigh the potential or likely civilian casualties or damage?[348] This situation is resolved in a review of particular operations and attacks.[349] Because weapons reviews are concerned with weapons that are *inherently* indiscriminate, the particulars of any possible situation are not important in resolving the legality of the weapon.[350] This concept is instead important because it explains the environment in which such weapons operate, particular in examining whether their effects may be indiscriminate.

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[345] CIHL, *supra* note 306, Vol. 1, Rules, at Rule 14; Schmitt, "International Law and Military Operations in Space" *supra* note 232 at 115-16. (Noting both that the rules as such would bar attacks from space onto land, or into space that affect civilians or civilian populations, as well as customary international legal principles applying in all domains.). Bonny Birkeland, "Space: The Final Next Frontier" (2020) 104 Minn. L. Rev. 2061 at 2078 n.113. Kubo Mačák, "Silent War: The Applicability of the *Jus in Bello* to Military Space Operations" (2018) 94 Int'l L. Stud. 1 at 23 n.132. (Citing to additional sources.).

[346] Waldrop, "Integration of Military and Civilian Space Assets" *supra* note 73 at 169-70.

[347] This is implied by the exclusivity of the definitions used in Article 51(1) and (2) in Additional Protocol I. *See also* DOD LOAC Manual, *supra* note 19 ¶ 5.6.1.2. ICRC, "The Principle of Proportionality in the Rules Governing the Conduct of Hostilities Under International Humanitarian Law" (2016) at 39. ("[F]rom a legal perspective, an object is either a military objective or a civilian object".).

[348] Caitlyn Georgeson & Matthew Stubbs, "Targeting in Outer Space: An Exploration of Regime Interactions in the Final Frontier" (2020) 85 J. Air L. & Com. 609 at 620. Notably, proportionality only weighs the military advantage against the civilian damage, that is, the damage which is not the object of the attack. These is no requirement in the *jus in bello* to conduct attacks on otherwise legitimate targets in proportion to the expected military advantage. DOD LOAC Manual, *supra* note 19 ¶ 5.10.

[349] *Ibid.*

[350] Boothby, *Weapons and the Law of Armed Conflict*, *supra* note 245 at 67.

These principles—barring inherently indiscriminate weapons, distinguishing between military objectives and civilian objects, and proportionality—are well-established and recognized as rules of customary international law.[351] The ICJ recognized this when it declared "States must never make civilians the object of attack and must consequently never use weapons that are incapable of distinguishing between civilian and military target."[352] States overwhelmingly agree, even those, such as the United States, which are not party to Additional Protocol I.[353]

There are very few clear examples of weapons that are inherently indiscriminate.[354] The ICRC has listed several categories, including chemical, biological and nuclear weapons; anti-personnel landmines; mines; poison; explosives discharged from balloons; V-1 and V-2 rockets; cluster bombs; booby-traps; Scud missiles; Katyusha rockets; incendiary weapons; and environmental modification techniques.[355] However, this list is unsatisfactory, as has been noted by critics.[356] The list includes broad categories of weapons, not all of which may be inherently indiscriminate. Numerous states use or maintain the right to use weapons in many of these categories, casting doubt as to whether they are inherently indiscriminatory as determined by state practice.[357] Most notably, the ICJ declined to hold nuclear weapons to be inherently indiscriminate.[358]

States positions are also difficult to discern from practice. As legal reviews of weapons come at the early stages of development, instances where ideas are rejected as inherently

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[351] CIHL Database, *supra* note 310, Rules 7-9. (Of Distinction, and defining both military objectives and civilian objects). Rule 14. (Proportionality). Rule 71. (Inherently Indiscriminate Weapons). Rome Statute of the International Criminal Court, 17 July 1998, 2187 U.N.T.S 90 (entered into force 1 July 2002) [ICC Statute] Art. 8(2)(b)(xx). Christopher Greenwood, "The Law of Weaponry at the Start of the New Millennium" (1998) 71 Int'l L. Studies 185 at 199. Michael N. Schmitt, "The Principle of Discrimination in 21st Century Warfare" (1999) 2 Yale Hum. Rts. & Dev. L.J. 143 at 148. (Acknowledging the more general targeting principles as customary.). *See also* Boothby, *Weapons and the Law of Armed Conflict*, *supra* note 245 at 67-71. (A greater discussion on the extent to which the rules are customary, including a more skeptical viewpoint, though apparently concluding it is binding.).

[352] *Nuclear Weapons Opinion*, *supra* note 254 at 257. (Discussing the cardinal rules of the law of armed conflict.).

[353] DOD LOAC Manual, *supra* note 19 ¶ 6.7. New Zealand LOAC Manual, *supra* note 212, ¶ 7.2.1.3. For a more thorough listing, *see CIHL, Vol. 2: Practice, Part 1*, *supra* note 339, Ch. 20, §§ 271-290, for military practice.

[354] Greenwood, *supra* note 351 at 200. (Suggesting V1 and V2 rockets and Scud missiles might be examples.).

[355] *CIHL, Vol. 1: Rules*, *supra* note 339, at 249.

[356] Boothby, *Weapons and the Law of Armed Conflict*, *supra* note 245 at 69. (*citing* Stephen Haines, *Weapons, Means and Methods of Warfare* in E. Wilmshurst and S. Breau (eds.), *Perspectives on the ICRC Study on Customary International Humanitarian Law* (Cambridge University Press, 2007) at 266.

[357] To use one example, landmines are banned by the Ottawa Treaty, but that agreement has only 164 parties, missing a number of major powers like Russia, China, and the United States. Ottawa Treaty, *supra* note 294. Other types of mines, such as naval mines, are barely regulated at all and not banned by a multistate treaty. International Security Department Workshop Summary, "International Law Applicable to Mines" (2014) at 2. It strains credulity that such weapons could be deemed illegal under customary international law.

[358] *Nuclear Weapons Opinion*, *supra* note 254 at 262.

discriminatory are not likely to be obvious.[359] There is no easy way to determine weapons states have chosen not to develop because of concerns over their legality, and all the more because the legal review process for weapons, like most of the research, development, and testing process, is typically very secretive. Further, many weapons which are cited as inherently indiscriminate are banned by specific treaties, raising the question of whether the weapon is barred because it is inherently indiscriminate as a matter of customary international law, or merely because there is a treaty barring the weapon.[360] As with unnecessary suffering, this principle might serve as the basis for a treaty ban, but that does not mean the weapon is *also* inherently indiscriminate as a matter of customary international law.[361]

While state practice is difficult to discern, several states provide definitions and examples in their military manuals. The United States defines an inherently indiscriminate weapon as one that is "incapable of being used in accordance with the principles of distinction and proportionality."[362] It provides examples such as a proposed bomb carried by bats in World War II.[363] New Zealand notes that even a largely unguided rocket could be used lawfully in "rare" circumstances where "only military objectives exist within the area of attack."[364] Canada cites to weapons that cannot be directed at a specific target as illegal, and points to the use of Scud missiles by Iraq in the Gulf War as an example of what "may be argued" as indiscriminate use.[365]

Few of the concerns that motivated the creation of this law in the terrestrial domain apply in outer space. Far from being indiscriminate, kinetic ASATs are very precise in their ability to track down a particular satellite: hitting an object moving at 8 km/s at a distance of several hundred kilometers is only possible with incredibly accurate targeting. Less is publicly known

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[359] Boothby, *Weapons and the Law of Armed Conflict*, *supra* note 245 at 70.
[360] Charles P. Trumbull IV, "Autonomous Weapons: How Existing Law Can Regulate Future Weapons" (2020) 34 Emory Int'l L. Rev. 533 at 556. (For instance, treaties that bar anti-personnel mines and cluster bombs but are only applicable to those states.). Boothby, *Weapons and the Law of Armed Conflict*, *supra* note 245 at 70. (Finding that the principle against inherently indiscriminate weapons probably inspired many treaty bans.). *See discussion* in note 316, *supra*, regarding superfluous injury, for the same principle.
[361] *Ibid.*
[362] DOD LOAC Manual, *supra* note 19 ¶ 6.7.
[363] *Ibid.* ¶ 6.7.1 n.151. It also includes the V2 rocket and Japanese balloon bombs in World War II, though specifically as weapons designed to attack civilians more then weapons that could not be controlled as such. ¶ 6.7.3
[364] New Zealand LOAC Manual, *supra* note 212, ¶ 7.2.14.
[365] Joint Doctrine Manual, "Law of Armed Conflict at the Tactical and Operational Level," National Defence (Canada), (2001) ¶ 509 [Canada LOAC Manual]. Scud missiles in this context refer to missiles utilized by Iraq, particularly during the Gulf War in 1991, where they may have had a circular error probable of 3 kilometers; that is, half of the munitions fired will land within 3 kilometers of their intended target and half will land farther. Kyle Mizakomi, "The Scud Missile Still Gives the World Nightmares" (2019) The National Interest, online: <nationalinterest.org/blog/buzz/scud-missile-still-gives-world-nightmares-80226> [perma.cc/X4D8-TY97].

about direct energy weaponry, but because such weapons require targeting a small object several hundred kilometers away, such weapons would simply be unfeasible and not usable if they were not accurate. Likewise, states may choose to interfere with satellite signals based on the particular satellite and frequency, targeting a particular uplink location.[366]

One type of weapon that likely would be indiscriminate is nuclear weapons used to target satellites. Had the Starfish Prime test been used to intentionally damage satellites, rather than having done so accidentally, there is good argument that such targeting would be inherently indiscriminate. While it could probably be aimed at a particular satellite, the EMP resulting from it is unlikely to be appropriately limited to the targeted satellite alone.[367] Ultimately, the use of nuclear weapons in space is largely moot, due to both treaty agreements—the Outer Space Treaty[368] and Partial Test-Ban Treaty[369]—and the more practical fact that the effects are likely to be too far-ranging and harmful to unintended targets to be useful.[370] Likewise, any fragmentation or pellet ASAT, designed to create a field of debris which might collide with a satellite, would have a high degree of likelihood of being illegal under this provision.[371]

Downlink signal jamming is more uncertain. One capability involves using ground-based devices to interfere with signals being received in a given area.[372] The nature of the jamming is such that it interferes with all signals used on a given system in a given area.[373] Jamming capabilities used in this sense would potentially be incapable of distinguishing between civilians and military.[374] The effects of interfering with navigational tools like GPS could be disastrous for

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[366] Wright *et al*, *supra* note 98 at 166.
[367] For example, the EMP from Starfish Prime damage infrastructure well over 1000 kilometers away in Hawaii on Earth, as well as satellites in orbit. Hollingham, *supra* note 129. It is not clear if this is, strictly speaking, a targeting or effects issue.
[368] OST, *supra* note 6, Art. IV. (Barring stationing nuclear weapons or weapons of mass destruction in outer space, though not prohibiting their transit through or use in space as such.).
[369]Partial Test-Ban Treaty, *supra* note 8. (Banning nuclear tests in the atmosphere, underwater, and outer space.).
[370] *See* ICRC Commentary, *supra* note 178, ¶ 1958. (The convergence of interests of humanitarian law and militaries in improving targeting accuracy and avoiding weapons which are less precise than alternatives.). Laura Grego, "A History of Anti-Satellite Weapons" (2012) Union of Concerned Scientists, online(pdf): <www.ucsusa.org/sites/default/files/2019-09/a-history-of-ASAT-programs_lo-res.pdf> [perma.cc/L58R-6FVP]. (Nuclear weapons make poor ASAT weapons due to being indiscriminate.).
[371] It is not known whether such a weapon actually exists. At best, it would likely be used by a state that cannot develop a more precise kinetic ASAT, but still wishes to retain some ASAT capability.
[372] Wright *et al*, *supra* note 98 at 166-67. Bourbonnière, "*Jus in Bello Satellitis*" *supra* note 24 at 67. Westbrook, *supra* note 172 at 1.
[373] *Ibid.*
[374] Westbrook, *supra* note 172 at 6-7. (Looking at the example in South Korea where civilian use was heavily disrupted.).

civilian aircraft.[375] While using such signal jamming technology in areas with no civilian presence would not trigger an issue, this appears increasingly rare in practice, particularly in urban warfare. Several commenters have suggested such jamming is itself an unlawful violation of distinction.[376]

It is not clear, however, that jamming capabilities are even a weapon, means, or method of warfare. In examining when LOAC applies to cyber operations, the Tallinn Manual 2.0 notes that an armed conflict must exist for LOAC to apply.[377] LOAC applies to cyber operations conducted along with or in support of an armed conflict.[378] As mentioned previously, cyber operations which have effects similar to kinetic attacks would also be considered armed attacks if used independently of and, consequently, fall under LOAC.[379] Therefore, cyber operations that do no rise to the level of armed attack by themselves—cause kinetic effects—or occur as part of an armed attack or military operation would not fall under LOAC at all.[380] Such an action might violate some other domestic or international law, but the specific application of the laws of armed conflict would not be an issue.

Applying that logic to jamming or interference, actions that interfere with satellite signals that occurs outside of an armed conflict and does not cause—or is not designed to cause—a kinetic effect would not be subject to LOAC. By contrast, jamming or interference that causes death, injury, or destruction, or occurs in conjunction with armed conflict, would be subject to LOAC.

While not directly addressing their legality in this context, the United States refers to "legitimate deception activities of the defending force, such as jamming."[381] This is addressed when declaring the *attacker* need not consider the impact of the defender's actions in assessing

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[375] Mario Bertoletti, "How Military GPS Jamming Affects Commercial Aviation" (Jan. 28, 2021) Airways Magazine, online: <airwaysmag.com/industry/military-gps-jamming-aviation> [perma.cc/24YZ-4978]. (Describing near-miss incidents.).
[376] Bourbonnière, "*Jus in Bello Satellitis*" *supra* note 24 at 67. ("It is…very difficult to reconcile this obligation [distinction] with the jamming of GPS signals in urban areas"). Mountin, *supra* note 156 at 164. ("If intentional interference cannot distinguish legitimate from illegitimate targets, there may be an obligation to either forego the attack or use some other weapon with an ability to satisfy the discrimination requirement."). S*ee also* ICRC Commentary, *supra* note 178, ¶ 1476. (The evolution of measures and countermeasures, including "electronic jamming (or interference) exacerbates the indiscriminate nature of combat.").
[377] Tallinn Manual 2.0, *supra* note 179, r. 80.
[378] *Ibid.*
[379] *Ibid.*
[380] *Ibid.*
[381] DOD LOAC Manual, *supra* note 19 ¶ 5.12.1.

the legality of its attack, though pointedly noting the defender would have to consider their impact on civilians.[382] Likewise, the United States defines "cyber capabilities"—which are subject to legal review—as including "any device…intended to deny, disrupt, degrade, destroy or manipulate adversarial target information, information systems, or networks."[383] Intelligence-gathering capabilities are excluded from review.[384] The U.S. position appears to be that jamming or interference (outside of that involved in espionage or counter-espionage) would be subject to LOAC rules.

The question faced by a reviewer is whether the particular system is designed for use in or alongside combat operations. A system inherently designed or intended to be used in response to combat operations, such as denying enemy planes in an area access to guidance systems, is clearly governed by LOAC rules. Systems that exist to deny GPS (or equivalent system) usage to an adversary within a geographic range might have some peacetime uses—for instance, the example of North Korean interference above was not used in wartime, nor was it apparently deemed a use of force.[385] However, it seems unlikely the principle use of most or all jamming or interference systems of this nature is anything other than to disrupt an adversary in combat or military operations. That would make the systems subject to LOAC's rules when considered their legality as a whole.[386] As such, systems which interfere with a broad range of GPS signals, and cannot or are not designed to be targeted to a specific frequency in their regular use, would risk being inherently indiscriminate.

However, this analysis runs into the same issue that arises with more traditional weapons: what if they can be used with *some* distinction? As stated above, Scud missiles during the Gulf War had a circular error probable of 3 kilometers, leading many states and commenters to refer to them as an example of indiscriminate weapon.[387] Yet, the Scud missiles *could* be directed to a target.[388] Instead, two factors lead to serious doubts as to their legality. First, the existence of much more accurate technology used by other states raised the issue of how to considered

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[382] *Ibid.*
[383] AFI 51-401, *supra* note 204, ¶5, Attachment 1, *Terms*.
[384] *Ibid.* (The Air Force categorizes electronic means "intended to provide access to an adversarial computer system for data exploitation," that is, espionage and intelligence, separately, and does not require a legal review.).
[385] Albeit probably still illegal, just not a violation of LOAC principles. *See* note 172.
[386] Consideration of the lawfulness of individual operations, by contrast, would depend on the particular operation. Using a system for espionage in peacetime would not trigger LOAC review for that particular use or operation.
[387] *See supra* note 365.
[388] Schmitt, "The Principle of Discrimination in 21st Century Warfare" *supra* note 351 at 148.

"discrimination" in a comparative sense.[389] Second, Iraq directed the missiles at crowded urban areas.[390] It is not that the weapons were inherently indiscriminate, but they were used in an indiscriminate fashion.[391] It is easy to imagine the weapons being fired at a military base that is not near civilian objects—the missiles may well be accurate enough such that an attack would be discriminating within the bounds of international law. The ICRC notes that "attacking an area that is unpopulated by civilians but may contain enemy military assets is not considered indiscriminate.[392]

The first problem—use of an inaccurate weapon when there are more accurate or less destructive options—will be discussed in the final section.[393] As to the second, that is a targeting concern, and is not inherent to the weapon. A weapon that can be aimed at a designated target, where the nature of the target *could* be hit by the weapon without threatening civilian infrastructure, is not inherently indiscriminate. Therefore, even jamming systems, while in usage perhaps quite likely to impact civilian objects, are not inherently indiscriminate within the meaning of weapons review law.

It is in the uncontrolled *effects* of space weapons where the present laws on armed conflict are more likely to interact with present and future technology in space. First and foremost, the debris created by physically destroying a satellite may affect numerous other satellites, including those of purely civilian use, those owned and operated by neutral nations, or both. This is most likely a risk with kinetic ASAT weapons, but may also be the case in using non-kinetic means that disable, interfere with, or destroy the control capabilities of a satellite. A disabled satellite may be unable to maneuver to avoid another object, or a directed energy weapon may cause the fuel source to explode.[394] In terms of weapons reviews, this is not likely to be a concern as such a possible after-effect does not render a weapon inherently indiscriminate.[395]

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[389] *See* Canestaro, *supra* note 82 at 451.
[390] Schmitt, "The Principle of Discrimination in 21st Century Warfare" *supra* note 351 at 148.
[391] *Ibid.*; *Compare* New Zealand LOAC Manual, *supra* note 212, ¶ 7.2.14. (Targeting an area with no civilian assets could render a weapon discriminate.) *with* Canada LOAC Manual, *supra* note 365, ¶ 509. ("[I]t may be argued" that Scud missiles in the Gulf War were indiscriminate, though notably not stating that such weapons were inherently indiscriminate.).
[392] ICRC Commentary, *supra* note 178, ¶ 1973.
[393] *See* Section IV.E., *infra.* (Considering the Least Harmful Means rule.).
[394] Koplow, "An Inference About Interference" *supra* note 143 at 796-97.
[395] Though a weapon or capability designed to take control or interfere with a satellite's maneuverability with the intent to cause it to collide with another object would be in the same category as a kinetic ASAT, since the intended

It is the debris-creating characteristic of kinetic ASAT weapons that has drawn the most concern. Some commenters believe such weapons are illegal under the inherently indiscriminate principle. David Koplow argues that debris-creating (mainly kinetic) ASATs are already illegal under existing legal principles because of the indiscriminate harm caused by debris.[396] Other commenters agree, for the slightly different reason that the environment is a civilian object that will be inherently damaged by a kinetic ASAT attack.[397]

Yet the prevailing view of others and of state practitioners is that such weapons are not *per se* indiscriminate. One commenter finds that the debris field concern "has not been realized" and further that such weapons could potentially be used in a manner to reduce debris.[398] Another possibility, as with the U.S. test in 2008, is that use against satellites in very low orbits would minimize the number of debris which could impact other satellites.[399] In other words, the weapon could in some ordinary circumstances be used in a manner so as not to cause uncontrolled effects, and so would not be indiscriminate *per se*. Instead, commenters agree that the potential for debris creates a concern in the targeting calculus when deciding if an attack is proportional.[400]

The full nature of state practice is, as always with weapons development, opaque. However, four states have fully tested kinetic ASAT capabilities. While states have issued objections to these tests and the development of such weapons, these largely take the form of political, rather than legal, protests.[401] Notably, the United States joined such objections to China's test, and Russia objected to the United States operation in 2008.[402] As states which possess and test kinetic ASAT capabilities, it cannot be understood that they argue that such weapons are illegal *per se*.

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normal use of the weapon would be to cause physical destruction leading to a debris field. It is unlikely a weapon or capability exists which is specifically designed for that purpose, as opposed to being a by-product or one possible use of such capabilities.

[396] Koplow, "Asat-isfaction" *supra* note 45 at 1245. Olney, *supra* note 114 at 756. (These weapons "could" be illegal under Article 36, suggesting they have largely escaped regulation thus far.).

[397] Murphy, *supra* note 45 at 137-38. S*ee* Thompson, *supra* note 13 at 147-151. (Examining whether the weapon is illegal because widespread harm caused to the environment rather than being inherently indiscriminate *per se*, though concluding it is lawful.).

[398] *Ibid.* (The suggestion that such weapons may be indiscriminate, but rejecting it.).

[399] Wolf, *supra* note 107.

[400] Bourbonnière, "*Jus in Bello Satellitis*" *supra* note 24 at 65-67. Thompson, *supra* note 13 at 147.

[401] *E.g.,* Koplow, "Asat-isfaction" *supra* note 45 at 1239-41. (Several states protested China's ASAT test, but only Japan referred to it as unlawful.).

[402] *Ibid.* at 1237-38. "US Spy Satellite Plan 'a Cover" (Feb. 17, 2008), BBC, online: <news.bbc.co.uk/2/hi/americas/7248995.stm> [perma.cc/G7XS-T8Z5].

There are other concerns regarding distinction, most notably second-order effects of satellite destruction on civilian populations who rely upon those satellites. As noted, militaries often utilize civilian satellites for communications and other purposes. This renders the satellites valid military targets during war, though subject to the principle of proportionality. However, while this may require a state to undertake a proportionality analysis before attack, it does not render the weapons used inherently indiscriminate. So long as the weapon can select a particular target and attack it with reasonable accuracy, and the state can with some accuracy ascertain which satellites are utilized by opposing militaries, the weapon should not be *per se* illegal.[403]

Thus, despite a few objections, there is little doubt that the space weapons now conceived, even kinetic ASATs, are not inherently indiscriminate in either their targeting or their effects. Nor, given the possession of those weapons by the major space powers, does it appear a change in the understanding of those rules or a comprehensive treaty laying out a specific ban is forthcoming. The limitations of this rule in inhibiting weapons development are most apparent by applying them to fiction: the Death Star from the "Star Wars" franchise. A device capable of destroying a planet—an attack itself which would almost always be indiscriminate—was also utilized to target and destroy individual enemy ships, and so would not be inherently indiscriminate.[404]

D. Protecting The Environment

Thus far, the only universally agreed-upon questions a weapon must face to survive a legal review provide no effective limitation on the development of space weapons. The less-accepted questions a weapon must face are more likely to provide some limitations, but because those provisions are not agreed-upon by all or most nations as a requirement, paradoxically do not provide much hope in this area either.

In the last half-century, states have begun to place more interest in protection of the natural environment during military conflict. These arose in large part out of the conduct of the Vietnam War, in which the use of chemical defoliants and other techniques caused immense

[403] Mike McKinnon, "How You Can Track Every Spy Satellite in Orbit" (Feb. 12, 2015) Gizmodo, online: <gizmodo.com/how-you-can-track-every-spy-satellite-in-orbit-1685316357>. (Demonstrating the relative ease with which even amateurs can identify and track spy satellites, as well as alluding to efforts taken by other governments.).
[404] *Compare "*Star Wars: A New Hope" 1977 [film] Directed by G. Lucas. Hollywood: Lucasfilm ltd. *with* "Star Wars: Return of the Jedi" 1983 [film] Directed by R. Marquand. Hollywood: Lucasfilm ltd.

harm to the environment that lasted beyond the confines of the war itself.[405] There are two potential bases by which a weapon can violate environmental rules: Articles 35(3) and 55(1) of Additional Protocol I, and the Environmental Modification Convention (ENMOD).

Additional Protocol I, Article 35(3) provides that "[i]t is prohibited to employ methods or means of warfare which are intended, or may be expected, to cause widespread, long-term and severe damage to the natural environment."[406] Similarly, Article 55(1) states:

> Care shall be taken in warfare to protect the natural environment against widespread, long-term and severe damage. This protection includes a prohibition of the use of methods or means of warfare which are intended or may be expected to cause such damage to the natural environment and thereby to prejudice the health or survival of the population.[407]

Article 35(3) requires consideration of either intent—deliberate destruction of the environment as a goal—or actions where that "may be expected," that is, the likely consequence of use of the weapon. The terms "widespread" and "severe" are not defined, but the drafters viewed "long-term" in terms of decades.[408]

Article 55(1) reads largely the same, but adds the proviso that the damage to the environment "thereby prejudice the health or survival of the population." The Commentary notes there was discussion in merging the two Articles, but that Article 55 "relates to the protection of the civilian population," creating an explicit focal difference between the environment itself, in Article 35, and the health and lives of humanity, in Article 55.[409]

As with the other parts of Additional Protocol I, these Articles are binding on parties to the treaty. However, unlike Article 35(1) and (2), Articles 35(3) or 55(1) are not reflective of customary international law. Many commenters do not believe there is sufficient practice to warrant as much.[410] France and the United States both take the position that those portions are

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[405] Michael N. Schmitt, "The Environmental Law of War: An Invitation to Critical Re-examination" (1995/6) 6 USAFA J. Leg. Stud. 237 at 239-40. [The Environmental Law of War].
[406] Additional Protocol I, *supra* note 14, Art. 35(3).
[407] *Ibid.*, Art. 55(1).
[408] Stephanie N Simonds, "Conventional Warfare and Environmental Protection: A Proposal for International Legal Reform" (1992) 29:1 Stan J Int'l L 165 at 173-74..
[409] ICRC Commentary, *supra* note 178, ¶ 1449.
[410] Luan Low & David Hodgkinson, "Compensation for Wartime Environmental Damage: Challenges to International Law After the Gulf War" (1995) 35 Va. J. Int'l L. 405 at 427-28. Boothby, *Weapons and the Law of Armed Conflict*, *supra* note 245 at 83-85. (Indicating there are aspects of environmental protection required by customary international law, but not Articles 35(3) and 55(1).). Greenwood, *supra* note 351 at 204-05 n.93. (Noting Germany also stated the rule was "new" at that time and providing other sources for discussion.). Schmitt, "The Environmental Law of War" *supra* note 405 at 260. ("[W]hile there may be an emergent 'operational code'

not customary, and Germany stated at signing that the rule was "new."[411] Many nuclear states took the position the rules did not apply to nuclear weapons.[412] While nothing precludes a new rule created in 1977 from becoming customary, the novelty of the law at that time highlights that principles being enshrined were new, at least insofar as the environment itself was highlighted as a consideration, contrasted with many of the previously discussed rules, which can be considered as putting already-extant principles of law to paper.

The *Nuclear Weapons* opinion noted the dispute, that some states argued that environmental provisions were binding and others denying they applied at least as to nuclear weapons.[413] The ICJ stated Articles 35(3) and 55(1) were "powerful constraints" for "states having subscribed to these provisions," implying they are not binding as a matter of customary law on all states.[414] The ICRC Commentaries state that the distinction between the "concept of the ecosystem" as opposed to "the human environment" has emerged "gradually" in the text, noting the first draft rule appeared in 1972.[415] The ICRC nevertheless asserts this is a rule of customary international law.[416]

On balance, there is no clear indication that either Article is itself binding on non-parties, given the lack of clear, consistent widespread practice out of a sense of legal obligation. This means that the Articles, insofar as they may act to limit the development or use of weaponry, only apply to parties, excluding states such as the United States and India.[417]

Article 55's anthropocentric focus means it is likely to have little application in outer space for warfare as it is presently conceived. Whatever damage may be done to satellites and the prospect of future space activities, it is unlikely to prejudice human survival. Even widespread destruction of satellites to the point where particular orbits become unusable, catastrophic as it may be, is unlikely to have such a direct and traceable link to "survival of the

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regarding environmental damage during warfare, it is premature to assert that customary law in the classic sense has surface".).

[411] *Ibid.*; ICRC Customary Law Study, Vol. II, Part 1, at 878; Note that France and Germany are party to Additional Protocol I; the U.S. is not.

[412] ICRC Customary Law Study, Vol. I, at 154

[413] *Nuclear Weapons Opinion*, *supra* note 254 at 241.

[414] *Ibid.* at 242.

[415] ICRC Commentary, *supra* note 178, ¶ 1444.

[416] CIHL, *supra* note 306, Vol. 1: Rules, r. 45.

[417] Though even the United States, while disputing that these conditions are binding, believes the principles apply but are "overbroad" "ambiguous" and apply only if the damage is "clearly excessive" in comparison to the military advantage to be gained. DOD LOAC Manual, *supra* note 19 ¶ 6.10.3.

population." The most likely potential application would be if attacks were to threaten astronauts in space.[418] However, at present there are two space stations and a handful of astronauts in space at a given time, making such a direct threat to human life relatively remote.[419] Perhaps in the science-fiction-inspired instance that technology permitting direction of a large body such as an asteroid to collide with Earth, such a provision would most likely apply.[420]

Article 35(3) possesses a slightly brighter prospect. It applies to actions where damage is planned or "likely," meaning it applies to damage that is incidental to a weapon's use, though reasonably expected.[421] This is consistent with the general concept of a weapons review, looking at the weapon's likely impact in normal or expected use.[422] The potential damage caused by debris in space could affect a huge area, significantly harm a number of satellites or orbital positions, and last for decades, if not longer, depending on where the damage occurred.[423]

Even here the rule fails as a constraint. Thompson notes that while it appears promising, proving "severe" damage is difficult, looking at examples from the Gulf War for determination of causation and compensation.[424] Moreover, as mentioned when discussing inherently indiscriminate weapons, kinetic ASATs can be used in a manner to minimize damage, and certainly one in which debris may be minimal or remain in orbit for a year, such as with the U.S. Navy in 2008.[425] While attacks against satellites in higher orbits—where the debris may last far longer—may violate this principle, that is a focus for targeting and specific operations, not the weapon as a whole.

Further, many states do not see Article 35(3) as binding, two of whom (the United States and India) have kinetic ASATs. The United States, for its part, believes that any limitations on the use of such weapons are tied to the concept of military advantage and proportionality.[426] Even an attack which would likely produce widespread, severe, and long-term damage to the

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[418] Thompson, *supra* note 13 at 15.2. (That would still not "threaten the population".).
[419] Steffi Paladini, "Tiangong: China May Gain a Monopoly on Space Stations" (May 15, 2021) SciTech Daily, online: <scitechdaily.com/tiangong-china-may-gain-a-monopoly-on-space-stations> [perma.cc/79AG-A6CK].
[420] "Starship Troopers" 1997 [film] Directed by P. Verhoeven. Hollywood: Tristar Pictures. Any number of other legal rules would also be broken by such an attack, and in any event such an action, were it feasible, would be so catastrophic and indiscriminate it is hard to conceive of any state undertaking it.
[421] Thompson, *supra* note 13 at 151.
[422] *E.g.,* Boothby, *Weapons and the Law of Armed Conflict*, *supra* note 245 at 85.
[423] Thompson, *supra* note 13 at 153-54. (Concluding kinetic ASAT attacks could very well meet all the requirements of Article 35(3).).
[424] *Ibid.*
[425] Wolf, *supra* note 107.
[426] DOD LOAC Manual, *supra* note 19 ¶ 6.10.3.

environment might nevertheless be legal if the military advantage to be gained outweighed the damage. That is a targeting or operation-specific determination, and would by no means render a weapon illegal.

The other potential limit on weapons comes from the ENMOD.[427] The Convention requires parties "not to engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State Party."[428] "Environmental modification techniques" are defined as "any technique for changing - through the deliberate manipulation of natural processes - the dynamics, composition or structure of the earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space."[429] Examples provided of "deliberate manipulation of natural processes," in turn, include:

> earthquakes; tsunamis; an upset in the ecological balance of a region; changes in weather patterns (clouds, precipitation, cyclones of various types and tornadic storms); changes in climate patterns; changes in ocean currents; changes in the state of the ozone layer; and changes in the state of the ionosphere.[430]

In a rarity, the agreement specifically references outer space, removing any doubt that it was within the vision of the drafters.

Unlike the "decades" for Additional Protocol I, "long-lasting" in the ENMOD means "lasting for a period of months, or approximately a season."[431] "Severe" means "involving serious or significant disruption or harm to human life, natural and economic resources or other assets."[432] Finally, "widespread" is given a numerical value of "an area on the scale of several hundred square kilometres."[433]

The ENMOD has 78 parties, which is substantially fewer than Additional Protocol I.[434] On the other hand, with the exception of France, all of the relevant space powers are party to the

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[427] Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques art. I, Dec. 10, 1976, 31 U.S.T. 333, 1108 U.N.T.S. 151 [ENMOD].
[428] *Ibid.,* Art. I.
[429] *Ibid.*, Art. II.
[430] Yoram Dinstein, *The Conduct of Hostilities Under the Law of International Armed Conflict* (Cambridge Univ. Press, 2016) at 232. (*quoting* ENMOD, Understandings.).
[431] ENMOD, *supra* note 427, Understandings.
[432] *Ibid.*
[433] *Ibid.*
[434] UN Treaty Collections, ENMOD, online: <treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXVI-1&chapter=26&clang=_en> [perma.cc/U6KE-5TM6].

treaty.[435] There is some suggestion that this rule is customary.[436] Notably, the commenters who support this view do not cite to the traditional requirement of *opinio juris* as a basis for their conclusions.[437] However, the recency of the rule and the lack of states as party to the ENMOD weigh heavily in favor of it not being binding on those that did not choose to be bound by it.[438]

Regardless, the ENMOD is not likely to be helpful in limiting the development of arms in space. First, it refers to techniques which are designed to deliberately manipulate natural processes, rather than an attack which does so incidentally.[439] It would not render an ASAT attack on a satellite that, when successful, creates a debris field, because the environmental damage (the debris field) is incidental to the attack, not the method or direct intent.[440] Conversely, releasing a massive amount of debris itself as a means of disabling satellites and thereby causing damage to a large area of the space environment might violate the ENMOD.[441] However, there is no evidence a state has developed such a weapon, and doing so would likely be counterproductive to any state desirous of having a presence in outer space.

Second, the ENMOD refers to damage to a "State Party." While there may be possessions such as satellites damaged by a weapon causing destruction in space, damage to the environment in space will likely not violate the ENMOD, as it is not within the sovereignty of any nation.[442]

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[435] *Ibid.*
[436] John Alan Cohan, "Modes of Warfare and Evolving Standards of Environmental Protection Under the International Law of War" (2003) 15 Fla. J. Int'l L. 481 at 525.
[437] *Ibid.* ("Moreover, given the fundamental importance of the environment for the well-being of peoples of the world, there is no rational basis why ENMOD should be limited to state parties." The rule for customary international law is a "general and consistent practice of states followed by them from a sense of legal obligation".).
[438] *See* CIHL, *supra* note 306, Vol. 1: Rules, r. 45. (The matter is debatable and that states such as Israel, South Korea, and New Zealand explicitly state it only binds parties, and citing in contrast that Indonesia, a nonparty, has it in its military manual. Notably, inclusion of a particular practice by a state does not mean the state is undertaking it out of a sense of legal obligation, which is the requirement for a matter under customary law.). Boothby, *Weapons and the Law of Armed Conflict*, *supra* note 245 at 85. (Doubting that ENMOD is customary.). Walter G. Sharp, Sr., "The Effective Deterrence of Environmental Damage During Armed Conflict: A Case Analysis of the Persian Gulf War" (1992) 137 Mil. L. Rev. 1 at 21.
[439] DOD LOAC Manual, *supra* note 19 ¶ 6.10.3. (Incidental damage is not prohibited.).
[440] Dinstein, *supra* note 430 at 234. ("[M]ere collateral damage" would not count, providing the example of bombing a chemical factor, leading to the release of chemicals as a byproduct of the attack.). Thompson, *supra* note 13 at 154. (Arguing the debris damaging orbital positions resulting from of a kinetic ASAT attack is likely incidental and not covered by ENMOD.).
[441] Though as noted in the discussion of inherently indiscriminate attacks, such a weapon would likely be illegal for that reason already.
[442] Dinstein, *supra* note 430 at 234. (The Convention does not apply to damage caused to a non-Party state or an area "outside the jurisdiction of all States," using the High Seas as an example.). OST, *supra* note 6, Art. II. ("Outer space…is not subject to national appropriation by claim of sovereignty…".).

By contrast, doing widespread damage to land or water within the possession of a State would constitute a violation of the ENMOD.[443]

On the high seas, there is an argument that damage to the environment which thereby interferes with the economic rights of states could constitute damage to states within the meaning of the ENMOD.[444] A similar argument could be advanced regarded orbital slots. They are a limited resource and utilized by states for economic gain, so it follows that deliberate damage to that "environment" could be treated in a like fashion.[445] This argument is enhanced in that both that the ENMOD mentions outer space specifically and uses the example of changes to the ionosphere—48 to 805 kilometers above Earth, encompassing LEO.[446]

To that end, weapons designed to damage the environment and render satellites inert, or destroy them outright, would be illegal if the state were a party to the ENMOD. In principle, this would likely apply to a fragmentation ASAT with enough destructive capacity to cause "widespread" and "severe" damage, or a nuclear weapon or other EMP releasing radiation that remained in the ionosphere for "a season" or more.[447] However, as discussed, such weapons are likely barred by nature of their indiscriminate nature, nor does it appear such weapons are in development, whether because they are likely illegal or simply impractical. Otherwise, there does not appear to be a likely application of ENMOD to space weapons as they exist now.

Finally, outside of weapons particularly damaging the outer space environment, weapons that cause interference with signals or other non-kinetic techniques are unlikely to be relevant to environmental concerns.

E. The Martens Clause: Principles of Humanity and the Dictates of Public Conscience

While not universal, the final element of review, as suggested by the ICJ, ICRC and at least Australia,[448] is whether the weapons violate the principles of humanity and the dictates of

[443] Boothby, "Space Weapons and the Law" *supra* note 215 at 192.
[444] George K. Walker, "The Tanker War and the Maritime Environment" (2000) 74 Int'l Law Stud. 500 at 514. (Damage to fishing rights and shipping lanes could be compensable, though noting in the case of damage during the Iraq-Iran War that Iraq not being a Party and the damage not being deliberate likely rendered it inapplicable.).
[445] Thompson, *supra* note 13 at 153.
[446] Ramey, *supra* note 4 at 20 n.80.
[447] This is part of the nature of the damage caused by Starfish Prime, which led to a temporary new radiation belt. Hollingham, *supra* note 129.
[448] The Australian Article 36 Review Process, *supra* note 260 at 15(e).

public conscience. As discussed above, this question is often said to derive originally from the Martens Clause, which reads in full:

> Until a more complete code of the laws of war is issued, the High Contracting Parties think it right to declare that in cases not included in the Regulations adopted by them, populations and belligerents remain under the protection and empire of the principles of international law, as they result from the usages established between civilized nations, from the laws of humanity, and the requirements of the public conscience.[449]

According to the Red Cross, "A weapon which is not covered by existing rules of international humanitarian law would be considered contrary to the Martens clause if it is determined *per se* to contravene the principles of humanity or the dictates of public conscience."[450]

This principle possesses the potential to have a large impact in outer space.[451] One understanding of the clause is to serve as a gap-filler: a principle to limit state action in some ill-defined manner until international or humanitarian law can develop.[452] Treaty law regarding space weapons, means, and methods of warfare is sparse, and as has been shown, the existing laws, norms, and practices developed for war on Earth have not had time to grow through experience to find application in space.

Yet the inherent vagueness of this principle also renders it of very limited usefulness. It has been referred to as an "irrelevant parameter because the principle does not provide normative content on its own."[453] Some view it as best understood as a reminder the customary international law exists along with treaty law to regulate warfare, without providing any further substantive rules.[454] The rationale behind it may serve as a reason for the development of a treaty barring a certain kind of weapon, though not as a source of the ban itself as customary international law.[455]

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[449] Preamble to Convention with Respect to the Laws and Customs of War on Land, July 29, 1899, reprinted in Texts of the Peace Conferences at the Hague, 1899 and 1907, at 48 (James Brown Scott ed., 1908). See Note 393
[450] Bernard, *supra* note 176 at 17.
[451] Jackson Maogoto and Steven Freeland, "The Final Frontier: The Laws of Armed Conflict and Space Warfare" (2007) 24 Conn. J. Int'l L. 165 at 174.
[452] Jeffery Kahn, "Protection and Empire: The Martens Clause, State Sovereignty, and Individual Rights" (2016) 56 Va. J. Int'l L. 1 at 16.
[453] Tobias Vestner & Altea Rossi, "Legal Reviews of War Algorithms" (2021) 97 Int'l Legal Stud. 509 at 527.
[454] Dinstein, *supra* note 430 at 14.
[455] Symposium: The Hague Peace Conferences: The Martens Clause, Principles of Humanity, and Dictates of Public Conscience, (2000) 94 A.J.I.L. 78 at 83-84. Much as the case with weapons which cause unnecessary suffering, where many weapons have been banned by agreement often for reasons along those lines, though the weapons themselves have not *necessarily* themselves violated the customary principle against causing unnecessary suffering.

While the opaque nature of weapons reviews limits the ability to discern how the principle is used in practice, the commentary made by states in their military manuals strongly suggest their views are in line with the views of the latter commenters. Australia, cited as the only state "known to take it into consideration,"[456] is explicit that this consideration is applied narrowly: in the "sense of preserving customary international law. That is the Martens clause 'prevents the assumption that anything which is not explicitly prohibited by the relevant treaties is therefore permitted.'"[457] Canada holds the same view.[458] The United States is little different: the Martens Clause means "when no specific rule applies, the principles of the law of war form the general guide for conduct during war."[459] In defending the legality of nuclear weapons, the U.K. argued "the Clause does not, on its own, establish their illegality. The terms of the Martens Clause themselves make it necessary to point to a rule of customary international law which might outlaw."[460] Russia has gone farther still, arguing that the development of humanitarian laws governing armed conflict have "filled in" the gaps and rendered the Clause's purpose complete.[461]

While use of the Clause provides an intriguing possibility to the seeming vacuum of weapons law designed for space, there does not appear to be a path forward for the Martens Clause, or the principles of humanity or dictates of public conscience, to serve as bar to any of the potential space weaponry. No state views it as particularly substantive, but rather all see it, if they see it at all, as a reminder that customary law principles remain in place to regulate warfare. While the ICJ has mentioned it repeatedly in rulings, the Clause has not served as an independent basis for rendering a weapon, practice, or attack illegal by itself.[462] Indeed, if the general principles of humanity and conscience cannot establish the illegality of nuclear weapons, it is hard to imagine less destructive, less deadly weaponry falling to it.

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[456] Vestner & Rossi, *supra* note 453 at 528.
[457] The Australian Article 36 Review Process, *supra* note 260 at 15(e) n.20.
[458] Canada LOAC Manual, *supra* note 365, ¶ 106(2) and (3).
[459] DOD LOAC Manual, *supra* note 19 ¶ 19.8.3.
[460] Written statement of the United Kingdom, Nuclear Weapons, 1996 ICJ Pleadings (June 2, 1994), reprinted in 1995 BRIT. Y.B. INT'L L. 712, para. 32.
[461] Rupert Ticehurst, "The Martens Clause and the Laws of Armed Conflict" (1997) 317 IRRC 125 at 127.
[462] *See* "The Martens Clause, Principles of Humanity, and Dictates of Public Conscience," *supra* note 455 at 82-84. (Discussing ICJ jurisprudence in this area.).

V. Chapter 5 - What Remains – Operational Concerns, Targeting, and Does it Even Matter?

The requirement to review new weapons, means, and methods of warfare is widespread, but may not be binding on all states. There is no evidence that more than approximately 20 states even engage in such reviews. For the states that acknowledge such rules and undertake review, it does not appear that any of the rules that render a weapon or system illegal to use will affect the development of many of the proposed or developing weapons systems in space warfare. At a first approximation, it may make one wonder whether Article 36 serves any purpose regarding space weapons?

This has led to no shortage of concern about the proliferation of danger and situations leading to Kessler's Syndrome.[463] The possibility of rendering nearly a century of technological development moot, or at least badly limited, by our own self-destructive tendencies in making orbit untenable, is a frightening prospect. The impact of widespread interference with satellite signals affecting civilians, while more mundane and less permanent, similarly remain without clear limitations. As states rely more heavily on space, targeting those assets will only become more tempting, leading to greater strife and disruption to civilian life as a result. While not all commenters agree with these specific permissive views that space weapons would likely receive upon being reviewed, many recognize the inherent weakness of the regime to place limits upon space weaponry, particularly with regard to creating the risk of orbital debris.[464] As a consequence, many propose the need for new rules, new interpretations of old rules, or new international agreements.[465]

These have not been met by any promising behavior on the part of states. The PPWT proposal from Russia and China appears to be at a dead-end, as the United States has declared it "fundamentally flawed."[466] In particular, the U.S. noted the lack of any means of reliable

[463] *See* note 42.
[464] Thompson, *supra* note 13 at 111.
[465] *Ibid.* at 158. (Advocating for a reciprocal agreement to restrict kinetic ASAT weapons.). Koplow, "Asat-isfaction" *supra* note 45 at 1262-63. (New CIL on environmental damage to limit kinetic ASAT weapons) and 1266 (suggesting a new treaty would be beneficial.). Olney, *supra* note 114 at 763-64. (Arguing for a need for a stronger regime and looking at the Chemical Weapons Ban as an example.).
[466] Jeff Foust, "U.S. Dismisses Space Weapons Treaty Proposal as "Fundamentally Flawed" (Sep. 11, 2014) Space News, online: <spacenews.com/41842us-dismisses-space-weapons-treaty-proposal-as-fundamentally-flawed) [perma.cc/9BPJ-VGC7].

verification of compliance and that parties could stockpile weapons on the ground, then use them should they withdraw from the treaty.[467] They are not alone in this criticism.[468] Without the support of Western space-faring nations, any agreement is doomed to irrelevance.

The West is not without its own proposals. The European Union has proposed a "Code of Conduct," which would establish and promote peaceful norms.[469] However, it would not act as a legal arms control or usage mechanism as such.[470] More significantly, it also not drawn adherence from the major space powers, such as the United States, Russia, and China.[471] This, too, appears to be insufficient to limit the proliferation of weapons and aggression in outer space. In short, the hope that the shortfall in weapons limitations might be rectified by calls for multilateral international action have not been met with results. The future does not appear promising for any such meaningful agreements.

However, while the development of weaponry may not be directly limited by the review requirement, the legal review process serves an important ancillary purpose which may have value in preventing escalation in space. Individual operations must also be in compliance with the laws of war. A weapon *capable* of distinction use must actually be *used* with distinction. An attack capable of causing destruction and death to civilians and civilian objects must be weighed against the military gain to be achieved in such an action. A weapon that could cause severe, widespread, and long-lasting damage to the environment must at a minimum be weighed against the military advantage to be gained.

These issues are considered during planning of operations. For example, the U.S. Department of Defense states that "legal advisors help ensure that the JFC and staff consider law of war principles during the planning process for all joint military operations, and particularly during planning for combat operations."[472] Judge advocates are made available at "all stages of the tasking cycle," available to the air operations centers, and assist commanders and planners at the tactical level.[473] Those law of war principles include proportionality, distinction, necessity, and humanity.[474]

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[467] *Ibid.*
[468] Jakhu, "Sixty Years" *supra* note 275 at 100.
[469] Beard, *supra* note 117 at 353-55.
[470] *Ibid.* at 357.
[471] *Ibid.* at 376-78.
[472] Joint Publication 1-04, "Legal Support to Military Operations" (Aug. 2, 2016) U.S. Dep't of Defense, II-2.
[473] Air Force Doctrine Publication, 3-60, "Targeting" (Mar. 15, 2019) at 99.
[474] JP 1-04, *supra* note 472, II-2 and 3.

While these are targeting concerns, they may also be addressed during the legal review of a weapon. The United States requires a determination as to whether the weapon being reviewed "has additional restrictions on use specific to that type of weapon" and "whether other measures should be taken that would assist in ensuring compliance with law of war obligations related to the type of weapon being acquired or procured."[475] Following a legal review, Australia requires one of three designations be given: clearance; clearance with conditions or limitations; or no clearance.[476] One outcome may include updating doctrine to ensure new weapons are used consistently with Australia's legal obligations.[477] This view is consistent with commenters who understand that states will analyze their weapons for potential issues with their use in the course of a legal review even if they do not lead to *per se* bans.[478]

In other words, states will also take the opportunity while doing a legal review to understand how use of a weapon—which may otherwise pass legal muster—might violate LOAC in an operational sense. The idea is one of practicality: just as states who do not feel bound by Article 36 may desire to review their weapons for legality because it would be wasteful to develop a weapon that it could not legally use, so too does it make sense to review at an early stage whether using a weapon in a certain manner is likely to pose legal problems.[479] For example, a kinetic ASAT may not be inherently indiscriminate, but if a legal review determined that using it in medium earth orbit would cause enough environmental or collateral damage to civilian objects such that use would in most instance violate the rule of proportionality, a state might decide the value in developing and testing a weapon it could only deploy in very limited circumstances might not be worthwhile.

Yet this method of review suffers from some inherent deficiencies. Attempting to assess the possible or potential ways a weapon might be deployed is difficult in the abstract. Satellites occupy numerous orbital regions, and trying to assess the amount of debris, its duration, and effects in multiple scenarios may be too uncertain or open-ended to provide clear guidance.

Alternatively, consider the difficulty in assessing the legality of an attack on a dual-use satellite. This requires a comparison of the military advantage to be gained compared to the

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[475] *Ibid.*
[476] The Australian Article 36 Review Process, *supra* note 260 at 15(f).
[477] *Ibid.* at 16.
[478] *Eg,* Boothby, "Space Weapons and the Law" *supra* note 215 at 189.
[479] *Cf* Schmitt, "Out of the Loop" *supra* note 179 at 272. (Noting the value in reviewing systems before developing and employing them.).

damage and harm to civilians.[480] Assessing civilian damage resulting from destruction of a satellite presents considerable difficulties in the abstract, given that there are hundreds of dual-use satellites with different uses for different segments of civilian population, which may be very different years after the review when the weapon is actually used. Further, trying to weigh the military advantage to be gained against that may be more difficult still.[481] Military advantage is not limited to direct effects but also indirect ones: in destroying a means of communication for the enemy, one would look to the likely effects *that* would have on operations to understand if the advantage one would obtain would outweigh civilian costs.[482] Attempting to assess these weapons pre-emptively for operational concerns will contain many limitations that can only be resolved at the time of a particular operation, with more concrete targets, objectives, and risks.[483]

Why does this distinction matter? After all, if a commander is going to review deployment and use of a weapon in a particular operation, privy to more information than a reviewer of a weapon in an abstract and conceptual sense, that review is likely to benefit from more information and be a more accurate assessment of the risks and rewards.

Limiting weapons *after* they've been developed is a much riskier proposition for limiting their use. A state cannot use a weapon it does not develop. While a legal review declaring a weapon *per se* illegal does not mean the state cannot possess the weapon, a state which intends to comply with its international obligations is not likely to invest money and time in developing weapons it has determined it cannot use.[484]

By contrast, a weapon a state has sanctioned for use, built, and deployed, will be much more tempting to utilize, even in the face of ambiguities and uncertainties of the law. The technology behind modern weaponry in general, and space weaponry in particular, may take years to move from concept to a fully functional weapons system.[485] This timeline and cost

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[480] *See* Section V.D., *infra*.
[481] Georgeson & Stubbs, *supra* note 348 at 616-17. (Military advantage in space is likely to be shifting and relativistic.).
[482] Dinstein, *supra* note 430 at 108.
[483] James D. Fry, "Contextualized Legal Reviews for the Methods and Means of Warfare: Cave Combat and International Humanitarian Law" (2006) 44 Colum. J. Transnat'l L. 453 at 481-82.
[484] Were it otherwise, there would be little interest in reviewing the weapons in the first place, especially when the review process is without sanction or transparency. There is no discernable value in engaging in a legal review the results of which the state will then ignore.
[485] *E.g.,* Mike Pietrucha, "Finding the Way (Again): Building the Air Force's New Century Series" (Jun. 11, 2019) War on the Rocks, online: <warontherocks.com/2019/06/finding-the-way-again-building-the-air-forces-new-century-series> [perma.cc/G6Q7-WPYG]. (Providing examples of the development of high-tech aircraft and examining the decades-long processes involved in their development.).

create pressures to justify the weapons' creation and maintenance by using it. The authority for the use of the weapon, including the legality of a particular operation, may fall to a relatively low-level commander. If the weapon has potential for widespread or long-lasting effects, there is fear that a commander focused on tactical concerns may be more likely to ignore or downplay those more remote factors in favor of the immediate ones, which would bias him or her towards use.

In order to assess the validity of these concerns, one needs to assess how states will examine their obligations to the operational use of space weaponry during a weapons review, and if, and how, that might help restrain use of such weapons. The concepts largely track the same concerns that deal with legality *per se*. However, their use in operational planning or targeting, or a weapons review regarding the same, focuses less on inherent principles of the weapons and more on the practical and specific scenarios likely to occur. That is, rather than asking if a weapon is *inherently* indiscriminate, a state will look to see if certain attacks or uses are likely to be indiscriminate.

A. Necessity

Military necessity is "the principle whereby a belligerent has the right to apply any measures which are required to bring about the successful conclusion of a military operation and which are not forbidden by the laws of war."[486] It does not override other legal restrictions. Rather, it requires that the use of force be applied with an aim towards achieving a legitimate military benefit.[487]

In and of itself, it does not often serve to restrict action. Instead, it works in conjunction with other principles. It is closely tied to distinction—targeting military and not civilian objects[488]—and humanity—not causing unnecessary suffering, in qualifying what suffering may be "necessary" to achieve a legitimate military objective.[489]

There is a view that military necessity might render an attack on an otherwise lawful military target unlawful by virtue of the target being completely removed from any need in the

[486] NATO Glossary of Terms and Definitions, AAP-6 at 2-M-6 (2009).
[487] Bourbonnière, "*Jus in Bello Satellitis*" *supra* note 24 at 47.
[488] DOD LOAC Manual, *supra* note 19 ¶ 2.2.1.
[489] *Nuclear Weapons Opinion*, *supra* note 254 at 257. Bourbonnière, "*Jus in Bello Satellitis*" *supra* note 24 at 47.

present conflict.[490] For example, in an armed conflict limited to a particular region, a state might attack military units, vehicles, or structures thousands of miles away, raising a question of whether such an attack was in any way beneficial towards achieving a military objective. However, even in this view—which is a minority view to begin with[491]—there is great latitude given to the military in deciding what is necessary. Conflicts can expand, units can move, and so typically an attack upon a military objective will not be a violation of the principle of necessity.[492] States are also permitted to take the broader strategic picture into account: they are not limited to the "necessity" of particular action on the immediate situation, but its overall operational effects on winning the war and doing so as quickly as possible.[493] This also tends to resolve itself more practically: states are interested in utilizing their militaries efficiently, and are unlikely to undertake actions that have no military value, as they present a diversion of resource and additional risk for no gain.

In outer space, this principle on its own will not provide any significant limitations, least of all at the early stage of reviewing the legality of weapons. Considering first anti-satellite weapons of all kinds, a reviewer would understand that any number of satellites would be of immense value to the enemy, and disabling or destroying them of considerable military necessity in most any conflict. Spy satellites used for surveillance, communications satellites utilized for command and control, or navigations satellites used for military navigation or targeting all possess obvious military utility for virtually any range of conflicts.[494] Indeed, it is hard to imagine a conflict where an adversary possesses satellites with military utility that would not be of value—even reconnaissance satellites that do not overfly the combat area or rival state might detect assets in transit, actions by an ally, or be maneuvered into a more useful observational

[490] William V. O'Brien (ed.), "The Meaning of 'Military Necessity' in International Law" 1 World Polity 109 at 148-49 (1957). S*ee* Koplow, "Asat-isfaction" *supra* note 45 at 1247-48. (Arguing that "a military operation that might be able to make a small contribution" to the military objective would not be legal under the principle of necessity.).
[491] *Eg.,* Fred Hampson & Yoram Dinstein, "Proportionality and Necessity in the Gulf Conflict" (1992) 86 Proceedings of the American Society of International Law 45 at 53. (Rejecting this interpretation of O'Brien's view and stating "The destruction of the opposing armed forces, however, does not appear to require the justification of military necessity."). Geoffery Corn, *et al*, "Belligerent Targeting and the Invalidity of a Least Harmful Means Rule" (2013) 89 Int'l L. Stud. 536 at 552.
[492] Dinstein, *supra* note 430 at 117. ("[T]he fleeing soldiers of today are liable to regroup tomorrow as viable military unit" and noting enemy soldiers can be killed at all times.).
[493] DOD LOAC Manual, *supra* note 19 ¶ 2.2.3.1.; Corn, "Belligerent Targeting" 89 Int'l L. Stud. at 557-58
[494] Schmitt, "International Law and Military Operations in Space" *supra* note 232 at 116.

position. For the same reason, jamming and spoofing technology would have the same obvious military value.

B. Distinction

Distinction, also called discrimination, requires an attacker to focus its actions on military objectives, and not to target civilian objects.[495] Whereas the legality of a weapon focuses on whether its targeting or effects are *inherently indiscriminate*, in targeting the state looks to whether in a particular attack it is able to identify whether a target is a military objective and utilize a means of force that is able to target that particular objective without damaging civilian objects.

Whether a space weapon targets a military objective is unlikely to be a difficult question in most instances. First, while spy and reconnaissance satellites are not usually publicly-identified as such, the ability of space-faring states to identify such satellites is not doubted.[496] The satellites associated with the Global Positioning System, Galileo, and GLONASS are known, since such systems have civilian uses. States may contract with commercial operators for use during wartime, as the U.S. has done during the Gulf War, Kosovo, and the Iraq War.[497] These satellites, if utilized by an opposing state, would also become targets.[498]

The *prospective* as opposed to current use of satellites may also render them targets. One factor which determines if an object is a military objective is its "purpose," which is concerned with future uses of that object.[499] Commercial remote sensing and communications satellites can and have been utilized by states in wartime.[500] It is clear that such objects that have been used, or demarcated by agreement for future use, by a military in a conflict are converted into military objectives.[501] However, this may not always be clear. Intelligence may not be sufficient to

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[495] *See* note 340.
[496] See notes 99 and 403.
[497] Waldrop, "Integration of Military and Civilian Space Assets" *supra* note 73 at 169-70.
[498] Schmitt, "International Law and Military Operations in Space" *supra* note 232 at 116.
[499] ICRC Commentary, *supra* note 178, ¶ 2022. ("The criterion of 'purpose' is concerned with the intended future use of an object, while that of 'use' is concerned with its present function. Most civilian objects can become useful objects to the armed forces").
[500] Waldrop, "Integration of Military and Civilian Space Assets" *supra* note 73 at 169-70.
[501] Mountin, *supra* note 156 at 161-62. (Commercial satellites are likely to be valid targets in wartime.). Dinstein, *supra* note 430 at 114. (A cruise ship which has been made subject of agreement during peacetime to be converted to a troop carrier should war break out becomes a lawful target by virtue of that agreement upon the outbreak of hostilities.).

ascertain what satellites are being used by a military, and such satellites may be converted to military use on a very short timescale.[502]

The particular targeting issues for anti-satellite weapons, from jamming to interference to direct energy to kinetic, are unlikely to be a concern: the specific satellites or communications in a certain area can be targeted with considerable particularity. The main question regarding their use in terms of distinction is the degree to which the state can be confident such satellites or satellite signals *are* military targets—that is, they understand what the satellite is—or will be—used for. Fundamentally, this is an intelligence problem, albeit one that affects the decision whether to utilize a weapon: a commander would have to make a decision on whether he or she is confident enough that the target is a military objective in order to attack it.[503]

Therefore, any weapons review, in looking at the potential issues that could arise, would have to identify several concerns, less about the weapon itself than its particular use. Can the military identify what a particular satellite or signal is being used for, in order to make a determination as to its military role? What is the military's position on the point in time commercial satellites become military objectives: must there be a clear indication they will be used by the opposing state—perhaps a contract stating this—or is the mere possibility, perhaps coupled with past practice and an understanding of what the adversary is expected to do, sufficient to render the commercial satellites or their signals a target?[504]

This Thesis's purpose is not to fully resolve those positions. Rather, they are critical questions resolving the legality of the likely or prospective use of space weaponry. They are questions that arise during actual operational planning and targeting in real-time, but for states that evaluate those situations as part of their weapons review, they will be forced to confront them earlier, well in advance of deployment. This has consequences that will be discussed below.

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[502] Georgeson & Stubbs, *supra* note 348 at 616. Schmitt, "International Law and Military Operations in Space" *supra* note 232 at 117. (Declaring it could be as simple as a private operator handing over reconnaissance data already taken.).

[503] *Eg,* ADDP 3-14, Targeting, (Mar. 1, 2006) Australian Dep't of Defense, at 1.31. (Noting the importance of intelligence in assessing targets) and 1-15 (providing an example where NATO forces mistakenly targeted the Chinese embassy in the Kosovo War due to incorrect intelligence.).

[504] One might also question the degree of confidence in the intelligence before making a determination. However, this is a question omnipresent in all targeting considerations, and does not present anything unique in outer space.

The principle of distinction may also be violated with indiscriminate *effects* as well.[505] However, that is best considered alongside proportionality.[506] In such a situation, the attacker will have targeted a military objective—otherwise it would be the first type of distinction violation—but the collateral damage from the attack may cause excessive or uncontrolled damage to nearby civilians. Such an attack is not *per se* illegal, but instead requires a comparison of the military advantage expected in relation to the civilian death and damage.

There is a final note on distinction worth considering. Distinction applies not only to the attacker but the defender: they cannot use civilian objects as a basis for conducting operations by, for example, placing a sniper in a hospital.[507] Users of satellites thus also have an obligation to separate or distinguish those engaged in military activities from those engaged in civilian pursuits.[508] For the most part, these satellites—reconnaissance, communication, navigation—are not themselves weapons, so they will not fail a legal review under Article 36, since they do not require one. However, states may face a choice about avoiding use of commercial satellites, or openly declaring their use when it occurs, or run the risk of bearing responsibility for damage resulting in attacks on such objects that they have failed to properly distinguish.

C. Humanity

Just as distinction in targeting is the companion to "inherently indiscriminate" weaponry in a weapons review, humanity mirrors the prohibition on weapons which cause unnecessary suffering.[509] The United States provides a definition of "humanity" which forbids not only actions which lead to unnecessary suffering but "destruction unnecessary to accomplish a legitimate military purpose."[510] In practice, this does not create a rule appreciably different than discussed under Article 35(2). The phrase "destruction" neither addresses damage to civilians, either collateral or intended, as those are addressed by the principles of distinction and proportionality, nor does it forbid destruction of military assets for being "too remote" from conflict.[511] Unlike assessing whether a weapon is designed or by its nature to cause unnecessary

[505] Additional Protocol I, *supra* note 14, Art. 51(4)(c).
[506] Jens David Ohlin, "Targeting and the Concept of Intent" (2013) 30 Mich. J. Int'l L. 79 at 113.
[507] William Boothby, *The Law of Targeting* (Oxford University Press, 2012) at 79 n.19. Ramey, *supra* note 4 at 47.
[508] *Ibid.* Boothby, *The Law of Targeting* at 365-66.
[509] DOD LOAC Manual, *supra* note 19 ¶ 2.3. S*ee also* Canada LOAC Manual, *supra* note 365, ¶ 202(6) (Same.).
[510] *Ibid.*
[511] *See* note 491.

suffering, operational concerns are directed to considering whether the attack or operation or the weapon's use in such will do so.

In the context of a weapons review, this is unlikely to have a significant independent impact. For the same reason that space weaponry is unlikely to cause unnecessary suffering to combatants by their nature, so too are they unlikely to do so through specific use.[512] None of the space weapons discussed above are designed or particularly likely to be aimed at humans. Whatever effects they may have, even indirect, are not likely to be of the specific type contemplated by the rules.[513]

The humanity principle does raise one particular scenario of potential interest. If a military were faced with the option of physically destroying a satellite on the one hand, or its ground control station on the other, do the laws of armed conflict dictate it take a particular action, or is it free to choose? The attack on the satellite is unlikely to cause any direct harm to humans, and is preferable under a humanitarian perspective. The latter avoids causing long-term destruction and damage to the space environment and to other civilian objects that are not involved in the conflict, but likely places humans in harm's way. Such a dilemma pits humanitarian concerns against indiscriminate damage to the environment and civilians.

However, under existing legal principles, this is not a true dilemma. While a kinetic attack on Earth may cause harm and death to people, a ground control station integral to the operation of a satellite being used for military purposes in a conflict is a valid military target.[514] There is no legal humanitarian concern in killing enemy forces via conventional means unless some other prohibition is triggered.[515]

There are contrary arguments in favor of a so-called "least harmful means" rule: that commanders must determine and utilize the means least harmful to accomplish the goal.[516]

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[512] *Eg,* Boothby, "Space Weapons and the Law" *supra* note 215 at 213. (Space laser weapons are unlikely to be used to blind a person.).
[513] As discussed in Section IV.B., *supra*.
[514] Bourbonnière, "*Jus in Bello Satellitis*" *supra* note 24 at 59.
[515] *See* note 491. Arden Rowell & Lesley Wexley, "Valuing Foreign Lives" (2014) 48 Ga. L. Rev. 499 at 542 n.166. (Examining proposals for a "new rule" of "least harmful means" but stating "the international law remains that any combatant may be lawfully targeted during an armed conflict".).
[516] Corn *et al*, *supra* note 491 at 539. (Summarizing those proposing such a rule.). International Committee of the Red Cross, "Interpretive Guidance on the Notion of Direct Participation in Hostilities Under International Humanitarian Law" (2008) at 1042-44, online(pdf): <www.icrc.org/en/doc/assets/files/other/irrc-872-reports-documents.pdf> [perma.cc/C2RQ-W7AW]. [Interpretive Guidance]. (Arguing that it would "defy basic notions of humanity to kill an adversary or to refrain from giving him or her an opportunity to surrender where there manifestly is no necessity for the use of lethal force.").

If deciding between two options, the commander must pick the one less likely to harm people, even combatants.[517] Such a rule would also require use of cyber or similar capabilities where possible because they present a lower risk of collateral or civilian damage than kinetic weapons.[518]

Article 57, Additional Protocol I, states that "when a choice is possible between several military objectives for obtaining a similar military advantage, the objective to be selected shall be that the attack on which may be expected to cause the least danger to civilian lives and to civilian objects."[519] Critically, however, this "take care" provision applies to *civilians*. The rule does not require an attacker to decide on a means of attack which takes fewer military lives.[520] Even the ICRC acknowledges that "operating forces can hardly be required to take additional risks for themselves or the civilian population in order to capture an armed adversary alive," suggesting that even under their vision of such a rule, the situations where it might apply would be limited to those in which the commander faces no additional risk or lesser advantage, but can simply utilize a less deadly means.[521]

This is unlikely to drive considerable change in the review of how to utilize space weaponry. First, while such a rule regarding military targets—or a perhaps more accurately a principle derived from the extant rules—has been discussed, it does not appear to have taken root in any meaningful away among state practice or jurisprudence.[522] Second, it is unclear if such a situation would ever realistically arise. The ability to transfer control and communications between ground stations is not particularly difficult or resource-intensive, and states utilizing satellites in military operations possess numerous built-in redundancies.[523] A commander faced with a decision to either play "whack-a-mole" with attacks on ground communications stations,

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[517] *Ibid.*
[518] Michael N. Schmitt, "War, Technology, and Humanitarian Law" in *The Law of War in the 21st Century: Weaponry and the Use of Force*, Anthony M. Helm, ed. (2005) at 43.
[519] Additional Protocol I, *supra* note 14, Art. 57(3).
[520] *Ibid.; See* Corn *et al*, *supra* note 491 at 580.
[521] Interpretive Guidance, *supra* note 516 at 1043-44.
[522] *See* note 515.
[523] Bourbonnière, "*Jus in Bello Satellitis*" *supra* note 24 at 55. (Remote sensing satellites have multiple downlink stations, some of which are mobile.). Tom Wilson, "Threats to United States Space Capabilities" (2001) Commission to Assess United States National Security Space Management and Organization, online: <fas.org/spp/eprint/article05.html> [perma.cc/349K-WASY]. (The possibility of multiple mobile ground control stations to avoid easy destruction.). Joint Publication 3-14, "Space Operations" (Apr. 10, 2018, incorporating changes made on Oct. 26, 2020) Dep't of Defense, at 11(b) (Among the U.S. configuration are "globally dispersed antennas" providing the necessary links to control and exchange data with satellites.).

subjecting their forces to defensive firepower in the process, or to destroy an expensive and difficult-to-replace satellite, an attacker is not likely to see the former as a comparable option. This principle would only apply in comparable situations to begin with: a state is not required, for instance, to mount a full-scale special operations ground attack on a facility because bombing it might be slightly more destructive in an unnecessary way.[524] The likely scenarios proposed would simply not be comparable, for the reasons discussed.

Third, states already build this in to their planning to some degree. The United States pursues reversible means of attack on satellites where possible.[525] This is likely out of self-interest more than a sense of legal obligation. Space debris presents a threat to all other space-faring nations. This does not resolve the issue legally, nor does it necessarily address concerns that a state without a significant space presence, and less to lose if the space environment were compromised, might be more willing to undertake damaging asymmetric actions. However, kinetic ASAT abilities thus far are limited to, and strongly correlated with, states that have significant space capabilities, rendering this concern moot for the present.[526]

This issue is relevant for weapons reviews, however. In considering the potential tradeoffs between an attack on a satellite or an attack on a manned ground station, the legal review would force the state to proactively consider these possibilities, and how to handle them.

D. Proportionality

The concept of proportionality is the most relevant rule for space weaponry.[527] The rule requires the attack to ask if an attack "may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated."[528] This is repeated in Article 57(2)(a)(iii) which demands states "refrain from deciding to launch any attack which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete

[524] Interpretive Guidance, *supra* note 516 at 1043-44. (Acknowledging that any such requirement would never require a commander to place more of their own forces in danger.).
[525] Koplow, "Asat-isfaction" *supra* note 45 at 1207.
[526] *See* Section II.A, *supra.*
[527] Schmitt, "International Law and Military Operations in Space" *supra* note 232 at 118. ("[T]he proportionality principle is of particular relevance to potential attacks in outer space".).
[528] Additional Protocol I, *supra* note 14, Art. 51(5)(b).

and direct military advantage anticipated."[529] Closely related is Article 57(3)'s demand that an attacker faced with two equivalent options must choose the one which is expected to do less harm to civilians.[530] These principles are generally accepted, even by non-parties, as cornerstones of the law of armed conflict.[531]

This assessment does not apply to the *per se* legality of a weapon, for the simple reason that weighing such specified risks and gains is, by definition, situational and relativistic.[532] In the evaluation of how a weapon might be used and what limitations might be placed upon it, however, a reviewer would want to consider a number of reasonably likely situations in advance.

A "military advantage" must be: concrete, meaning tangible as opposed to vague and speculative; direct, having a causal relationship between the attack and the advantage; and military, meaning it must contribute towards success in the armed conflict in some manner, rather than affecting some tertiary goal.[533] So long as the target is otherwise a military target, its destruction will likely assist with a military goal.[534] Dinstein provides the targeting of a power plant in order to compel a *political* capitulation and ceasefire as an example of non-military advantage.[535] At a glance, this seems questionable: first, because the Ethiopia-Eritrea Claims Commission disagreed on the particular example he references when evaluating the issue, and second because, as Clausewitz famously wrote, war is a continuation of politics by other means.[536] Securing a favorable peace, and indeed compelling the opposing political leadership to bring an end to war on terms favorable to the attacker, is a military end, perhaps *the* military end—war is "an act of force to compel our enemy to do our will."[537] However, one can distinguish between an attack whose sole goal is to threaten or destabilize political leadership—

[529] *Ibid.*, Art. 57(2)(a)(iii).
[530] *Ibid*., Art. 57(3).
[531] Dinstein, *supra* note 430 at 152-53. DOD LOAC Manual, *supra* note 19 ¶ 5.12.2.1.
[532] *Ibid.* at 161-62.
[533] Int'l Law Ass'n Study Grp., "The Conduct of Hostilities and International Humanitarian Law: Challenges of 21st Century Warfare" (2017) 93 Int'l L. Stud. 322 at 364.
[534] Dinstein, *supra* note 430 at 104. (Destruction of "an objective making 'an effective contribution to military action' will almost automatically offer 'a definite military advantage.'" While this does not define the nature of the particular advantage or how it is weighed in comparison to the civilian damage, it does mean that an attack on a legitimate military target will likely procure a *military* advantage, as opposed to a non-military one.).
[535] *Ibid.* at 107.
[536] *Ibid.* n.617. (*citing* Eritrea-Ethiopia Claims Commission, Partial Award, Western Front, Aerial Bombardment and Related Claims, Eritrea's Claims 1, 3, 5, 9–13, 14, 21, 25 and 26 (2005), 45 ILM 396 at 420. Clausewitz, *supra* note 84 at 605.
[537] Clausewitz, *supra* note 84 at 75.

which would be a non-military advantage—as opposed to merely being the byproduct of an attack made for other reasons.[538]

Military advantages are not merely localized at the tactical level, but instead viewed in the totality of the operation or war.[539] The United States provides the example of how destroying an element used to communicate could lead to a larger advantage if it is part of a larger operation against the enemy's command and control than would be obtained in an isolated attack.[540] Applying this to outer space, an attack on an enemy satellite would be excepted to yield a greater advantage if part of a coordinated attempt to deprive the enemy of command and control, or to deprive it of reconnaissance in advance of a coordinated attack, than attacking it in isolation. The advantage to be gained in a particular attack or operation will of course be highly variable, but given the wide array of critical military capabilities that satellites are used for, as a potential "center of gravity" for some states, an attack upon them will likely be expected to yield large and significant advantages in most cases.

To utilize a concrete example, the Gulf War has been described as the "first space war."[541] While the contributions have been mentioned previously, it is worth noting that Coalition forces used satellites for communication, navigation, targeting, weather, and missile detection measures.[542] As one analyst succinctly put it, the use of satellites made the "hundred-hour ground war" possible.[543] Without it, the war may have lasted much longer and been considerably more destructive.

Conversely, the ground war began with a feint, a so-called Left Hook, to mislead Iraqi defensive forces, and the Coalition then engaged in a large flanking maneuver to devastating

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[538] Boothby, *The Law of Targeting*, *supra* note 507 at 501. However, Boothby uses the example of an attack on a power station solely to affect the morale of the civilian population. While this is illegal, it is not because it is a military target that does not provide a military advantage, but because on attack on a civilian power station solely to affect a civilian populace's morale, without more, is not a military objective. The analysis is germane if there were an attack on a power station providing power to the military and civilians alike, but the purpose of the attack had no relation to the military usage, but instead was only designed to harm civilian morale.
[539] DOD LOAC Manual, *supra* note 19 ¶ 5.12.2.1. (Also citing statements from the U.K., Germany, and the Netherlands to this effect.).
[540] *Ibid.*
[541] Steven J. Bruger, "Not Ready for the First Space War: What About the Second?" (1995) 48:1 Naval War College Rev. at 73.
[542] *Ibid.* at 75-79
[543] *Ibid.* at 76

effect. This was both made possible by satellite usage and navigation,[544] but also by the absence of satellite reconnaissance available to Iraqi.[545] Satellite utilization was astoundingly critical to the results of the war, and therefore the military advantage to be gained by disabling or destroying such means—either as existed for the Coalition or as hypothetically could have for Iraq—would have been, if not quite incalculable, massive.

Any such destruction is weighed against the potential civilian damage or loss. First, the attacker has to assess what damage is anticipated or foreseeable.[546] A state may be responsible for the reasonably direct effects of destroying a power plant, resulting from the damage itself and that resulting from a power outage among the civilians who rely upon it, but not the economic effects of those who lost their jobs working there because the plant was destroyed.[547]They would also consider the reasonably likely effects of ammunition, but not remote or unlikely effects: the circular error probable for a missile or bomb would be a factor in assessing collateral damage, but the harm that may result if a bomb fails to detonate until much later would not be considered, unless that bomb had a known defect making it likely to do so.[548] Commenters have stated that "mere inconveniences" are not considered, citing to food shortages, blackouts, and economic troubles being the inevitable result of war.[549] Dinstein, however, merely points to the unintended effects of war, such as defensive or rationing-induced blackouts, as those which do not count, and Boothby contends that deprivations do not count if they arise from actions which do not constitute attacks.[550] That is to say, while incidental and unintended inconveniences may not be counted, the inconveniences and losses borne by civilians from the likely effects of attacks should be. Destroying a satellite and thereby depriving civilians of the ability to utilize it for navigation would be an effect which should be factored in an attack.

While ordinarily this includes civilian lives and property, the calculus in space comes down to two sets of actions: damage to other satellites themselves, via debris, and the secondary

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[544] Jay Bennett, "Space War: How the Air Force Plans to Defend the Final Frontier" (Nov. 6, 2017) Popular Mechanics (quoting Air Force Space Command Commander General John Raymond, "Going through a desert, at night, without roads and maps—it was all enabled by GPS".).
[545] Bruger, *supra* note 541 at 80.
[546] Dinstein, *supra* note 430 at 157.
[547] DOD LOAC Manual, *supra* note 19 ¶ 5.12.1.2.
[548] *Ibid.*
[549] *Ibid.*, n.385. (*citing* Dinstein, *supra* note 430 at 149. Boothby, *The Law of Targeting*, *supra* note 507 at 370.).
[550] *Ibid.*

effects of the destruction or disabling of satellites or their signals on Earth, whether from dual-use satellites that are intended targets or satellites which may be affected by debris.[551]

This comparison is inherently difficult. The nature of a military advantage may be nebulous. The range of possibilities in both advantage and damage could be vast, with a great deal of uncertainty as to either. Most importantly, the two features are not like things. It is not a comparison of the number of lives lost, property damaged, or dollar value in civilian damage nad those saved by obtaining a military advantage.[552] Instead, an attacker must weigh, for instance, several potential civilian casualties against the tactical and strategic value in destroying a bridge in the course of a battle.[553] This is a bit like asking if the letter "A" is larger than the color "red." Some have said the comparison is "so complicated, needs to take into account such a huge amount of data and so many factors, that any attempt to design a formula which is both comprehensive and precise would be ridiculous."[554]

Proportionality concerns in space may lead states to the conclusion that use of kinetic ASAT capabilities other than in a very LEO would, in many or most circumstances, cause disproportionate damage to civilian objects. There is uncertainty about the long-term effects of more satellites debris, but extant examples of collisions, damage, and maneuvers to avoid the same abound.[555] It is well-known from experience, including from ASAT tests specifically, that higher-altitude explosions lead to longer-lasting debris, even in the context of LEO.[556] The fact that destruction of one—or more—satellites in orbit will to a near-certainty produce a large debris field in a crowded orbital plane for a period of years raises the considerable risk of doing tens or hundreds of millions of dollars of damage to those satellites alone.

On top of that, the destruction of particular sets of satellites—for example, those used for GPS or weather communication—can have reasonably ascertainable effects on the civilian economy. While a state need not account for all inconveniences—a temporary delay in consumer using their personal devices to navigate while going about their day-to-day business is certainly a minor inconvenience—the overall impact of the destruction of a satellite with a defined role in

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[551] Boothby, "Space Weapons and the Law" *supra* note 215 at 189. Boothby, *The Law of Targeting*, *supra* note 507 at 370.
[552] Dinstein, *supra* note 430 at 154.
[553] *Ibid.* at 156 (Whether a bridge is worth five or fifty lives may depend greatly on the individual circumstances.).
[554] Stefan Oeter, "Methods and Means of Combat" in *The Handbook of International Humanitarian Law* (Dieter Fleck ed., 2d ed. 2008). at 198.
[555] See notes 113, 114, & 120.
[556] As in the results from tests by China, the U.S., and India, discussed above.

the civilian economy, or the risk of damaging any number of satellites in an orbit over a period of years, renders the cost to civilians of most kinetic ASAT attacks high.

It is not precisely known how states will view these obligations, for the reasons that govern much of the opacity in these matters: little is public. As has been discussed, while objections have been raised to tests and development of kinetic ASATs, they are rarely grounded in strictly legal objections.[557] Of the four kinetic ASAT states, the United States has indicated it is likely to use kinetic ASATs at a last resort.[558] It revealed a policy of incrementalism, utilizing "destruction" as its final approach if lesser means are not sufficient.[559] Critically, however, neither it nor any other ASAT power has publicly announced legal restrictions upon the use of their kinetic ASAT capabilities. This does not mean they do not have any such restrictions, only that those are not publicly-known.[560]

Many scholars have offered viewpoints on the likely outcome of such an analysis in outer space. Georgeson and Stubbs are doubtful that the nebulous concept of proportionality will adequately limit kinetic ASATs, owing to the lack of foreseeability of damage: an indeterminate amount of debris in orbit for a period of time does not necessarily correlate with a defined risk of damage to satellites.[561]Schmitt argues that there is little risk in general from space attacks due to the lack of anything in proximity to satellites, but that there is "some risk" of debris harming other satellites.[562]

Others are more doubtful. Boothby states that use of destructive ASAT capabilities in parts of orbit where fragments may remain indefinitely, such as MEO or GEO, "may breach Article 51(4)(c)" for being inherently indiscriminate.[563] He also indicates that the damage to civilian networks from attacks on dual use satellites would have to be considered before an

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[557] *See supra* notes 401 & 402.
[558] *See* Schmitt, "International Law and Military Operations in Space" *supra* note 232 at 119.
[559] *Ibid.*
[560] For good reason: a state that made its precise strategy known—for instance, that it would forego kinetic attacks under most circumstances—might inspire adversaries to focus resources on defending against interference and other lesser means. This is the reason Rules of Engagement are usually classified. *See* Peter Rowe, "International Humanitarian Law: Think Piece: The Rules of Engagement in Occupied Territory: Should They be Published?" (2007) 8 Melbourne J. of Int'l Law 327 at 330 n.15.
[561] Georgeson & Stubbs, *supra* note 348 at 659.
[562] Schmitt, "International Law and Military Operations in Space" *supra* note 232 at 118-19.
[563] Boothby, "Space Weapons and the Law" *supra* note 215 at 188. As discussed above, likely kinetic ASATs could be used in LEO—indeed, all have been—so unless a weapon is designed specifically for use in higher orbits, that may not be inherently indiscriminate. However, using an otherwise legal weapon in MEO or GEO may well be an illegal use of that weapon.

attack.[564] Koplow suggests that while proportionality may not limit *all* kinetic ASAT attacks, "most kinetic ASAT strikes would be of dubious legality."[565] Bourbonnière considers the use of kinetic ASATs legally "questionable" at best.[566]

One interesting result of this analysis is the proposal for a "soft kill" requirement: that should a state possess the ability to disable a satellite with non-kinetic means, it must do so in lieu of using kinetic means.[567] This appears to mirror the proposal for a "least harmful means" rule discussed above. However, it has much stronger support in existing law. The "least harmful means" rule imposes a new requirement in the considerations of combat that would overrule prior considerations that military members are targets during warfare without further discussion.

The soft kill rule, by contrast, applies existing legal requirements to a new situation without modifying or adding to the rule. An otherwise legitimate attack may do damage to civilian objects, but another means or method may achieve the same advantage without doing so. It is no "new" rule at all, but a particular application of an extant one.[568] The so-called "Precautionary Principle" or "Take Care Clause," as has been referenced, requires a choice of the least destructive means to civilians among comparable choice.[569] More broadly, it mandates "constant care" be taken to ensure harm to civilians is limited.[570]

The concept is consistent with the established legal requirements. The questions faced by one reviewing different space weaponry, from kinetic ASATs to direct energy to spoofing and jamming technologies, include the degree to which destruction of a satellite—or more than one—might do excessive collateral damage, and whether other lesser means would be effective to accomplish the mission. A state must weigh its options based on the technology available to it: a state with equal kinetic and non-kinetic means may have to choose non-kinetic means, whereas a state with only kinetic might be able to engage in such an attack—provided it met the proportionality principle.[571]

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[564] *Ibid.* at 189.
[565] Koplow, "Asat-isfaction" *supra* note 45 at 1247.
[566] Bourbonnière, "*Jus in Bello Satellitis*" *supra* note 24 at 69.
[567] *Ibid.* at 622. Schmitt, "International Law and Military Operations in Space" *supra* note 232 at 120.
[568] *See* Additional Protocol I, *supra* note 14, Art. 57(3).
[569] *Ibid.*
[570] *Ibid.*, Art. 57(1).
[571] Ramey, *supra* note 4 at 38 & n.160. (*quoting* Michael N. Schmitt, "Bellum Americanum: The U.S. View of Twenty-First Century War and its Possible Implications for the Law of Armed Conflict" (1998) 19 Mich. J. Int'l L. 1051 at 1088. ("The law of armed conflict is designed primarily to minimize suffering and prevent unnecessary destruction. This being so, belligerents are held to the standards to which they are capable of rising.")).

The great "unknown" is the capability of militaries to utilize soft kill or other disabling techniques in practice. There exists dramatic proof-of-concept of states physically destroying satellites. It is far less clear if states possess commensurate abilities with non-kinetic techniques.[572] While the states themselves may well have a good idea as to the quality of their capabilities, neither kinetic nor non-kinetic uses—other than simple ground-based, localized jamming—have been proven to have been utilized in wartime, leading even those states with such capabilities to wonder as to their effectiveness in full combat operations against a foe with untested defensive capabilities.

This is critical because, for a state to be required to utilize a less destructive means as a matter of law, there must be a close comparison between the two possibilities. An attack cannot be required to utilize substantially less effective or unproven techniques. Instead, states have broad authority to undertake necessary matters of defense.[573] Therefore, from the outside and without examples in practice, it is especially difficult to draw a definitive conclusion as to how states will view the comparability of the means available to them, and whether they believe they *have* to utilize non-kinetic means first.

A legal review of ASAT capabilities will almost assuredly identify "issues" with potential use that could violate proportionality. Whether particular types of attack are understood by those states to violate those requirements—and when—is going to depend a great deal on the state's capabilities, the nature of the struggle it finds itself involved in, and how it views the uncertainty of the impact of debris upon the space environment.

One is left to doubt that any such attack would be illegal under all circumstances, no matter how destructive. If the comparison from the Gulf War is any indication, destruction of satellite capabilities would be of immense value in many war-fighting situations. The ICJ was unwilling to declare the use of nuclear weapons illegal if a state were facing annihilation.[574] If those immensely powerful weapons, which prompted J. Robert Oppenheimer to quip, upon birthing them, that he had "become Death, destroyer of worlds",[575] are legal to use in some instances, it is unlikely the law, or a state's interpretation of it, will restrict anti-satellite warfare

[572] Though it is worth remembering all successful results of kinetic ASATs are tests on a state's own targets, rather than a potentially evasive enemy target in war-time.
[573] *See* note 515.
[574] *Nuclear Weapons Opinion*, *supra* note 254 at 263.
[575] James A. Hijya, "The *Gita* of J. Robert Oppenheimer" (Jun. 2, 2000) 144:2 American Philosophical Society 123 at 123.

in a serious conflict. Taking this signal, at a minimum it appears unlikely that a state—faced with a war in which its survival may be at stake—would find legal hesitancy to utilize anti-satellite capabilities.

E. The Value of Targeting Concepts in Legal Reviews

The above is not meant to be a comprehensive review of targeting law in outer space.[576] Instead, it is important to recognize that while legal reviews of new weapons are not likely to find many space weapons illegal *per se*, they may detect issues with the particular manner in which they are to be utilized, including potentially identifying ways in which such use will or could violate the laws of war.

Initially, this appears to fail to provide an effective limit on the spread of the weapons of war into space. For the reasons discussed above, many of these decisions cannot be made until faced in an actual war, or else the inputs are too abstract. When faced with serious threats to their survival, states may have the leeway to take nearly any action to ensure their survival. While scholars have commented as to how they think particular attacks might interact with international law, no one knows how states—the prime actors in this field—view the issues or will act when faced with a real-world situation. Pointing out the issues a state must consider or offering an assessment as to the proper legal outcome on a particular use of a weapon does not meaningfully answer the question as to when such attacks *would* be illegal, particularly as determined by the states who will be the ones to use, or not, the weapons in question.

Even accepting scholarly attempts to answer the question, the most that can be said is the potential outer limits of when an attack might be allowed or might not be is as far as one can go. Use of any and all space means available is probably legal when facing annihilation. Use of kinetic ASATs may not be justified in a very minor skirmish. In any conflict falling between those extremes, the uncertainty involved renders any assessment in advance difficult to impossible to make with any accuracy.

This understates the value that comes from early legal review of a weapon or weapons system. The reviews in most cases will consider those targeting and operational principles and identify potential limitations, well in advance of deployment and use.[577] In turn, this can

[576] For fuller treatment of this concept, *see* Bourbonnière, "*Jus in Bello Satellitis*" *supra* note 24. Georgeson & Stubbs, *supra* note 348.
[577] See *supra* notes 475-478.

motivate the state to pre-emptively consider its doctrinal and strategic approach as a whole, taking into consideration the legal limitations *before* being in a combat situation.

Consider as an example the United States doctrine, such as it is publicly known, in the use of force and weapons in outer space. In 2004, the U.S. Air Force discussed the "Five D's" in counterspace operations: deception, disruption, denial, degradation, and destruction.[578] The document also outlined potential targets for such offensive capabilities: on-orbit satellites; communication links; ground stations; launch facilities; command, control, communication, computer, and ISR systems; and third-party assets, when used by the enemy.[579] The Air Force declared that the choice of target and means depended upon the situation, though there was a stated preference to avoid means which could cause harm to "friendly forces."[580] Discussion of explicit legal limits was omitted, instead leaving the commentary to a reminder that a judge advocate should be involved in all phases of planning to ensure compliance with the law.[581] It also stated "There may be times when temporary, reversible counterspace operations prove more appropriate than operations that permanently degrade or destroy space capabilities."[582]

However, though the document, by design, is vague, there are hints that limitations on usage are prioritized more highly than is let on. For instance, when discussing the approval authority—the level of commander necessary to authorize an action without higher approval—it warns that "Certain counterspace operations carry greater consequence than others. For example, operations against on-orbit systems may have greater consequences than those against satellite ground stations."[583] While the particular level of approval for different space operations is not specified, "Approval authority should be delegated to the lowest level …However, depending on the potential effect of the operation, approval authority may be held at the most senior levels."[584] Of considerable note, the 2008 operation Burnt Frost to shoot down the malfunctioning satellite was approved by President George W. Bush.[585]

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[578] U.S. Air Force Doctrine Document 2-2.1, "Counterspace Operations" (Aug. 2, 2004) at 31.
[579] *Ibid.* at 32-33.
[580] *Ibid.* at 33.
[581] *Ibid.* at 39
[582] *Ibid.* at 40. It also declares a preference for "minimizing unintended consequences," though this is stated generally and not specifically linked to debris. *Ibid.* at 24.
[583] *Ibid.* at 42.
[584] *Ibid.*
[585] Dwayne A. Day, "Burning Frost, the View From the Ground: Shooting Down a Spy Satellite in 2008" (Jun. 21, 2021) Space Review, online: <www.thespacereview.com/article/4198/1>[perma.cc/65HP-A2SD].

In its most recent iteration, the doctrine reiterates the targeting options without an open preferential order.[586] It more accurately spells out authorities for action, in particular noting the Space Coordinating Authority (SCA), who is tasked with the coordination between the combatant command—the command which is requesting the use of force—and the Space Operations unit—which is involved in the decision-making process on how best to effectuate the desired effects.[587] Though the document doesn't specify the precise command level involved with a decision to, for instance, launch kinetic ASATs, it mandates coordination between the combatant command and Space Force.

Even more recently, the DOD-wide publication on Space Doctrine reiterates the five D's but refrains from indicating any preference or limitation.[588] It ensures legal analysis accompanies decisions at all levels of planning.[589] The doctrine mandates that planning and doctrine are considered along with the principles of the National Space Plan, National Strategy for Space, DOD Space Policy, and Defense Space Strategy, which are created at varying high levels of the executive branch.[590]

For reasons elaborated on previously, none of these documents lay out a precise statement of U.S. legal policy on the use of weapons in and around outer space, or how it would particularly resolve some of the issues identified here. What it does do is create and institutionalize rules and norms guiding the decision-making for actions in outer space, in an area where such norms are far from institutionalized.[591]

The development and possible uses of weaponry strongly influence the development of security and military doctrine.[592] States review the development of their doctrine for legal issues, as they would with specific weapons or operations.[593] SIPRI contends that the U.S. does not

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[586] U.S. Air Force Doctrine Publication 3-14, "Counterspace Operations" (Aug. 27, 2018).
[587] *Ibid.* at 1-2.
[588] JP 3-14, Space Operations, *supra* note 523, ¶ 3(b). (Discussing Offensive Space Control (OSC) options.).
[589] *Ibid.*, ¶ 3(d).
[590] *Ibid.*, ¶ 3(b).
[591] Thompson, *supra* note 13 at 158-59. *See also* discussion of the European Union Code of Conduct, *supra* note 469-470, for attempts to fill this void.
[592] Charles J. Moxley, Jr., John Burroughs, & Jonathan Granoff, "Nuclear Weapons and International Law: A Nuclear Nonproliferation Regime for the 21st Century: Nuclear Weapons and Compliance with International Humanitarian Law and the Nuclear Non-Proliferation Treaty" (2011) 34 Fordham Int'l L.J. 595 at 677. ("The possible use of [nuclear] weapons is an important factor in the structure of their military establishments, the development of their security doctrines and strategy…").
[593] SIPRI Compendium, *supra* note 181, at 3-4, 6, 8, 17. (Belgium, Germany, the Netherlands, the United Kingdom, respectively.).

specifically require legal reviews of the development of doctrine, but "in practice, such reviews may be conducted as part of advice to the writers of military doctrine" and "DOD policy establishes a responsibility for the heads of DOD Components to make qualified legal advisers at all levels of command available to provide advice about law of war compliance during the planning and execution of military exercises and operations."[594] The DOD itself states "commanders have implemented the requirements of the principle of proportionality through military procedures, such as rules of engagement, doctrine, standard operating procedures, and special instructions."[595] Norway dictates that means and methods are incorporated along with operational planning and operational manuals, all of which are assessed for their legality under international law.[596] For the United Kingdom, legal reviews of weapons and means and methods of warfare are conducted by the Development Concepts and Doctrine Centre which also develops overall doctrine.[597]

This is not surprising, since a state will not invest resources into development of capabilities unless it has a sense of how they will fit into their larger strategic picture, nor will a state endorse larger-scale policies or strategies that don't comply with its international legal obligations. The legal review process ensures the issues are identified early, incorporated into the legal concerns that come with operations and doctrine, and ensure actions such as raising significant decisions to use weapons with significant issues or concerns to a commander or leader at the appropriate level who can appreciate the risks and issues.

A state that has resolved in advance to utilize kinetic ASATs as a last resort, or only in certain low-orbit trajectories, is in a better position to resist using them. First, it has developed a doctrine, passed on to its members, on the use of the weaponry. Knowing a particular method of warfare will often or likely not be available in most situations allows the commanders to incorporate that into their planning. To use an obvious example, American commanders in the Iraq War understood their superiors were unlikely as a matter of law and doctrine to authorize use of nuclear weapons, so they would have planned operations around the means more reasonably available and likely to be approved. During the Cold War, the American and Soviet planners had to incorporate their doctrinal assumptions about the use of nuclear weapons into,

[594] *Ibid.* at 21.
[595] DOD LOAC Manual, *supra* note 19, ¶ 5.10.3.
[596] Norwegian Directive, *supra* note 208, ¶ 2.4.
[597] U.K. Weapons Review, *supra* note 242 at 3.

for instance, deciding how much to rely on ground forces in defending their respective spheres of Europe.[598]

Second, it allows the state to identify concerns and withhold decision-making to an appropriate level. Given the long-term and potentially catastrophic consequences that could flow from kinetic ASAT attacks, a state could place the decision to utilize such attacks at any arbitrarily high level—its civilian leadership, or a general officer at a top command. This allows for proper consideration of the full and long-term effects.[599]

It is through these means, especially through proactive early consideration of legal issues, that will help will develop appropriate limitations on space weaponry. In turn, this early analysis allows—and helps ensure—the elevation of those issues in developing how those weapons can be used to a higher doctrinal and strategic level, since those decisions need to be integrated with the larger strategic concerns of the state. As opposed to creating a risk of pressure to use a weapon because it exists, it counterbalances that concern by elevating the risk to higher levels.

The example of nuclear weapons is instructive. In 1945, the United States dropped atomic bombs on Hiroshima and Nagasaki, Japan, the only two instances of such weapons being used in conflict. Nuclear weapons proliferation began as the Soviet Union developed nuclear weapons, leading to fears of a nuclear Armageddon. Gradually, states entered into a number of agreements to limit the testing, deployment, and proliferation of such weapons, including the Nuclear Non-Proliferation Treaty, Partial Test-Ban Treaty, and Comprehensive Nuclear Test Ban Treaty.[600] Such agreements have had mixed results. Some testing regimes, such as the PTBT, have been hailed as successes in limiting testing.[601] Conversely, the Comprehensive Nuclear Test Ban Treaty never entered into force due to a number of states such as the United States failing to ratify it, or in the case of North Korea, Pakistan, and India, declining to sign.[602] Since the

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[598] "Russian/Soviet Doctrine" (Sep. 4, 2000) Federation of American Scientists, online: <fas.org/nuke/guide/russia/doctrine/intro.htm> [perma.cc/3ECX-STL5]. (For instance, looking at Soviet planning evolution. In the early 1960's, Soviets planned around tactical use of nuclear weapons rather than overwhelming traditional ground forces. Later, as it doubted the viability of a nuclear exchange, it was forced to build up traditional forces.).

[599] JP 3-14, Space Operations, *supra* note 523, ¶ 3(b). *Cf* DOD LOAC Manual, *supra* note 19 ¶ 5.10.2.1. (A commander at the appropriate level will have an appreciation for the full scope of an operation including its risks and gains, and it is important that a commander without the proper level of awareness not be responsible for making those decisions.).

[600] Masahiko Asada, "CTBT: Legal Questions Arising from Its Non-Entry-Into-Force" (2002) C&S Law 2002 7(85)

[601] *See* note 278.

[602] Winston P. Nagan & Erin K. Slemmens, "National Security Policy and Ratification of the Comprehensive Test Ban Treaty" (2009) 32 Hous. J. Int'l L. 1 at 90.

creation of the Non-Proliferation regime in 1968, nuclear weapons have been limited, but still spread to India, Pakistan, North Korea, and Israel.[603]

Despite nuclear weapons causing devastating, widespread, and long-lasting damage, the weapons were *not* declared illegal in all circumstances by the ICJ, though it labelled certain uses as illegal.[604] Only one state—South Africa—has voluntarily given up nuclear weapons after developing them.[605] Even with the restrictions that come with non-proliferation agreements, states have endeavored, sometimes successfully, sometimes not, to develop nuclear weapons.[606] Thus, despite potential negative diplomatic and economic consequences and with likely legal restrictions on the way the weapons can be used, the security concerns of states have driven many non-nuclear states to develop nuclear weapons.

And yet, despite this proliferation of weaponry and legal failure to bar the weapons *per se*, no weapons have been used since 1945. This has not been for a lack of willingness on the part of some actors. In the Korean War, great controversy ensued as U.N. commander Douglas MacArthur advocated deploying and using nuclear weapons on mainland China as a means of bringing the conflict to an end more satisfactory to the U.N., but was overruled by President Harry Truman.[607] During the Cuban Missile Crisis, the U.S. and Soviet Union engaged in a tense standoff over the deployment of Soviet missiles to Cuba, but neither side engaged in kinetic or nuclear warfare.[608] In Vietnam, the U.S. commander, General Westmoreland, authorized the movement of nuclear weapons to South Vietnam to be ready to use should the situation arise, only to have the order countermanded by President Lyndon Johnson.[609] One direct, albeit limited, military action has been fought between nuclear powers—the Kargil War, between India and Pakistan,[610] along with countless "proxy wars" between various nuclear powers, from Korea to Vietnam to Syria, all without nuclear weapons being utilized.

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[603] Moxley, *et al*., *supra* note 592 at 598.
[604] *See generally Nuclear Weapons Opinion*, *supra* note 254.
[605] Ramey, *supra* note 4 at 12. Although some Soviet successor states also turned the weapons they inherited at the Soviet Union's dissolution over to Russia.
[606] Moxley, *et al*., *supra* note 592 at 598.
[607] Se Young Jang, "How the Korean War Put the President in Charge of Nuclear Weapons" (Jan. 2, 2018) Washington Post.
[608] *See* Yoo, *supra* note 81 at 167.
[609] David Sanger, "U.S. General Considered Nuclear Response in Vietnam War, Cables Show" (Oct. 6, 2018) NY Times. Khlaid Elhassan, "FRACTURE JAW: The Plan to Nuke North Vietnam" (Aug. 10, 2019) History Collection, online: <historycollection.com/fracture-jaw-the-plan-to-nuke-north-vietnam> [perma.cc/V4N9-NCTH].
[610] Ashley J. Tellis, C. Christine Fair, & Jamison Jo Medby, "Limited Conflicts Under the Nuclear Umbrella: Indian and Pakistani Lessons from the Kargil Crisis" (Santa Monica, CA: RAND Corporation, 2001).

Nuclear weapons, then, are comparable to space weaponry, especially ASAT technology, in that it is technologically complex, expensive, and time-consuming to develop; has the potential to cause widespread destruction and raises attendant concerns in international relations and among the public; but may be seen by states as an important to maintain security as a virtual necessity to ensure their security and influence, and so may develop such weapons even with the concerns about their effects.

The experience with nuclear weapons presents the optimistic case for slow development of the law and space weaponry, in the following ways. First, even with formal treaty limitations placed on the proliferation of nuclear weapons, states *have* developed the weapons.. In the case of space weapons, states may not even need full orbital technology to create usable ASAT weapons.[611] Relying on international agreements to limit development may not be useful in absolutely limiting weapons. This is particularly true as the technology behind most forms of space weaponry is inextricably tied to perfectly legitimate means and methods: missiles, launch vehicle, satellites, communications signals, and satellite tracking. Moreover, states that do not have the weaponry will be less likely to agree to arms control, which would lock them in place behind other nations in arms development.

This is borne out by the failure of the PPWT to gain traction, or any other meaningful agreements to take hold. States will not enter agreements or adopt legal positions that threaten their own security. To the extent proposed solutions to the concerns about war in space simply call for states to enter into such agreements, it is plain that, at present, there is no appetite for it. And as nuclear proliferation suggests, even with the existence of agreements, weapons systems will be developed if states find them in their interest. This further takes the wind out of the sails of such demands, since even if an agreement were in states' interests, it may not be effective.

Second, though they may be slow to come about, international agreements *can* develop, and provide useful regimes for limiting warfare. While evaluating the nuclear proliferation regime is well beyond the scope of this Thesis, it is noteworthy that states which may be attempting to obtain nuclear weapons, or those that have done so, were forced to go through long, expensive, arduous paths to achieve them, in part because of the restrictions.[612]

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[611] Koplow, "An Inference About Interference" *supra* note 143 at 806.

[612] *See, e.g,* the case of North Korea, facing U.N. Security Council Resolutions for testing nuclear weapons. S.C. Res. 1718, U.N. Doc. S/RES/1718 (Oct. 14, 2006). S.C. Res. 1874, U.N. Doc. S/RES/1874 (June 12, 2009).

Commenters have hailed the anti-testing regimes as successful in restricting or limiting tests and their negative effects on the environment.[613]

In the context of anti-satellite weapons, both kinetic and those that may merely disable or damage satellites, the overarching concern is that use or testing may quickly ruin the outer space environment for everyone. The concerns identified in legal reviews of such systems can, when incorporated with the state's view of doctrine and strategy, place internal limits on a state's use and develop the norm of non-use internally, while buying the necessary time for those norms to coalesce across nations, leading to more formal limitations and agreements. The development of trust and cooperation sufficient to form useful, formal nuclear limitations took decades, for instance.[614]

Third, while nuclear weapons were outside the purview of Article 36, as they predated the Article for most nuclear states, and not subject to a review as such, proceedings such as the ICJ opinion reveal the extent to which legal concerns framed states' conceptions of those weapons. States, and particularly the nuclear weapons states, for example, developed arguments and opinions on when they believed they could utilize their nuclear weapons for national defense.[615] States argued they could be used pursuant to legal norms in self-defense, consistent with existing law.[616] This, along with the development of norms and procedures governing their deployment and use, indicates a role for the legal regime in governing planning around development and use of weapons. Coupled with the statements of various states as to how legal considerations are incorporated from weapons development through doctrinal planning, one can expect similar considerations to play a role in space weaponry.

This Thesis is not meant to explore the full strategic and game theory analytics behind decisions to design, expand, and use—or threaten to use—new weapons technology, a force that in international politics often drives diplomatic, legal, and normative developments. Instead, the point is to examine the legal regime and understand the ways in which such a regime will be applied in the anarchic, self-interested system of international law and politics that pervades. In

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[613] *See* note 278.
[614] John Yoo, "Embracing the Machines: Rationalist War and New Weapons Technologies" (2017) 105 Calif. L. Rev. 443 at 475.
[615] *Nuclear Weapons Opinion*, *supra* note 254 at 245 (State positions applying proportionality); 252 (State positions regarding interpretation of Treaty law); 254 (State positions on use and threat for deterrence.); 261 (U.S. and U.K. views on valid use in self-defense).
[616] *Ibid.* at 261.

such a system, the hope of many commenters that states reach new agreements of interpretation of law to fill the void and limit warfare in space is misplaced.[617] With no extant power able to force agreement or a change in law, and the states themselves showing no collective will to reach agreement, however grand such ideas are, they do not truly propose an effective solution, any more than the Kellogg-Briand Pact's declaration that war is illegal forestalled armed conflict.[618]

However concerning the prospect of warfare in space might be, the present process, though limited, can act to limit actors sufficiently to deter unwise, potentially illegal, and ultimately self-destructive behavior. The legal review process and its early analysis of the pitfalls of the use of space weaponry may not result in outright restrictions of the development of weapons. However, it is likely to force states to confront the legal limits of the prospective Frankenstein's monster that could be unleashed. This process, early and ingrained in the development of states' defense strategies, will likely serve to place appropriate limits on the excesses of such weapons, while permitting states the freedom of action that they desire and will not concede with ease.

Conclusion

Regrettably, warfare will remain part of the human condition for the foreseeable future. Humanity's spread to space might make warfare in space appear inevitable, too. Certainly, states have utilized space in warfare, and have made preparations to engage in warfare in space should the need arise.

Despite the gathering of dark clouds on the horizon, those weapons, means, and methods of warfare have not been unleashed in outer space. Their development has been guided by the legal requirements to ensure those weapons comply with the laws of armed conflict, under Article 36 of Additional Protocol I. The laws of armed conflict were designed with terrestrial warfare in mind, and will not act to restrict many space weapons outright. However, the laws will likely place limits on the specific uses of such weapons. The issues and concerns they will identify in those reviews will help limit and shape the development of the rules, norms, and

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[617] *See supra* note 465.

[618] "The Kellogg-Briand Pact, 1928" U.S. Dep't of State, Office of the Historian, online: <history.state.gov/milestones/1921-1936/kellogg> [perma.cc/6UZB-N7JJ]. ("The Kellogg-Briand Pact was an agreement to outlaw war …but it had little effect in stopping the rising militarism of the 1930s or preventing World War II."). General Treaty for Renunciation of War as an Instrument of National Policy, Aug. 27, 1928, 46 Stat. 2343, 94 L.N.T.S. 57 (entered into force Jul. 24, 1929).

doctrines designed to use those weapons. That in turn will help place effective limits on their usage, buying time for the development of more formal and effective limitations.

While there is good reason to be concerned about the devastation that could befall outer space should total war extend there, the legal processes in place to review and consider the legalities of those outer space weapons can place limits on their usage and ensure their compliance with the rules of war.

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